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EFFECT OF GRAPHICAL-SYMBOL TEACHING APPROACH ON SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN NUMBER AND NUMERATION IN ANAMBRA STATE

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ABSTRACT

The study investigated the effect of graphical-symbol teaching approach on secondary school students' academic achievement in number and numeration in Anambra State. Four research questions and seven hypotheses guided the study. It study adopted quasi-experimental design, specifically; pre-test post-test nonrandomized control design was used. The population comprised 18,336 (7,966 males and 10,370 females) Senior Secondary two (SS2) students. A sample size of 280 SS2 students (119 males and 161 females) drawn using multi-stage sampling procedure from six out of 49 Co-educational secondary schools in Awka Education Zone was involved in the study two from department of science education and measurement and evaluation both in faculty of education Nnamdi Azikiwe University Awka and one from the department of Mathematics Education Federal College of Education (Technical) Umunze. Number and Numeration Achievement Test (NNAT) were used for data collection. The instruments were validated by three expects. Kuder- Richardson (K-R 20) was used to determine the reliability coefficient of NNAT which was found to be .85 respectively. The experimental procedure was done using the stages in GSTA in treatment groups and stages in TTA. Mean and standard deviation were used to answer the research questions while analysis of covariance was used to test the null hypotheses at .05 alpha levels. The findings of the study revealed among others that, students taught number and numeration using graphical-symbol teaching approach (GSTA) had higher mean achievement scores than those taught using traditional teaching approach (TTA). Hence, there are significant differences between the mean achievement scores of students taught number and numeration in favour of GSTA group. Also, GSTA enhanced male and female students' achievement in number and numeration more than the TTA. Based on the findings it was recommended that secondary school teachers of Mathematics should adopt the use of GSTA when teaching number and numeration (branch of

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Mathematics). Also, Ministry of Education in partnership with STAN and MAN should train in-service Mathematics teachers on the use of GSTA in form of Mathematics instruction.

Key word: Graphical-Symbol, Teaching Approach, Students, Academic Achievement and Number and Numeration.

Introduction

Science Technology Engineering and Mathematics (STEM) is established to help train young individual learners to grow in the areas of science, technology, engineering and mathematics for stable and improved technological society. Technology, science and mathematics are regarded as a vehicle for economic and social development in a country. This can only be possible depending on the quality of scientists and Mathematicians produced through science education. This implies that nation's advancement in science depends to a large extent on its strong Mathematics education programmes.

Mathematics is an essential discipline that is recognized as a tool for solving everyday problem faced by individuals. According to Santosh and Laurent (2015), Mathematics is a methodical application of matter because the subject makes a man and its environment methodical and systematic. The authors further asserted that, Mathematics is the cradle of all creations, without which the world cannot move an inch. For example, the cooks, farmers, carpenters, mechanic, shop keeper, doctors, magicians and so on, all needs Mathematics in their day to day life. Lathan (2021) concluded that all animals use Mathematics in everyday of their life for existence.

Snails make their shells, spiders design their webs, and bees build hexagonal combs; there are countless examples of mathematical patterns in nature's fabric. According to Lathan (2021), anyone can be a mathematician and posses Mathematics knowledge, if the individual or person is given proper guidance and training in formative period. This is because, Mathematics knowledge is used to enhance a person's reasoning, problem-solving skills and in general, the ability to think. Sunday, Akamu and Fajiemidegba (2014) stated that Mathematics knowledge makes every living individual life orderly and prevent chaos. They also added that, certain qualities that are nurtured through Mathematics knowledge are the power of reasoning, creativity, abstract or spatial thinking, critical thinking, problem-solving ability or ability to solve problem and even effective communication skills.

One of the trusted instruments for solving problem or challenges facing the society is Mathematics which is widely regarded as the science of all sciences and art of all arts which has its branches (Scholer and Amalraj, 2016). According to Scholer and Amalraj, the branches of Mathematics include number theory, algebra, geometry, arithmetic, combinatoric, topology and Mathematical analysis. Numbers theory is one of the branches of Mathematics concerned with

properties of the positive integers (eg 1, 2, 3, …). Sometimes it is called higher arithmetic and it is one of the oldest and most natural of mathematical pursuits. Algebra deals with symbols or variables and uses arithmetic operations like +, -, x and ÷ to find the unknown quantities represented by these variable (Irshad *et al*, 2018). Irshad *et al* further asserted that geometry is the branch of Mathematics that is concerned with the shape of individual objects, spatial relationships among various object and the properties of surrounding space.

Arithmetic consists of the study of numbers, especially concerning the properties of the traditional operations of them, that is, addition, subtraction, multiplication, division, exponentiation and extraction of roots (Santosh and Leurent, 2015). Combinatoric is the field of Mathematics concerned with problems of selection, arrangement and operation within a finite or discrete system. Topology is a branch of Mathematics, sometimes referred to as rubber sheet geometry while mathematical analysis is the branch of Mathematics that is dealing with limits and related theories such as differentiation, integration, measure, sequence, series and analytic functions. All these branches of Mathematics are used to find solutions to everyday life problems such as power supply and food production. This stands to reason therefore that Mathematics can be applied to every aspect of things in life including the economic development of any country like Nigeria according to Okigbo and Okeke (2017).

