

**Effect of Mathematics Laboratory on Students' Achievement in Mensuration in
Ibadan North Local Government Area, Oyo State, Nigeria**

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Certification

This is to certify that ABDUS-SALAM Islamiyat with Matriculation Number LCU/PG/005010 carried out this research work titled 'Effect of Mathematics Laboratory on Students' Academic Achievement in Mensuration in Ibadan North Local Government Area, Oyo State, Nigeria' in the Department of Science Education, Faculty of Education, Lead City University, Ibadan, Oyo State and this has not been previously submitted.

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Dedication

The research work is dedicated to Almighty Allah, and my late parents Alhaji and Alhaja Bam Salam, from the beginning to the end.

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Acknowledgement

My uttermost desire is to acknowledge my citadel of learning, one of the best, Lead City University, Ibadan Oyo State. Nigeria for the opportunity to learn and conduct this research work. My sincere appreciation also goes to AMIS, Oyo state chapter

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“Even though the above mentioned person have assisted in the process of this work, I alone stand responsible for the error, if any found in the work”.

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Abstract

Despite the importance of Mathematics in shaping students' future careers, many struggle to grasp fundamental concepts, hindering their overall academic progress. The introduction of Mathematics laboratories has been touted as a solution, but its impact on student achievement in Mensuration is unclear, especially considering the diverse learning environments and student backgrounds. As a result, this study aimed to investigate the effect of Mathematics laboratory on senior secondary school students' academic achievement in Mensuration in Ibadan North Local Government Area, Oyo State, Nigeria. The study population consisted of five thousand seven hundred and fifty-eight (5,758) students which represents all the 2023/2024 academic year Senior Secondary School two (SSS 2) students of government owned secondary schools in Ibadan North Local Government Area of Oyo State, Nigeria. However, one hundred and fifty (152) SS 2 student selected from four schools using multistage sampling techniques were used to represent the population. The study employed a pretest-posttest control group design. Data were analyzed using Analysis of Covariance (ANCOVA) and descriptive statistics. Mathematics Achievement Test (MAT) was used to measure students' academic achievement in Mensuration. Results showed a significant difference in Mensuration achievement between students exposed to traditional Mathematics laboratory [$F_{(1;146)} = 12.020$; $P < 0.05$], and those taught using virtual Mathematics laboratory methods [$F_{(1;146)} = 10.018$; $P < 0.05$]. Additionally, class size interacted with mathematics laboratory to influence achievement [$F_{(1;246)} = 8.380$; $P < 0.05$], but students' socio-economic background failed to statistically moderate the students' academic achievement in Mensuration. The study recommends integrating Mathematics laboratory into Mathematics curriculum and prioritizing resource allocation for laboratory development. The findings contribute to Mathematics education research and inform teaching practices, policy decisions, and future research directions.

Keywords: Mathematics Laboratory, Mensuration, Academic Achievement, Socioeconomic Background, Class size.

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List of Acronyms

Abbreviations		Meaning
WASSCE	-	West African Senior Secondary School Certificate Examination
NECO	-	National Examination Council
GCE	-	General Certificate Examination
MAT	-	Mathematics Achievement Test
SSCE	-	Senior Secondary School Certificate Examination
SSS	-	Senior Secondary School Certificate
TML	-	Traditional Mathematics Laboratory
VML	-	Virtual Mathematics Laboratory
DML	-	Digital Mathematics Laboratory

Chapter One

Introduction

1.1 Background of the Study

Mathematics serves as a discipline, method, and language simultaneously. It can be utilized across various fields of study, including Mathematics itself. This discipline involves organizing, validating, and sharing knowledge through the principles of logic, resulting in a pure and unambiguous domain for manifestation and application where the truth of propositions is universally acknowledged and not subject to interpretation. Mathematics uniquely possesses the capability to examine concepts of any nature and level of generality, while also being self-referential and self-applicable, mirroring the essence of human reasoning¹.

Artificial intelligence, machine learning, and data science exemplify emerging research fields that recognize the significance of Mathematics and mathematical thinking. While Mathematics is often viewed as a collection of assumptions leading to logical conclusions, it is also seen as a discipline focused on numeracy and calculation, often constrained by the notion of a singular correct answer. It involves the study of abstract systems consisting of intangible elements². Consequently, Mathematics emphasizes making generalizations, identifying relationships, and enhancing logical reasoning over mere "number work" or "computation." The systematic process of teaching Mathematics facilitates the transfer of mathematical knowledge and information from an expert to others through effective instructional methods and resources. Moreover, human reasoning and cognition rely significantly on Mathematics to enhance logical reasoning and cultivate mental discipline. A solid understanding of Mathematics is essential for grasping concepts in various subjects, including social studies, science, and even music and art³.

The complexity of certain issues necessitates that student engage with advanced Mathematics by assimilating new mathematical concepts in a manner that resonates with their personal contexts essentially, their internal worlds of memory, experience, and response. Mathematics is a subject that requires active engagement through reading, reciting, and practice; otherwise, effective teaching and learning are compromised⁴. Mathematical literacy is a crucial attribute of individuals who aspire to lead responsible, thoughtful, and productive lives. It encompasses basic computational skills, spatial reasoning, and quantitative reasoning. The applications of Mathematics span various fields and disciplines, enabling problem-solving through mathematical concepts and techniques in science, engineering, and economics. Furthermore, there are distinctions in the concepts and procedures of Mathematics; for example, understanding complex numbers is essential for grasping many principles in electronics. It is one's responsibility to advance the cultural heritage of Mathematics, which is an intrinsic aspect of human characteristics.