Despite the importance of Mathematics to national development of any nation like Nigeria, the achievement in Mathematics by senior secondary school students in Nigeria is not quite encouraging just as shown by the data collected from WAEC office Anambra state. In the year 2013, out of 1,238,163 that enrolled in May/June WAEC Mathematics examination only 676,860 passed with grades A1 to C6 containing only 54.67% of the students that enrolled. Secondarily, in the year 2014, out of 1,259,964 that enrolled in May/June WAEC Mathematics examination only 485,664 passed with grades A1 to C6 containing only 38.55% of the students that enrolled. In 2015, out of 1,593,442 that enrolled in May/June WAEC Mathematics examination only 544,638 passed with A1 to C6 containing only 34.18% of the students that enrolled. In 2016 out of 1,544,234 that enrolled for May/June WAEC Mathematics examination only 597,310 passed with A1 to C6 containing only 27.31% of the population of students that enrolled in the year. Similarly, out of 1,558,349, that enrolled in 2017 only 517,216 passed with A1 to C6 pass containing only 33.19%, of the population of students that enrolled in that year. In 2018, out of 1,553,727 that enrolled for May/June WAEC Mathematics examination only 467,671 passed with A1 to C6 making 30.10% of the population of students that enrolled in that year.

In 2019, out of 1,563,829 that enrolled for May/June WAEC Mathematics examination only 486,351 got up to with C6 and above making 31.10% of the

population of students that enrolled that year. In 2020, out of 1,598,442 that enrolled for May/June WAEC Mathematics examination only 559,455 got up to C6 and above making only 35.00% of the students that enrolled that year. In 2021 out of 1,573,849 only 1,274,784 got A1 to C6 and above making 81.7% of students that enrolled. Finally, in year 2022, out of 1,593,442 that enrolled in May/June WAEC Mathematics examination only 602,714 passed between C6 – A1 containing only 37.82% of the students that enrolled in WAEC that year. Going from these reports, it is clearly understood that from 2013 – 2022 (over a 10 years period), the percentage pass from A1 to C6 is not up to 50% accept in 2013 and 2021 (Appendices A pages 118 refer). However, there was a remarkable improvement recorded in 2021 (81.7%) which suddenly dropped in 2022 (37.82%). This suggests that all is not well with the teaching and learning method used in teaching Mathematics in Nigeria.

More so, the WAEC Chief examiners for Mathematics from 2013 to 2015 (from WAEC office Anambra State) reported that students performed poorly in areas of set theory, distance and bearing, inequality, vectors, statistics, numbers and numeration among others. In 2016, the WAEC Chief Examiner revealed that lack of basic mathematical tools in number and numerations may form the bases of poor performance in Mathematics in areas like approximation, rounding up and collusion among candidates. WAEC Chief Examiner's report from Anambra state in 2017 also noted inability to identify the principle or concepts to be used in solving a problem, adherence to the rubrics of question and poor interpretation of questions in the areas of number and numeration which forms the bases of mensuration, set theory and quadratic equation which were the areas the candidates had a massive failure.

In 2018, Chief examiners from Anambra State reported that candidates performed poorly in the areas of circle geometry and its application, geometrical construction, graphical solution to quadratic equation and in 2019 they reported again that candidates do not do well in the areas of set theory, graphical solution to quadratic equation. In addition, the WAEC Chief examiners' reports from Anambra state (2020 – 2022), showed that candidates performed poorly in inclusion of essential details and units, representing given information in appropriate diagram, circle geometry and its application, geometrical construction, graphical solutions to quadratic equations, reading from the graph and inadequate knowledge of drawing graphs and reading from it. According to all these reports, the poor academic achievement on Mathematics may be as a result of fundamental knowledge in Mathematics tools like in number and numerations.

The researcher is compelled to ask, could it be that the approaches used in teaching different mathematical concepts in secondary schools over the years were not proper? According to Okigbo and Okoli (2016), a teaching approach comprises the

principles and methods used by teachers to enable students learn. The authors further opined that, teaching approach determines the activities of teachers and students, the quality of the teaching process, but more importantly engage, motivate and reach the students in their classes, whether in person or online. According to Lathan (2021), there are many types of teaching approaches which include; teachers – centered, student – centered / constructivist, project based learning, Montessori, inquiry based learning, flipped classroom, co-operative learning, personalized education and graphical symbol approach. These approaches could be used in teaching various areas of science and Mathematics.

Teacher-centered approach include traditional method of teaching, direct teacher instruction, lecture teaching approach, expository method among others. Over the years, many teachers and instructors prefer this teacher-centered teaching approach hence, Omokaadejo (2015) reported that the Nigerian classroom whether primary, secondary or tertiary institutions level tends to resemble a one person show with a captain (teacher) who often command audience (students). One of the oldest teacher-centered approaches to teaching is the traditional approached / method of teaching. Guisti (2018) defined traditional approach of teaching as teacher-centered approaches to teaching in the sense that the teacher and those up in the high educational hierarchy are considered as the possessor of knowledge to be transferred to the students and such decides how the knowledge transfer takes place.

Advantages of traditional teaching approach as asserted by Gogo and Nduka (2017) include interactive, motivating, accessible, organized, punctuality, social interactions, extracurricular activities, passive listeners and face to face interactions. The author further outlined disadvantages of traditional teaching approach as thus: generalized learning, no flexible time, expensive, teacher-centered learning, time-bound, high cost, generic methodologies, theory-based lessons, physical presence of teacher and learner. This is also in line with what Oguguo and Uboh (2020) stated about disadvantages of traditional teaching approach. Based on the disadvantages of teacher-centered approach in teaching, the researcher is motivated to observe the effect of student-centered approach such as graphical-symbol teaching approach on the academic achievement of secondary school students in number and numeration (branch of Mathematics).

Graphical symbol can be defined as the representations of direct reality, which comes in the form of object, chart, diagrams, maps, sketches, cartoons and symbols. Graphical-symbol teaching approach seeks to reveal patterns which indicate the problem with either the model or the data and often are useful in suggesting ways to improve the data analysis such as in the transformation of the variables or other specification of the model. According to Santosh and Laurent (2015), graphical-symbol teaching approach is a visually perceptible figure with a particular meaning used to transmit

information independently of language. Helingo, Amin and Masriyah (2018) opined that graphical symbol teaching approach is an icon that denotes a program or a command or a data file or a concept in a graphical user interface. According to the authors, the approach can appear in form of visual images or designs to represent figures in Mathematics on some surface, such as a well, canvas, screen, paper or stone, to inform, illustrate, or entertain especially among children to represent concepts in Mathematics.

More so, in representing concepts in Mathematics using graphical teaching approaches, the teacher should observed the following procedures which includes; Choose the right type of graphic or diagram, create clear and consistent graphics and diagrams and integrate graphics and diagrams with text (Santosh and Laurent, 2019). The author further explained that, the graphics/object must be directly relevant to the content, the graphic should be big enough to be seen by the farthest students and objects/graphics also must be attractive and the image should be aesthetically presented to maintain good taste indicating that, the students learn more based on what they see and practice.

Santosh and Laurent (2015) summarized the importance of graphical symbol approach to include: facilitation and improving learning, understanding content, flexibility to use in teaching and learning, increases structured thinking, supports creative, personalized reports for more engaging and stimulating visual presentations, improves communication and ability to show the whole picture of said concept. Irshad *et al* (2018) added that, graphical symbol teaching approach is commonly used to determine whether the data support an interpretation of mixing of two potential sources or fractionation of a single source in Mathematics concepts. This is to say that, graphical symbol approach may help secondary school students understand and increase their academic achievement towards learning the Mathematics concepts.

Pinjarkar, Sherma and Selot (2018) observe that, there was no significant difference in academic achievement of male and female students in set theory using demonstration approach of teaching. The authors further asserted that students taught with demonstration approach achieve better than students taught in control group using traditional teaching approach (TTA). Nur-Hidayatul, Nur-Fatihah and Amalia (2020) however observed that, female students achieve better than their male counterpart in 100 level Mathematics exams in North Idian University due to the female high concentration in calculations related subjects. This further revealed that mental ability is related to academic achievement.

Academic achievement is the accomplishment of acquired proficiency in the achievement of an individual in a given skill or body of knowledge (Anggreni, Budyeno and Pratiwi, 2018). The authors opine that, academic achievement is considered as a key criterion to judge one's total potentiality and capabilities irrespective of gender. Ogoke and Okigbo

(2021) observed that male students taught with Planned Lesson Mode (PLM) and Modified Planned Lesson Teaching Mode (MPLTM) achieved better than their female counterpart. The authors also observed that Mathematics students taught in experimental groups of PLM and MPLTM achieved better than students taught in control group using traditional teaching approach (TTA).

Susana *et al* (2019) had a contrary opinion, hence they found that there is no significant difference in academic achievement of students in Mathematics when taught with graphical teaching method and traditional method. Also, Bichi, Suleiman and Ali (2019)'s study revealed that, overall results showed that students achieved below average and a significant gender difference exists in Mathematics in favour of female students when taught with traditional method. More so, Abin *et al* (2020) observed that female students achieved better than their male counterpart when taught Mathematics subject using traditional teaching approach (TTA). According to the researchers this could be as a result of level of curiosity among the female students to that of male students in most of Mathematics concepts. Hwang and Soni (2021) however reported that male students achieve better in Mathematics concepts than the female students due to their positive attitude towards the subject. According to Ogugua and Udoh (2020), there is no significant difference in achievement of students in Mathematics provided they are giving equal platform, example environment and approach when it required the social learning activities of the students.

Social Learning Theory (SLT) was propounded by Albert Bandura in the year 1954. The theory states that learning best takes place in social context through observation, imitation and modeling. Social Learning Theory (SLT) challenged the traditional principles of behaviorism which believe that behaviourism is a one dimensional approach to understanding human behaviour and also do not account for free will or internally influences by moods, thought and feelings. It called into question whether true learning could only result from the experiences of reinforcement or punishment, which was the prevailing behaviourist view of the time. SLT also deviated from the basic tenets of behaviourism by espousing the importance of cognition, which had been excluded from the central ideas of behavioural theories, and by supporting the major role that cognitive approaches play in learning process especially in learners' mental ability.