Mathematics enhances one's ability for rational thought, logical reasoning, and analytical thinking, which in turn improves problem-solving skills and increases the effectiveness of addressing various challenges. The more mathematical problems one solves, the better equipped they become to tackle real-world issues. Mathematics is fundamental to human reasoning and cognitive processes, fostering logical thinking and mental discipline. Additionally, a solid understanding of Mathematics is crucial for comprehending content in other fields, including science, social science, music, and the arts⁵. It bolsters one's capacity for rational thought, facilitating improved problem-solving skills across diverse contexts. Just as it is for Computer Science, Information Technology, and Computer Engineering, Mathematics serves as the cornerstone of modern science. It equips students with the ability to accurately understand and

interpret principles of general science and technology. Mathematical concepts and methods are applied across various disciplines, including Engineering, Science, and Economics. Proficiency in Mathematics is a prerequisite for numerous careers, such as Engineering, Accounting, Medicine, Economics, Finance, and Technology. To analyze, connect, and evaluate knowledge for generating new insights in various settings, Mathematics is essential. Thus, for a nation to advance scientifically and technologically, Mathematics must be prioritized^{5,6}.

Laboratory practice is a fundamental aspect of scientific education, providing a space for students to deepen their understanding of scientific concepts, engage in scientific inquiry, and explore the various knowledge claims made by scientists. Instructional strategies focused on laboratory experiences can incorporate a variety of teaching and learning activities, allowing students to use tools and materials to observe and understand the natural world. Furthermore, students can participate in established protocols for formulating research questions, testing hypotheses, designing experiments, and developing and discussing explanatory models⁷.

Throughout history, various methods have been employed to teach Mathematics, with the most effective approach identified as the use of instructional resources. These resources not only alleviate some of the teaching burdens but also minimize mathematical abstractions by providing concrete evidence for learners to grasp the subject. Effective use of instructional materials has been shown to ignite and sustain students' interest, fostering conceptual thinking and promoting long-lasting learning in the classroom⁸.

A Mathematics Laboratory is a specialized space furnished with tools designed for teaching and learning Mathematics⁹. These laboratories aim to facilitate the teaching of mathematical skills in educational environments. However, many basic schools in Nigeria lack adequately equipped Mathematics Laboratories for both teachers and students, which have

negatively affected the implementation of the Mathematics curriculum. It has been found that most basic schools face challenges such as insufficient laboratory materials, limited time for administering tests and grading student work, and inadequate infrastructure. Additionally, students' apprehension regarding assessments and teachers' limited knowledge and negative attitudes toward laboratory assessment methods hinder the adoption of laboratory techniques.

Utilizing a Mathematics Laboratory as an instructional approach is essential for effective teaching and learning in Mathematics¹⁰. Laboratory teaching strategies are designed to improve Mathematics education. Without practical experience in these areas, learning science, technology, and Mathematics may fail to provide a solid understanding of their fundamental concepts. Mathematics Laboratories foster observational skills, deliver comprehensive information, and stimulate students' curiosity. Moreover, this approach is more effective in engaging students in the learning process compared to traditional expository or discussion-based methods, which often treat students as passive recipients of knowledge¹¹.

There are two main types of Mathematics Laboratories: traditional Mathematics Laboratories and virtual Mathematics Laboratories. Unfortunately, secondary schools in Nigeria lack both forms of these laboratories. A traditional Mathematics Laboratory refers to a physical space equipped with tangible tools designed for teaching and mastering Mathematics. It serves as a dedicated area within a school where mathematical experiments and research can be conducted. This space allows for hands-on activities related to Mathematics, such as constructions, demonstrations, and practical instruction. Consequently, a traditional Mathematics Laboratory can be defined as a specific environment where Mathematics teachers and students engage with various resources to facilitate teaching and learning activities, including the verification of mathematical facts, theorems, and principles¹².

In contrast, the terms "virtual Laboratory" and "Laboratory" function as distinct nouns. The word "virtual" describes something that is emulated or reproduced to mimic reality without being physically real. A "Laboratory" refers to a space or facility equipped for study and experimentation. Therefore, a virtual Laboratory combines these concepts to create an interactive environment featuring simulated instruments for designing and conducting experiments. By definition, a virtual Laboratory is a computer-based learning environment where students can use computers to replicate experiments typically performed in a traditional Laboratory.

A virtual Laboratory is a digital or computerized environment that replicates actual Laboratory equipment for conducting research¹³. It provides students with access to resources stored on computers, CDs, and websites to facilitate experiments. Virtual Laboratories can effectively replace traditional Laboratory functions by utilizing computer models and simulations, acting as dynamic simulations of conventional Laboratories. For this study, a virtual Mathematics Laboratory is defined as a computer-based learning space where students can replicate experiments typically conducted in a real Mathematics Laboratory. In other words, the virtual Mathematics Laboratory acts as an alternative to traditional Laboratory activities by simulating common Laboratory tools. The essential role of virtual Laboratories in hands-on learning for Laboratory-based courses cannot be overstated. Their growing popularity in education is largely due to the advent of technological devices such as laptops, iPads, tablets, and smartphones, which engage students when utilized. The development of virtual reality tools and facilities, enabled by these technologies, has the potential to enhance practical activities in educational settings and beyond. Moreover, these technological resources offer opportunities to minimize rote learning, promoting more effective and meaningful learning experiences in the classroom.

Virtual Laboratories serve as computer-based learning tools that enhance student engagement and facilitate the design of experiments, making complex concepts easier to grasp. Research indicates that students find virtual Laboratories to be stimulating and interactive, providing an effective alternative or supplement to traditional Laboratories in the classroom. These virtual mathematical Laboratories can address challenges related to Laboratory capacity, equipment costs, and accessibility for both teachers and students. When conventional Laboratory resources are unavailable, students can still develop essential skills in a virtual environment. Given these advantages—such as cost-effectiveness, reliability, safety, flexibility, and accessibility—there has been a push to integrate virtual Laboratories into educational settings¹⁴.