The SLT pointed out that, social context is operating in the same way throughout life by observational learning. Observational learning may take place at any age in as much as the individual is exposed to new influential and powerful models which control resources. These resources occurred at life stage as new learning academic achievement through which the modeling process is always possible in social context.

The SLT come in perspective of different uses including some related to

education and mental health. The SLT help students' to learn through drawing and graphical expressions. The theory also helps to influence lesson design. For instance, some teachers use consistent encouragement to help student learn that which graphical symbol approach emphasized on, to encourage students' academic achievement of any concepts.

Based on social context, learning can occur without a change in behaviour. In other words, behaviourists say that learning has to be represented by a permanent change in behaviour; while in contrast social learning theorists say that because people can learn through observation alone, their learning may not necessarily be shown by their achievement rather by ability. Thus, such learning resulted in a behaviour change by academic change via social context for better understanding.

This theory is of value to this study in considering that most calculation concepts like number and numeration in Mathematics are abstract and students can easily forget what they have learnt. But when sufficient social learning context is provided during teaching process, it will aid the students' ability towards their mental ability to recall large proportion of their learning which may lead to individual achievement in calculative subject like Mathematics. SLT do support learning through positive change in brain to accept the said idea otherwise known as mental ability but have no or less contribution on academic achievement of learners. This study will be looking at Behaviourism learning theory which concentrated more on learners' academic achievement than SLT. The study therefore investigates how graphical-symbol teaching approach affects secondary school students' academic achievement in number and numeration in Anambra state, Nigeria**.**

Statement of the Problem

Realizing the importance of Mathematics for national development, a lot of students tend to register Mathematics in secondary school because the subjects is general and compulsory to all students that registered for WAEC examination. Mathematics is compulsory for students who wish to attain any higher institution especially in science related courses in Nigeria. Despite these facts, it is very disheartening to see from the evidence provided by WAEC reports that out of millions of candidates that registered for the subject in WASSCE, their achievement in every year is still below 50% each year from the year 2013 to 2022 accept in 2013 and 2021. It is also noted that, from the Chief examiners report collected from the Anambra state WAEC office each year from 2013 to 2022, number and numeration is one of the fundamental concepts in Mathematics that students weaknesses are observed based on the academic achievement data of the said years.

The situation may be as a result of teaching and learning methods/ approaches used in teaching and learning the subject. Some teaching and learning approaches such as graphical symbol approach have proven as a treat to students' academic achievement in many school subjects. The problem of this study is 'what is the effect

of graphical-symbol teaching approach on secondary school students' academic achievement in number and numeration in Anambra State?'

Aim and Objective of the Study

The purpose of this study was to determine the effect of graphical-symbol teaching approach on secondary school students' academic achievement in number and numeration in Anambra State. Specifically, the study will determine the;

1. Mean achievement scores of students taught number and numeration using GSTA and that of those taught using TTA.
2. Mean achievement scores of male and female students taught number and numeration using GSTA and those taught using TTA.
3. Interaction effect of teaching approaches (GSTA and TTA) and gender on academic achievement of secondary school students in number and numeration.

Research Questions

The following research questions were guided this study:

1. What are the mean achievement scores of students taught number and numeration using GSTA and those taught using TTA?
2. What are the mean achievement scores of male and female students taught number and numeration using GSTA and those taught using TTA?

Research Hypotheses

The following null hypotheses were tested at.05 level of significance:

1. There will be no significant difference between the mean academic achievement scores of students taught number and numeration using GSTA and those taught using TTA.
2. There will be no significant difference between the mean academic achievement scores of students taught number and numeration using GSA and those taught using TTA.
3. There will be no interaction effect of teaching approaches (GSTA and TTA) and gender on secondary school students' academic achievement in number and numeration.

Literature Review

Graphical Symbol Teaching Approach (GSTA) and its benefits

Graphical symbol is the representations of direct reality, which comes in the form of object, chart, diagrams, maps, sketches, cartoons and symbols. Also, graphical symbol is a visually perceptible figure with a particular meaning used to transmit information independently of language. The meaning assigned to each graphical symbol is expressed by its title, which may be supplemented by an application note. Graphical symbol approach is one of the teaching approaches that enhance learning. Gate (2018) stated that apart from geometrical understanding, one other clear area of the Science Technology Engineering Mathematics (STEM) and curriculum that waves visual processing into conceptual development is the use of

graphical representation. According to Gate, graphical symbol approach has characteristics of the visual display; it has an easy understanding of subject being taught or learns, it has the content of the viewer or learners, prior knowledge and expectations about the content of a subject being taught. In another development, Stylianou (2013) viewed graphical symbol approach as an enhancer that help student to develop skill and enhances students' mental ability and academic achievement. The author also opined that female students tend to achieve more in quadratic equations when taught with graphical symbol approach. This may be as a result that the teaching approach is visual because women go on what they see when the graph are properly organized.