Virtual Laboratories can be categorized into online and offline types. Offline virtual Laboratories do not require an internet connection and can be used both inside and outside schools, typically installed on personal computers or accessed via disks or CDs. In contrast, online virtual Laboratories can be accessed from any location with internet connectivity. For this study, an offline virtual Mathematics Laboratory will be utilized. One key advantage of using a Mathematics Laboratory in the classroom is the opportunity for students to explore, test, and validate mathematical concepts, properties, facts, and theorems. Additionally, these Laboratories enhance student enthusiasm and confidence in Mathematics, allowing for more hands-on engagement that increases interest in the subject matter. Given that virtual Mathematics Laboratories are generally more affordable and accessible than traditional ones, implementing them can effectively boost student interest in Mathematics, particularly in areas like Mensuration. This suggests that establishing a virtual Mathematics Laboratory is likely to be more cost-effective than building and equipping a traditional Mathematics Laboratory.

Virtual Mathematics Laboratories are more accessible to students than traditional Mathematics Laboratories, thanks to their availability on CDs and the internet for use at home and in schools¹⁵. The cost and accessibility advantages of virtual Mathematics Laboratories offer opportunities that traditional Laboratories cannot provide. Unlike many traditional Mathematics Laboratories, which are only available during school hours, virtual Laboratories can be accessed by students anytime and anywhere, provided they have a computer or device with the virtual Mathematics Laboratory installed. This flexibility allows students to conduct experiments and review material at their convenience.

Research on the use of virtual Laboratories has shown highly variable results; however, overall findings indicate that combining virtual Laboratories with real-world activities yields better outcomes than using traditional or virtual Laboratories alone. Virtual Laboratories enhance students' abilities to conduct appropriate experiments, while traditional Laboratories offer a superior environment for interaction and collaboration. Although some students may appear disengaged with the challenges posed by virtual Laboratories and prefer real-life representations, it has been observed that positive effects on comprehension occur when virtual Laboratories are supplemented with other learning materials, such as relevant textbooks and equipment¹⁶.

It has been observed that most educational institutions in Nigeria lack adequate teaching resources for Mathematics. Rather than focusing solely on rote memorization, Mathematics education should prioritize understanding processes¹⁷. The Laboratory approach emphasizes the need to highlight the mathematical foundations of experiments, indicating that resources should be provided to help students appreciate the significance of Mathematics. Additionally, it is important to recognize that Mathematics Laboratory experiments have two main objectives: to apply previously taught concepts and to create new mathematical problems for exploration¹⁸.

However, mathematical practice is essential for achieving true mastery in laboratory experiments. Laboratory techniques are predominantly applied in Science and Mathematics subjects. By utilizing problem-solving strategies, such as those employed in Chemistry labs, students can improve their communication, teamwork, and skills in information retrieval and application. The laboratory serves various academic objectives in science education, including the enhancement of cognitive abilities related to problem-solving, application, analysis, synthesis, and understanding the nature of science. Additionally, the concept of mastery encompasses elements such as thesis development, theoretical models, and taxonomies. Furthermore, it promotes scientific endeavors, familiarizes students with scientific methods, highlights the diversity of scientific disciplines, and fosters a scientific mindset characterized by curiosity, risk-taking, objectivity, perfectionism, confidence, perseverance, fulfillment, and accountability¹⁹.

The following eight elements of scientific attitudes can be promoted at the school's science Laboratory: Some of them include modesty, reverence for life, intellectual honesty, rationalism, curiosity, and the ability to set aside judgment. Therefore, it stands to reason that Laboratory techniques should be incorporated into Mathematics instruction. Students studying Mathematics are not currently sent to Laboratories. Most learning occurs in classrooms, where teachers assign homework that children usually do at home with help from their parents or guardians. Most learning is theoretical, with a few practical components. According to the study, using useful tools can improve students' conceptual understanding and learning. Classes in Chemistry, Biology, and Physics are usually held in a Laboratory. In that instance, Mathematics Laboratories can be beneficial²⁰. The Mathematics Laboratory promotes more effective teaching and learning by removing abstraction, displaying mathematical data, and offering rapid access.

In the Mathematics Laboratory, students can study and investigate mathematical generalities. There, they can use a range of tools and activities to confirm different mathematical theories and facts^{19,20,21}. A Laboratory is a physical location where scientific experiments are conducted with students as a part of practice, instruction, or research. A Laboratory room is a special kind of classroom that is designed or furnished with specialized tools so that students can participate in educational activities, such as real-world or scientific experiments. It is an area or structure intended for carrying out research, especially in controlled settings²¹.

During the West Africa Examinations Councils (WAEC) in 2017, 2020, and 2021, chief examiners in Mathematics frequently observed that candidates were unable to accurately solve almost all general Mathematics issues. According to the WAEC chief examiner report, the candidates shown deficiencies in the following areas: Demonstrating evidence by reading from a graph, converting word problems into mathematical equations, resolving issues with geometry and Mensuration, making inferences from statements that make sense

Mensuration must therefore be taught with a focus on the needs of the individual student in order to foster excellent learning and performance in Mathematics. As should be evident, it seems that not even educators understand the necessity of Mathematics Laboratories. The idea that Laboratories are exclusively for physics, chemistry, and biology is a common one. Nonetheless, these courses aid in the understanding of the fundamentals, and the abilities that students acquire will be useful in the future workplace. Through lesson plans or teaching tools, the research has shown how important these Laboratories are in assisting students in taking ownership of their communication and cooperation skills. The study finds that students do better when they use Laboratory methods as opposed to traditional ones²². Students' capacity to complete projects and engage in other activities that offer active, sensory

mathematical experiences is further demonstrated to be improved by Mathematics Laboratories²³. Therefore, the center of all Mathematics instruction in schools needed to be the Mathematics Laboratory. It has been noted that secondary school Mathematics teachers teach mathematical concepts using traditional methods, which have a negative effect on students' academic achievement in Mensuration, which necessitates conceptual mastery prior to computation²⁴. Mathematical principles should be taught and learned through practical application, investigation, and experimentation in a Mathematics Laboratory. Students will be forced to organize their true abilities and talents, develop work habits and high moral and ethical standards, acquire Mathematics, and describe its value system in relation to real-world scenarios and the expansion of the country's economy. Concrete items should be used to illustrate abstract topics in Mathematics Laboratory. This has the potential to increase pupils' interest in Mathematics²⁵. Mensuration is one of these abstract notions. The mathematical field of measuring of geometric magnitudes, such as surface areas and solid volume, is known as Mensuration. This area of Mathematics is applied. There are two sections to it: solid Mensuration and plain Mensuration.