Graphics and diagrams can enhance the clarity, readability, and usability of procedures, especially for complex or technical tasks. However, using them effectively requires following some best practices to avoid confusion, inconsistency, or distraction. The three basic steps and procedures or tricks for choosing, creating and using graphics and diagrams as a teaching approach includes;

i. Choose the right type of graphic or diagram

Depending on the purpose and content of your procedure, you may need different types of graphics or diagrams to illustrate the steps, concepts, or results. For example, you can use flowcharts, decision trees, or swim lanes to show the sequence and logic of a process; tables, charts, or graphs to compare or display data; maps, schematics, or diagrams to show the layout or structure of a system; or photos, drawings, or icons to show the appearance or location of an object. Choose the type of graphic or diagram that best suits your message and audience, and avoid using too many or too diverse formats that may confuse or overwhelm the reader.

ii. Create clear and consistent graphics and diagrams

Once you have chosen the type of graphic or diagram, you need to create it with clarity and consistency in mind. Use simple and familiar shapes symbols, colors, and fonts that are easy to recognize and understand. Avoid cluttering your graphic or diagram with too much detail, text, or decoration that may distract from the main point. Use labels, legends, captions, or titles to explain the meaning and relevance of your graphic or diagram. Follow the same style, format, and convention for all graphics and diagrams in your procedure, and align them with the overall design and tone of your document. Because color often has implied meaning (e.g. red), your chosen colors should be thoroughly explained to avoid assumptions or confusion. Flow diagrams should move from left to right and top to bottom in a simple stream while avoiding snaking back. If your procedure is too complex to understand without a diagram and the diagram is too complex itself, you may need to revise your procedure.

iii. Integrate graphics and diagrams with text

Graphics and diagrams should complement and support the text of your

procedure, not replace or contradict it. Therefore, you need to integrate them smoothly and logically with the text. Refer to your graphic or diagram in the text before or after you present it, and use clear and consistent terms to identify it. For example, you can say "See Figure 1 for an example of the wiring diagram" or "As shown in the flowchart below, you need to verify the input before proceeding". Place your graphic or diagram close to the text that relates to it, and use appropriate size, alignment, and spacing to make it visible and accessible. Avoid inserting graphics and diagrams in the middle of a sentence or a step, as this may interrupt the flow and coherence of your procedure (Santosh and Laurent, 2019).

Graphics and diagrams can enhance your procedures by providing visual information that can help the students understand, remember, and perform the task effective academic achievement. Dethemdge and Rampoulou (2015) added that students understand the use of graph in teaching calculative subject like Mathematics and Physics because it aids high level of retention which is one of the benefits of graphical symbol approach.

Santosh and Laurent (2015) summarized the benefits of graphical symbol approach thus; it aid fast learning, faster to use and easier in problem solving, easier remembering, it is more natural, it has fewer errors, it increased feeling of control and Immediate feedback.

i. *Aid fast learning:* **G**raphical symbol approach aids learning, and due to the symbols involvement in the teaching approach, the concept being taught can easily be learned.
ii. *Faster use and problem solving:* Graphical symbol approach through visual or spatial representation of information has been found to be easier to retain and manipulate and leads to faster and more successful problem solving.
iii. *Easier remembering:* Because of greater simplicity of graphical symbol approach, it is easier for casual users to retain operational concepts.
iv. *More natural:* symbolic displays of graphical symbol approach are more natural and advantageous because the human mind has a powerful image memory.
v. *Increased feeling of control:* Graphical symbol approach because it makes user initiates actions and feels in control. This increases user confidence
vi. *Fewer errors:* Due to the reversibility procedures in graphical symbol approach, the action reduces error rates because it is always possible to undo the last step. Error messages are less frequently needed.
vii. *Immediate feedback:* The results graphical symbol approach of actions furthering user goals can be seen immediately. If the response is not in the desired direction, the direction can be changed quickly. With these benefits of graphical symbol approach this study will focus on effect of graphical symbol approach on secondary school students' academic achievement in number and numeration

Academic Achievement of Students in School Subjects

In a general sense, academic achievement of students in school subjects is the current level of students learning in a particular subject. More so for the purpose of education, academic achievement of students in school subjects refers to the percentage of students at a school whose learning currently meets or exceeds their grade – level standards (Cassidy, 2016). Alegre, Mohner and Maroto (2020) reported that peer tutoring increases students academic achievement in Mathematics. The authors maintained that there is significance different between male and female students taught Mathematics using peer tutoring in favour of female students. Bintilghak *et al* (2020) observed that students Mathematics resilience increases when taught with innovative learning strategy like think pair - share. More so, the authors asserted that there was no significant differences between student academic achievement taught with think pair share.

Chiketa and Okigbo (2021) reported that, there was no relationship between students' critical thinking ability and Mathematics achievement of secondary school students in Anambra state while Nwankwo *et al* (2019) opined that, meta conceptual teaching approach improves students academic in physics. According to the authors, if meta conceptual teaching approach is appropriately utilized, it can help in fundamental knowledge of students calculative ability and can help in students mental ability. This study focuses on effect of graphical symbol approach on secondary school students' mental ability and academic achievement in number and numeration (branch of Mathematics) in Anambra state, Nigeria.