- i) Plain Mensuration is the study of measurements of planar figures, including polygons, such as their perimeters and areas.
- ii) Solid Mensuration measures, among other things, the surfaces, areas, and volumes of cubes, cuboids, spheres, cones, and cylinders.

Additionally, because Mathematics is hierarchical, students' performance may be enhanced by the knowledge they acquire at any level through the use of Laboratory materials. Mensuration thus seems to be the fundamental element of all deep knowledge in Mathematics, particularly when it comes to the measurement, computation, and estimation of length, areas, and volumes as well as the building of three-dimensional objects. This study hypothesizes that

teaching arithmetic topics, particularly Mensuration, using homemade resources could greatly raise everyone's expectations and result in improved accomplishment. The public has deemed the unencouraging students performance in Mathematics examinations over the years in the West African Senior Secondary Certificate Examination (WASSCE), General Certificate in Education (G.C.E.), and National Examination Council (NECO) revealed that the majority of pupils steer clear of Mensuration-related issues. Could it be attributed to a teacher's approach, pupils' misconceptions, or a lack of manipulative skills? A detailed examination of previous WASSCE questions showed that there is no year and that Mensuration questions are not based on objectives or theoretical frameworks. This may demonstrate the significance of Mensuration in the growth of students' cognitive domains¹⁶.

The following are some benefits of using a Mathematics Laboratory: presenting mathematical data as a means of experimenting through hands-on work; a repository of mathematical resources for convenient access aimed at eliminating abstraction and enhancing the efficacy of instruction and learning. Given the benefits of Mathematics Laboratory, it is anticipated that using them to teach and learn Mathematics will help to lessen the abstract aspect of the topic and encourage students to follow.

The mathematical study of measuring quantities such as line and surface lengths, volume, surface areas, and perimeters is known as Mensuration. It is necessary to have the following knowledge: The first subject is the definition of volume, area, and perimeter. Mass, volumetric, and dimensional standards. Form particular equations, a solution to a simple problem, a solution to a word puzzle. Mensuration is a subject that students often find difficult to understand and solve problems in. One reason for this could be that pupils struggle to remember details about various shapes. Secondly, kids must learn how to use different measurement formulas. Not to

mention, they have to apply these concepts to problems in a variety of situations. Often, they must visualize the situation, create an appropriate map or diagram, and then use the appropriate Mathematics to come up with a solution.

The following are the main reasons why secondary school Mensuration answers are incorrect:

1. Improperly applying a well-established rule to a new situation.
2. Abusing an established process to deal with an unanticipated situation.
3. It is possible to see the incorrect diagram and draw incorrect connections between the data in the problem and the diagram when answering word problems²⁶.

Various factors have been linked to the low arithmetic achievement among Nigerian children. These include teachers' reliance on traditional teaching methods, primarily the "chalk and talk" approach combined with textbooks. Other contributing factors encompass mathematical phobia, students' disinterest in the subject, poor retention of concepts, gender-related issues, a shortage of qualified math teachers, teachers' impatience and lack of preparation, the abstract nature of Mathematics, the use of inappropriate teaching strategies, students' poor socioeconomic backgrounds, insufficient mathematical foundation, and the absence of Mathematics Laboratories in Nigerian secondary schools²⁷. Many scholars have highlighted that the lack of a Mathematics Laboratory in Nigerian secondary schools significantly hinders effective teaching and learning of Mathematics, thereby contributing to students' poor performance in the subject, particularly in Mensuration.

Larger class sizes are often linked to challenges in maintaining student discipline by professors and lecturers, resulting in a classroom environment that prioritizes behavior management over

academic achievement²⁸. Consequently, larger classes compel teachers to allocate instructional time to management rather than teaching, directly affecting classroom instruction. Additionally, class size influences the nature of interactions between students and teachers, which further impacts instructional effectiveness. Numerous studies have indicated that smaller classes lead to higher levels of student engagement and increased interaction between students and teachers. Moreover, large classes may face spatial constraints that hinder the enforcement of conduct rules and the implementation of innovative teaching methods. Overall, class size significantly affects student academic performance, classroom management, and the quality of education.

Class size is a significant factor that has been shown to affect students' academic performance. It is a widely discussed phenomenon in educational literature, impacting not only student achievement and attitudes but also administration, quality, and school budgets. As student enrollment increases, class sizes also grow, raising concerns about their effect on student performance²⁹. Over the years, extensive debate has centered on how the number of students in a class influences a teacher's instructional strategies, classroom management, and overall academic outcomes.

Active sensory experiences in the laboratory provide students from diverse socioeconomic backgrounds and abilities with opportunities to engage and develop concepts in a supportive environment³⁰. Additionally, parental education and socioeconomic status significantly influence children's academic performance, serving as essential emotional and financial support systems. Consequently, students vary in their educational outcomes based on their parents' educational attainment and socioeconomic backgrounds³¹. More educated parents are better positioned to evaluate their children's abilities and academic needs, which positively influences their children's expertise in specific subjects. When financially stable, these parents

can provide access to the latest resources and technologies, thereby enhancing their children's educational potential³². Additionally, adolescents who experience mobility tend to have higher educational expectations, which mediate the relationship between academic achievement and family socioeconomic background. Interestingly, for youth with a higher subjective socioeconomic status, there is a weak correlation between their actual family socioeconomic background and their educational expectations. This suggests that subjective socioeconomic background can mitigate the negative effects of a disadvantaged family socioeconomic background on adolescents' academic achievement through the influence of educational expectations³³.

For instance, parents with higher socioeconomic status and education levels often have more opportunities to engage in their children's education. These parents are likely to impart essential social skills and problem-solving techniques that contribute to their children's academic success. Consequently, students from families with higher socioeconomic backgrounds and educational attainment may exhibit a greater appreciation for learning, possess more positive beliefs about their abilities, maintain a stronger work ethic, and utilize more effective learning strategies compared to their peers from lower socioeconomic backgrounds^{34,35}.

The Mathematics Laboratory serves as a vital space for acquiring essential mathematical skills and knowledge, facilitating a progression from concrete to abstract concepts by emphasizing hands-on learning and observation. During this process, students utilize practical resources from the real world to deepen their understanding of mathematical principles. Motivation, defined as the impetus to act, plays a crucial role in influencing students' engagement and the intensity of their involvement in learning activities. It is essential that Mathematics is taught in a practical Laboratory setting, as this approach fosters positive attitudes

and provides students with opportunities to demonstrate their skills through real-world projects³⁶. The mathematical competencies required by today's youth and adults differ significantly from those of the past, necessitating teaching strategies that prioritize student interaction to enhance educational outcomes. Consequently, the Laboratory method promotes student engagement and increases the likelihood of success for those capable of communicating, collaborating, and applying knowledge to solve mathematical problems. Secondary school students aspiring to careers in Mathematics or technical fields should actively engage with the Mathematics Laboratory technique.

Student achievement is one of the most critical outcomes of any educational system, with individuals classified as high, medium, or low achievers based on their performance levels³⁷. Numerous studies indicate that various factors influence academic success, including the school's structure, students' financial backgrounds, aspirations for higher education, and behavioral conduct, as well as personal traits such as ambition, creativity, intelligence, attitude, and values. Parents play a crucial role as the child's primary influence; their education and socioeconomic status significantly impact their child's personality and development. Educated parents are generally more adept at assessing their children's abilities and educational needs, enabling them to support their early learning and enhance subject-matter expertise³⁸. Furthermore, access to modern tools and resources provided by parents can greatly facilitate children in reaching their full educational potential. The educational achievements of parents and their socioeconomic circumstances are, therefore, significant factors affecting children's academic performance, providing a stable environment and necessary financial support. Students from diverse socioeconomic backgrounds and parental education levels exhibit noticeable differences in their academic outcomes³⁹.

Education is widely regarded as a vital factor in achieving social and economic success, providing pathways to improved opportunities and a higher quality of life⁴⁰. The choice of the study area was influenced by the West Africa Examination Council's (WAEC) chief examiners' reports from 2017, 2020, and 2021, which highlighted unsatisfactory performance in Mensuration. Consequently, the researcher aimed to investigate whether the implementation of a Mathematics Laboratory could enhance students' performance in Mensuration assessments.

1.2 Statement of the problem

The fact that secondary school pupils are not performing well in Mathematics indicates that the most sought applications of Mathematics in technology, science, and business cannot continue. This makes it imperative to look for a teaching method for Mathematics that attempts to increase students' comprehension and performance. There is ample evidence that one of the main causes of secondary school students' low Mathematics achievement is the absence of a Mathematics Laboratory and the teachers' failure to apply Laboratory techniques in their instruction. Thus, the study examined how students' progress in Mensuration in Ibadan North Local Government, Oyo State, is impacted by the Mathematics Laboratory and size of the class.

1.3 Aim and Objectives of the Study

The primary aim of the study was to find out how students' achievement in Mensuration in Ibadan North Local Government, Oyo State, was affected by the Mathematics Laboratory.

These objectives are to

- i. investigate the achievement of Senior Secondary School student in Mensuration topic when taught using conventional method in Ibadan North local government area, Oyo state;

- ii. investigate the achievement of Senior Secondary School student in Mensuration topic when taught using Virtual Laboratory method in Ibadan North local government area, Oyo state;
- iii. examine the achievement of Senior Secondary School student in Mensuration topic using Traditional Laboratory in Ibadan North local government area, Oyo state;
- iv. verify the achievement of Senior Secondary School student in Mensuration topic using Virtual Laboratory approach and Traditional Laboratory approach in Ibadan North local government area, Oyo state;
- v. verify the effect of socio economic background of senior secondary school students academic achievement in Mensuration topic using Mathematics Laboratory method in Ibadan north local government area, Oyo state;
- vi. verify the effect of socio economic background of Senior Secondary School students academic achievement in Mensuration topic using Virtual Mathematics Laboratory in Ibadan North local government area, Oyo state;
- vii. investigate the effect of Mathematics Laboratory, class size and socio economic background of senior secondary school students academic achievement in Mensuration topic using Mathematics Laboratory method in Ibadan north local government area, Oyo state;
- viii. verify the effect of conventional method and socio economic background on senior Secondary School Students academic achievement in Mensuration topic using Laboratory method in Ibadan North local government area, Oyo state;

- ix. verify the effect of conventional method and Traditional Laboratory method on senior Secondary School Students academic achievement in Mensuration topic in Ibadan North local government area, Oyo state;
- x. verify the effect of conventional method and class size of senior secondary school students academic achievement in Mensuration topic in Ibadan North local government area, Oyo state;
- xi. verify the effect of socio economic background and Traditional Mathematics Laboratory on Senior Secondary School students academic achievement in Mensuration topic in Ibadan north local government area, Oyo state;
- xii. verify the determine of socio economic background, Mathematics Laboratory and conventional method of Senior Secondary School students academic achievement in Mensuration topic in Ibadan North local government area, Oyo state;
- xiii. examine the effect of class size, Traditional Mathematics Laboratory and conventional method of Senior Secondary School students academic achievement in Mensuration topic in Ibadan North local government area, Oyo state;
- xiv. investigate the effect of class size, socio economic background and conventional method on senior Secondary School Students academic achievement in Mensuration topic using Virtual Mathematics Laboratory method in Ibadan north local government area, Oyo state;
and
- xv. examine the effect of class size, Virtual Mathematics Laboratory and socio economic background on Senior Secondary School students' academic achievement in Mensuration topic in Ibadan North local government area, Oyo state.