Factors that Influence Students' Academic Achievement

Academic achievement is the extent to which a student or institution has achieved either short or long term educational goal. Academic achievement may be measured through students' grade point average, whereas for institutions, achievement may be measured through graduation rate which must follow systematic factor (Cavillon, 2017). According to Meenu Der (2016), factors like attendance to lectures, early revision, prioritization learning needs, deep learning, learning in small groups, mind mapping, learning skill in laboratory, learning with patients, learning from mistakes, time management and family support are some factors that influence students academic achievement towards learning Mathematics concepts. The authors added that if the greater percentage of this factor should be provided, students are sound to achieve well irrespective of the Mathematics concept.

Supporting Meenu Der (2016), Stenmayr, Weidnger, Schwinger and Spinath (2019) stated that, family support is great a factor that trigger students to greater achievement especially in science and set theory. Okwuduba and Okigbo (2018) also reported that with family support which is a good factor for student academic achievement, female students are bound to

achieve well in calculative areas in chemistry more than their male counterpart. Yet, Alegre, Mohner, and Maroto (2020) found that no significant differences in academic achievement of students when taught in peer tutoring in Mathematics even with family support. To contribute to the foregoing argument, the researcher is motivated to investigate if graphical symbol teaching approach will affect secondary school students' academic achievement in number and numeration.

Gender Issues in Mathematics and Sciences

Gender is a cultural construct that distinguishes the roles, behaviour, mental and emotional characteristics between male and female develped by the society. It is a socially ascribed attribute which differentiates feminine from masculine (Hornby, 2010). The author further defined it as sexual classification into male and female. The consequences of gender stereotyping cut across economic, social, political and educational development especially in the areas of science (Mathematics). In the context of Education, gender issues are referred to as the difference, both real and perceived, between boys and girls in their relative achievements and opportunities (Westminster Institute of Education, 2013). Makarova, Aaschliman and Hergog (2019), reported that gender issue like inferiority complex has being an issue in study of science subject like chemistry, physics, and Mathematics especially among female students. The authors further asserted that high academic achievement of the male and female students prove to be a significant variable for high achievement of students in Mathematics.

Issues related to gender in the teaching and learning of Mathematics has attracted the attention of many researchers in science education in secondary schools regarding the direction of achievement for either males or females. While some found out that female students outperformed their male counterparts in mathematics, others say otherwise. And so, for over the years, no consensus has been reached concerning this argument. For instance, Chiketa and Okigbo, (2021), open that male students have great achievement in Mathematics than their female counterpart due to male students' high interest in science and calculative related subjects while Chung (2008) observed that female students achieve more than male students in Mathematics word problems due to the patient and ability to stay calm in a place. On the contrary, Odutuyi (2014) revealed that there is no significant difference in the achievement of male and female students in science subjects. But when also compared, several research report (Okigbo & Agu, 2010; Obialor & Osuafor, 2016; Chikwebdu, 2018) have shown that the influence of gender on student's achievement is still inconclusive whether in Mathematics, biology, or chemistry. Hence, as a result of this inconclusiveness in student's academic achievement in Mathematics with respect to gender, this study also investigated the effect of gender on secondary on secondary school students'

academic achievement in numbers and numeration.

Research Method

The study adopted a quasi – experimental research design. Four research questions guided the study and seven hypotheses were tested at .05 alpha level. The population comprised 18,336 Senior Secondary two (SS2) students for 2022/2023 session in 263 public secondary schools in Anambra State. The sample size of 280 SS2 students was obtained using purposive and simple random sampling techniques. The instruments for data collection was Number and Numeration Achievement Test (NNAT) validated by three experts. The reliability of NNAT was established using Kuder-Richardson Formula 20 at 0.85. The experimental group was taught using GSTA while the control group was taught using TTA. The data generated through pre-test and post-tests were analyzed using mean, standard deviation and Analysis of Covariance.

Presentation of Result

Table 1: Mean Achievement Scores of Students Taught Number and Numeration using GSTA and TTA

		Pretest		Posttest		
Groups	N	Mean	SD	Mean	SD	Mean Gain
GSTA	148	19.37	6.02	38.93	6.00	19.56
TTA	132	18.52	5.52	36.65	4.83	18.13

The result presented in Table 3 reveals the mean differences in achievement scores of students taught number and numeration using GSTA and those taught using TTA. The pretest mean achievement scores for the groups in the GSTA and TTA are 19.39 and 18.52 with standard deviation scores of 6.02 and 5.52 respectively. The posttest mean achievement scores are 38.93 and 36.65 with standard deviation scores of 6.00 and 4.83. The standard deviation scores for the pretest for both groups were higher than the standard deviations for the posttest. This suggests more variability in the pretest mean achievement scores of the students than the posttest mean achievement scores. More of the scores near the mean in the pretest than in the post test. Since the pretest mean achievement score in is smaller than the posttest mean achievement score, in both groups, the treatment which is GSTA improves students' academic achievement in number and numeration than TTA.