1.4 Hypotheses

The following null hypotheses were tested at .05 significance alpha level.

H₀₁: There is no significant main effect of Virtual Mathematics Laboratory method on Senior Secondary School students' achievement in Mensuration topics in Ibadan North local government area, Oyo state.

H₀₂: There is no significant main effect of Traditional Mathematics Laboratory method on senior Secondary School students' achievement in Mensuration topics in Ibadan North local government area, Oyo state.

H₀₃: There is no significant interactive effect of Virtual Mathematics Laboratory method and Traditional Mathematics Laboratory method on Senior Secondary School students' achievement in Mensuration topics in Ibadan North local government area, Oyo state.

H₀₄: There is no significant effect of socio economic background on Senior Secondary School students' achievement in Mensuration topics in Ibadan North local government area, Oyo state.

H₀₅: There is no significant interactive effect of socio economic background and class size (large or small) on Senior Secondary School students' achievement in Mensuration topics in Ibadan North local government area, Oyo state.

H₀₆: There is no significant interactive effect of Virtual Mathematics Laboratory method, class size (large or small) and socio economic background on Senior Secondary School students' achievement in Mensuration topics in Ibadan North local government area, Oyo state.

H₀7: There is no significant interactive effect of Traditional Mathematics Laboratory method, class size (large or small) and conventional method on Senior Secondary School students' achievement in Mensuration topics in Ibadan North local government area, Oyo state.

H₀8: There is no significant interactive effect of Virtual Mathematics Laboratory method and socio economic background on Senior Secondary School students' achievement in Mensuration topics in Ibadan North local government area, Oyo state.

H₀9: There is no significant interactive effect of students' achievement and socio economic background on senior secondary school students' achievement in Mensuration topics in Ibadan North local government area, Oyo state.

H₀10: There is no significant interactive effect of Traditional Mathematics Laboratory method, socio economic background on students' academic achievement on Senior Secondary School students' in Mensuration topics in Ibadan North local government area, Oyo state.

H₀11: There is no significant interactive effect of conventional teaching method and socio-economic background on senior secondary school students' academic achievement in Mensuration topics in Ibadan north local government area, Oyo state.

1.5 Significance of the Study

The teaching of Mathematics has concerned some factors like as teaching style, teaching strategies, teaching methods and using of instructional materials. Teaching of Mathematics becomes more meaningful by use of proper materials. Mathematics is one of the major subjects in our education system. It is taught from the elementary level. The present problem faced by people is of well understanding of its structure. Students, curiosity, motivation, participation play important role to promote mathematical skills in the students. For this, teacher should select proper instructional materials. While implementing the curriculum of Mathematics using proper

instructional materials can help students to learn Mathematics with proper understanding. So there should be research on instructional materials. The significance of this study are; to identify the role of Mathematics Laboratory on achievement of Mathematics; to find out whether the Mathematics Laboratory are used in our school environment or not; to help Mathematics teacher to achieve better result with the use Mathematics Laboratory.

The results may be used by the Ministry of Education to develop suitable initiatives aimed at raising secondary school pupils' Mathematics proficiency. Curriculum designers must comprehend the advantages and difficulties of using the Laboratory approach in order to produce lesson plans, textbooks, and suggestions for implementing it in Oyo State secondary schools. The results of this investigation will support this effort. The findings will benefit Mathematics educators since they can apply the approach to train Mathematics teachers, who can subsequently implement it in other schools to improve Mathematics success. The study's findings may help administrators and educators better understand how to use a Laboratory method to teach Mathematics.

1.6 Scope of the Study

The scope of this study was Senior Secondary School II students, while geographical scope is Ibadan North local Government Area of Oyo State. The subject and content scope is Mensuration in Mathematics while the class size of the students as well as their socio economic background will also be considered.

1.7 Limitation of the Study

This study focus on the impact of Mathematics Laboratory on Students' Academic Achievement in Mensuration in Ibadan North Local Government Area of Oyo State, it was

limited to schools within one Local Government in Ibadan and the exploration was specifically conducted within three Secondary Schools which have available Mathematics Laboratory.

1.8 Operational Definition of Terms

Laboratory method: describes the process by which the participating students in this study acquire mathematical skills through performing practicals in a Laboratory setting.

Mensuration: This is the study of practical exercise, which entails Laboratory modeling, sketching, measuring, observing, documenting, and pondering in a room as it is applicable to this study

Mathematics Achievement: This is the result of the test given to students using MAT in the course of study

Conventional Method: Also known as the "chalk and talk" method, it involves direct instruction from the teacher, whose main duties include imparting knowledge to students and conducting test and assessment in this study

Mathematics Laboratory: This is a place to enjoy Mathematics through informal exploration

Class size: Number of students in the study

Socio economic background: Social standing or class of individual, it is often measured as combination of education, income and occupation.

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Chapter Two

Literature Review

The review of related literature is discussed under the following subheadings;

2.1. Conceptual Review

2.1.1. Academic Achievement

2.1.2. Mathematics

2.1.3. Mensuration

2.1.4. Mathematics Laboratory

2.1.5. Class Size

2.1.6. Socio Economic Status

2.2 Theoretical Review

2.2.1 Activity Theory

2.2.2 Cognitive Psychology

2.3 Empirical Review

2.3.1 Mathematics Laboratory and Students' Academic Achievement

2.3.2 Class Size and Students' Academic Achievement

2.3.3 Parent Socio Economic Status and Students' Academic Achievement

2.4 Conceptual Model

2.5 Summary of the Gap in the Literature Reviewed

2.1 Conceptual Review

2.1.1 Academic Achievement

Achievement encompasses various outcomes, including individual student marks, results from school achievement exams, standardized test scores in key subjects, GPA, and teacher rating scales¹. It is assessed using a composite score of these metrics. Schooling is often gauged by factors such as attendance, goal attainment, enrollment, or completion rates. Academic achievement represents excellence across academic disciplines and co-curricular activities², including sportsmanship, communication skills, punctuality, and cultural involvement, achievable through proper adjustment. It signifies a student's progress towards educational goals, reflecting the knowledge or skills acquired in school subjects, typically measured by test scores or teacher-assigned grades. Academic achievement can be categorized as high or low based on these scores, indicating good or poor performance^{3,4}.

In other words, Academic achievement is the extent to which students achieve their educational objectives, typically assessed through exams and the effective application of skills that contribute to realizing personal aspirations⁵. It reflects the expectations of educational stakeholders, such as teachers, and can be influenced by factors like school leadership and classroom settings. Although defining academic achievement can be challenging, it is often measured by students' academic performance and associated behaviors. It is demonstrated by

students' participation in school activities and their ability to apply learned knowledge and skills to solve real-world problems².

Academic accomplishment is the term used to describe performance results that show how well a student has accomplished particular learning objectives. It includes the information, abilities, and experiences that students possess in relation to the curriculum's stated learning objectives. In this study, pupils' mathematical skill serves as a proxy for academic accomplishment. Various factors, such as the classroom atmosphere, can influence academic achievement, making it crucial for teachers to create a school environment that supports learners' interests to maximize learning outcomes. Academic achievement is often described as students' attainment on a defined scale, ranking them by scores to assess whether they have met expected competency levels. Some scholars argue that it is determined by the mastery of academic content acquired at a given level and improves with quality classroom instruction.

One perspective view academic achievement as the level of attainment expected by policymakers, teachers, curriculum designers, the community, and the students themselves³. Another view suggests that academic achievement is influenced by various factors, such as school administration, classroom environment, and interactions between students and teachers or peers. Factors affecting academic achievement include teacher quality, learning strategies, classroom atmosphere, and school leadership. A positive classroom environment boosts student achievement, and studies indicate that academic success is significantly shaped by the school setting, demonstrated through active lesson participation. Therefore, fostering a supportive school and classroom atmosphere is crucial for enhancing learning outcomes and ensuring students feel comfortable and free to learn.

Various scholars have emphasized the significance of classroom atmosphere for effective learning, with classroom settings playing a crucial role in students' success or failure^{4,5}. It has been argued that learning achievement is unattainable without an environment conducive to fostering it. When correctly implemented, the classroom environment's many facets—including the physical setting, time management, and teacher effectiveness—can have a favorable effect on students' academic performance. Creating a positive classroom atmosphere is crucial, as it can either enhance or hinder learning, depending on its nature. Effective room arrangement, including furniture setup and class size, greatly influences learning outcomes, while both physical factors (e.g., chair and table arrangement, lighting, ventilation) and social factors (e.g., teacher leadership, student participation) are essential for academic success.

Effective teaching and learning depend on the psychological environment in addition to the physical setup. A positive psychological environment results from meaningful interactions among students and teachers, ensuring that students' psychological needs, such as love and belongingness, are met⁶. These needs, also known as social needs, foster a sense of belonging and motivate students to actively engage in the learning process when they feel supported and cared for by teachers and peers. A well-organized, visually stimulating, and disruption-free classroom further enhances learning effectiveness.

According to a research, the number of pupils in a classroom has a big influence on how well children learn, with crammed classrooms making it hard for them to participate in the process⁷. Conversely, a manageable class size positively affects students' academic achievement, as instructional practices are more effective when fewer learners are present. In smaller classes, students are better able to focus, and teachers can utilize small group discussions to enhance learning outcomes.

When students actively participate in classroom activities and decision-making, they are likely to achieve more, even in the presence of physical challenges. Seven key elements contribute to a positive classroom environment are as follow⁸:

Personalization: The instructor shows concern for each student and offers chances for interaction between students and teachers.

Involvement: This occurs when the instructor promotes active engagement in the classroom, encouraging each student to take on a variety of responsibilities in the teaching-learning process.

Cohesion: The class is defined by an environment where students are kind, supportive, and familiar with one another.

Satisfaction: When classes are organized effectively and have engaging activities, students like going to class.

Task orientation: Every student must understand his or her role in the teaching and learning process, and class activities must be well-structured and transparent.

Innovation: This is the process by which a teacher develops original lesson plans and exercises. A classroom environment that is favorable to successful learning is created by well-organized pedagogy and material.

Individualization: Depending on their unique characteristics, aptitudes, and interests, students are given the freedom to choose and receive varied treatment.

Research demonstrates a substantial prevalence of inadequate academic performance among secondary school pupils in Nigeria, resulting in considerable dropout rates. The ongoing underachievement of senior secondary pupils in the Senior School Certificate Examination

(SSCE), despite significant educational expenditure, has elicited great anxiety among stakeholders. A multitude of apprehensive Nigerians have underscored the deteriorating quality of education in the nation. Only 35% of candidates who took the secondary school exam in May/June 2012 passed in English Language, Mathematics, and three other subjects, according to statistics released by the West African Examination Council (WAEC) in December 2012. This means that 65% of candidates did not meet the requirements for admission to Nigerian universities. Social issues like alcoholism, cultism, vandalism, hooliganism, terrorism, drug abuse, and child trafficking are common among Nigerian youth and can be brought on by poor academic performance. These issues can have a negative impact on the country's social, economic, educational, and technological development. Factors contributing to this widespread failure include inadequate learning environments, insufficient qualified teachers, poor infrastructure, and parental poverty⁹.

Student academic achievement is a fundamental goal of educational institutions and a societal expectation. Consequently, when education systems establish their goals and objectives, they prioritize academic achievement alongside various competencies¹⁰. For students, achievement signifies reaching the objectives outlined in the curriculum¹¹. In educational settings, the aim of academic achievement is to enhance and advance students academically. It encompasses the knowledge, skills, successes, and development imparted by teachers in schools, reflecting changes in student behavior across all curriculum domains, excluding those related to psychomotor and affective behaviors. To achieve academic success, students are expected to effectively complete assigned tasks, adopt a perfectionist mindset, demonstrate resilience in overcoming obstacles, and develop strategies to address difficulties¹². Key factors influencing students' academic achievement include their economic circumstances, study and homework

habits, time management skills, health conditions, and family relationships. A review of the literature suggests that academic achievement is a fundamental objective of the education system, and reaching these goals is crucial for societal development and the enhancement of overall welfare¹³.