More so, the mean gain achievement scores of students taught number and numeration using graphical-symbol teaching approach (GSTA) and those taught using traditional teaching approach (TTA) are 19.56 and 18.13 which depicts that the students in the GSTA taught number and numeration have higher

academic achievement scores than those taught the same Mathematical concept of number and numeration using TTA.

Table 2: Mean Achievement Scores of Male and Female Students Taught Number and Numeration using GSTA and TTA

		Pretest		Posttest		
Groups	N	Mean	SD	Mean	SD	Mean Gain
GSTA	148					
Male	60	18.20	5.10	39.00	5.04	20.80
Female	88	20.17	6.47	38.89	6.31	18.72
TTA	132					
Male	59	17.95	5.94	34.92	5.36	16.97
Female	73	18.99	5.14	38.05	3.85	19.06

The result presented in Table 4 reveals the mean achievement scores of male and female students taught number and numeration using graphical-symbol teaching approach (GSTA) and those taught using traditional teaching approach (TTA). The pretest means achievement scores of male and female students for the groups in the GSTA and TTA are 18.20, 20.17, 17.95 and 18.99 with standard deviation scores of 5.10, 6.47, 5.94 and 5.14. The posttest means mental ability scores of male and female students for the groups in GSTA and TTA are 39.00, 38.89, 34.92 and 38.05 with standard deviation scores of 5.04, 6.31, 5.36 and 3.85. The standard deviation scores for the pretest mean achievement scores for male and female students in both groups were higher than the standard deviations posttest mean achievement. This suggests more variability in the pretest mean achievement scores of the male and female students than their posttest mean achievement scores. More of the scores near the mean in the pretest than in the post test. Since the posttest mean achievement scores of female students is less than their male counterpart in the Mathematics concept of number and numeration taught using GSTA, male students achieved more academically than their female counterpart in the treatment group. More so, since the posttest mean achievement scores of male students is less than their female counterpart in the Mathematics concept of number and numeration taught using TTA, female students achieved more academically than their male counterpart in the control group.

Table 3: ANCOVA Test of significant deference in the mean Achievement Scores of Students in the two Groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	553.261[a]	2	276.630	9.102	.000	.062
Intercept	29198.229	1	29198.229	960.671	.000	.776
Pretest	190.269	1	190.269	6.260	.013	.022
Groups	323.640	1	323.640	10.648	.001	.037
Error	8419.025	277	30.394			
Total	410258.000	280				
Corrected Total	8972.286	279				

Data shown in Table 7 reveals the ANCOVA results on the effect of graphical symbol teaching approach and traditional teaching method on students' achievement on number and numeration. The results show a significant difference F (1, 277) = 10.648, p = .001< .05, η^2_p = .037 in the mean achievement scores of the students taught number and numeration using the two teaching approaches (GSTA and TTA). In all, the null hypothesis which stated there is no significant difference between the mean achievement scores of students taught number and numeration using graphical-symbol teaching approach (GSTA) and those taught using traditional teaching approach (TTA) is rejected. Hence, there is significant difference between the mean achievement scores of students taught number and numeration using graphical-symbol teaching approach (GSTA) and those taught using traditional teaching approach (TTA) in favour of students in GSTA.

Table 4: ANCOVA Test of significant deference in the mean Achievement Scores of Male and Female Students in the two Groups based on Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model						
Intercept	29129.553	2	29129.553	786.446	.000	.984
Pretest	166.312	1	166.312	5.632	.018	.020
Groups	378.648	1	378.648	1.953	.395	.661
Gender	194.278	1	194.278	.579	.060	.023
Error	8120.909	277	29.531[b]			

Total	410258.000	280
Corrected Total	8972.286	279

The data presented in Table 8 shows the ANCOVA results in the mean academic achievement scores of male and female students taught number and numeration using graphical-symbol teaching approach (GSTA) and those taught using traditional teaching approach (TTA). The results reveal no significant difference in the mean academic achievement scores of male and female students taught number and numeration using graphical-symbol teaching approach (GSTA) and those taught using traditional teaching approach (TTA) F (1, 277) = .579, p = .060 > .05, η^2_p = .023. Therefore, the null hypothesis is not rejected. Hence, the result shows that there is no significant difference between the mean academic achievement scores of male and female students taught number and numeration using graphical-symbol teaching approach (GSTA) and those taught using traditional teaching approach (TTA).

Table 5: Interactive Effect of Teaching Approaches and Gender on Students Academic Achievement Scores in Number and Numeration

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model						
Intercept	29129.553	2	29129.553	786.446	.000	.984
Pretest	166.312	1	166.312	1.777	.018	.020
Groups	378.648	1	378.648	6.368	.184	.661
Gender	194.278	1	194.278	.579	.060	.023
Error	8120.909	277	29.531[b]			
Total	410258.000	280				
Corrected Total	8972.286	279				

Data shown in Table 10 reveals the ANCOVA on the interaction between the teaching approaches (graphical symbol approach and traditional teaching approach) and gender (male and female) on the students' academic achievement mean scores in number and numeration. The tables reveal no interaction F(1, 277) = .579, p = .060, η^2_p = .023. Thus the null hypothesis is not rejected.

Findings

The findings of this study shown that the students taught Mathematics concept of number and numeration using graphical symbol teaching approach performed significantly better in Number and Numeration Achievement Test (NNAT) than those taught the same concept with traditional teaching approach. The difference may be as a result of the fact that

graphical symbol teaching approach improves communication and ability to show the whole picture of said concept. The finding is in line with Owolabi and Adaramali (2015) who observed that students taught algebraic word problem using graphic symbol approach achieved better than students taught using conventional approach as a result of improved communication the teaching approach and the report of Richard and Lisa (2016) who revealed that graphical symbol teaching approach improves students' performance in Mathematics than conventional method. The finding of the study also is in line with researchers reports in other mathematical concepts like arithmetic, ratio learning and other field of studies that graphical symbol teaching approach significantly perform better in achievement than traditional teaching approach due to content understanding in graphical symbol teaching approach (Kambouri, Pampoulu & Pieridou 2016; Nwoye 2009; Ogan & Nchelem 2016; Babalola, 2021; Yinusa, Akinwarere & Fakotujo 2017). This implies that the students in the treatment group (GSTA) have significant higher gain in their content understanding than those in the control group (TTA).The result from the traditional teaching approach suggested the need to also adopt other teaching approaches in addition that would likely develop adequate content understanding in number and numeration in our secondary schools.

Also, the ANCOVA analysis indicated that there is significant difference between the mean achievement scores of students taught number and numeration using graphical-symbol teaching approach (GSTA) and those taught using traditional teaching approach (TTA) in favour of students in GSTA. The finding is in line with Dominic, (2015) revealed that there is a great significant in relevance of error analysis in achievement between using of graphical symbol teaching approach and use of traditional teaching method in favour of graphical symbol teaching approach. The significant in academic achievement among students taught number and numeration using GSTA and those taught the same concept using TTA in favour of those taught with GSTA could be as a result that graphical symbol teaching approach improving learning, understanding content and flexibility among students. Hence, one would be in a position to say that the students taught using GSTA has an improved academic achievement than those taught using TTA as a result of understanding content concept in GSTA.

The finding also shown that graphical symbol teaching approach enhanced male and female secondary school students' academic achievement in Mathematics concept of number and numeration than their counterparts in traditional teaching approach. The difference may be as a result of the fact that graphical symbol teaching approach engages students in stimulating visual presentations of Mathematics concepts. This finding is not in consonance with Richard and Lisa (2016) who observed that the female students in graphical symbol teaching approach performed slightly better

than their male counterparts in graphical symbol teaching approach and Kambouri, Pampoulu and Pieridou (2016) who observed that female pupils taught in both experimental groups achieved better than their male counterpart in the same group due to students engagement in stimulating visual presentations offered by the teaching approach in experimental groups. Similarly, the finding is not in line with groups of researchers in their different studies and fields who observed no significant differences in academic achievement among male and female students taught with graphical symbol teaching approach (Nwoye 2009; Ogan & Nchelem 2016; Yinusa, Akinwarere & Fakotujo 2017). But the finding is in line with Owolabi and Adaramali (2015) who reported that the treatment appeared to be more effective among male students than their female counterparts. From table 4 male and female scores in GSTA in posttest scores is higher than their counterpart scores in TTA in posttest scores. In GSTA session, mean gain of male students is 20.80 and that of female is 18.72 then the difference in main gain is 2.08 in favour of male students, the slight difference may be as a result of level of interaction between male while learning with GSTA. But then, GSTA has reduced the male domination in academic achievement to the barest minimum by encouraging equal participation.

Also the ANCOVA analysis indicated that there is no significant difference between the mean academic achievement scores of male and female students taught number and numeration using graphical-symbol teaching approach (GSTA) and those taught using traditional teaching approach (TTA). The findings of this study is not surprising because both teaching approaches enhanced male and female secondary school students' academic achievement in Mathematics concept of number and numeration though graphical symbol teaching approach enhanced students' academic achievement than traditional teaching approach but was not significant in the study.

Conclusions

The findings of the study revealed that graphical symbol teaching approach significantly improved students' academic achievement in Mathematics concept like number and numeration irrespective of gender. The conclusion is that graphical symbol teaching approach is an effective approach for the teaching and learning of Mathematics concept. The graphical symbol teaching approach is also activity-oriented thus making it possible for the students to retain more of the Mathematic concepts because it increases students' academic achievement. It can also be concluded that when Mathematics teachers adopt graphical symbol teaching approach, student to student interaction increases thereby making students to take responsibility for their learning.

Recommendations

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

1. Teachers should be encouraged by curriculum planners to employ graphical symbol teaching approach more often in teaching and learning Mathematics concepts.
2. Teachers should direct the presentation of Mathematics lessons away from the traditional teaching approach to a more students-centered approach, visibly oriented and graphic representation like graphical symbol teaching approach.
3. Curriculum planners and developers in Mathematics subject should include graphical symbol teaching approach in restructuring Mathematics curriculum in our secondary schools in order to help the students to be mentally creative and for better academic achievement in the subject.

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