The family serves as a fundamental building block for both society and the education system, as it is where individuals receive their first education¹⁴. Consequently, the family acts as the individual's first teacher. The educational level of the family can significantly influence a student's mindset, perspectives, beliefs in democracy, and academic achievement. Families nurture values such as love, responsibility, social roles, decision-making, and creativity in individuals. Active family involvement in children's activities at home, along with effective communication, plays a crucial role in shaping the child's future¹⁵. Today, schools encompass more than just classrooms, a teachers' lounge, and administrative offices; they require a multifaceted structure to deliver quality education. From the perspective of student development and academic achievement, schools play a significant role in various respects, with physical conditions contributing to students' academic success. Key aspects of a school's physical environment include classroom design and equipment, libraries, indoor and outdoor sports facilities, conference halls, exhibition spaces, science laboratories, map rooms, foreign language classrooms, technology classrooms, and study centers¹⁶.

A school's physical attributes and infrastructure include the building's look, furnishings, security measures, neighborhood, sports facilities, library, staff appearance, hygienic standards, and green areas¹⁷. These factors, such as practicality, hygiene, aesthetic appeal, educational planning, and student orientation are crucial for students' academic achievement and overall development. Adequate physical conditions, including sports halls, information technology resources, library

and media facilities, hygiene standards, and school grounds, significantly influence academic success. Additionally, designing educational institutions to capture children's attention and interest, creating an engaging building image, and fostering a school environment reminiscent of a nurturing home can positively affect students' attitudes toward school¹⁸.

Key aspects of a school's physical conditions include students' seating and study areas in the classroom, the equipment and materials used textbooks, and the board, all of which significantly impact academic achievement. Optimal physical conditions should support the ongoing process of teaching and learning, align with students' developmental levels, accommodate transportation needs, consider the student population, and ensure protection from disasters and hazards. Factors such as the colors of the equipment, class size, heating, lighting, hygiene, overall appearance, and acoustics are crucial for facilitating students' adaptation to the school and classroom environment¹⁹. To achieve academic success, generate high-quality outcomes, and ensure students feel comfortable in the school environment, it is essential for schools to have well-equipped areas such as classrooms, laboratories, libraries, sports halls, workshops, and lecture theaters outfitted with educational technologies. A review of studies indicates that adequate physical conditions in schools play a crucial role in helping students adapt to and accept their school environment, fostering a desire to spend time there, which in turn positively influences their academic achievement²⁰.

The school administration, management structure, and school leaders play a vital role in facilitating academic achievement. Principals with leadership skills and a broad perspective can help achieve academic objectives as well as enhance other aspects of school life. Effective school principals act as mentors, demonstrating people-oriented qualities, self-awareness, tolerance for mistakes, and a commitment to their institution's performance. They possess self-

confidence, successfully guide those around them, and are sensitive to the needs of staff. Additionally, they demonstrate adaptability, originality, effective communication, a favorable outlook on the organization, work experience, tolerance for differing viewpoints, and a readiness to commit their time and efforts to the school²¹. The school environment significantly influences academic success by reflecting families' socio-economic and socio-cultural values, their views on education, and the role of the school in society²². Additionally, the school's location affects access to transportation and activities that can either support or hinder teaching and learning. Key environmental factors include the adequacy of local infrastructure, housing and heating conditions, opportunities for personal development, social activity facilities, transportation safety, and access to healthcare services, and hygiene education. A safe and organized environment along with strong school-family cooperation is essential characteristics of effective schools. Factors such as anxiety, achievement motivation, the family's social and economic status, educational conditions, environmental influences, and nutrition and health all play a role in shaping students' academic achievement²³.

Teachers are a central element of the education system, significantly impacting students' academic achievement. They play a crucial role in fostering students' cognitive, affective, and behavioral development, guiding their careers, and preparing them to be productive members of society while promoting diverse thinking styles and worldviews. A teacher's empathetic approach, warmth, and tolerance for mistakes positively influence the teacher-student relationship. To enhance students' academic success, teachers engage in practices that help students understand lesson content, reinforce learning through exercises, apply effective assessment methods, utilize time efficiently, keep students actively engaged in class, and encourage them to generate their own ideas²⁴. In effective schools, teachers adopt a planned and

disciplined approach, focusing on both the academic success of the institution and their students. They possess sufficient knowledge in their subject areas, reinforce positive student behaviors, progress systematically through educational stages, collaborate with students, and provide appropriate feedback. By preparing the classroom for instruction and collaboratively establishing class rules with students, efficient teachers enhance learning retention and encourage positive learning behaviors. Effective teachers foster trust with students, value their achievements, and stimulate interest in lessons through recognition and rewards. They also create a supportive classroom environment, demonstrating tolerance and flexibility while making informed decisions and respecting individual differences.

Successful teachers' exhibit patience and self-control, respect individual differences, and remain open to personal development and constructive criticism. They motivate students, serve as role models, establish classroom discipline, demonstrate leadership qualities, and provide encouragement and support. Such teachers are affectionate, witty, and sincere, adept at problem-solving, monitor homework diligently, and facilitate learning effectively. When these characteristics are present in a teacher, they significantly contribute to enhancing students' academic success²⁵.

2.1.2 Mathematics

Our everyday lives revolve around Mathematics, which is essential to many disciplines such as science, technology, and economics. Its influence permeates all sectors, making a solid understanding of mathematical concepts essential for navigating an increasingly complex global society²⁶. Therefore, it is crucial to teach Mathematics in a clear and engaging manner to students. Given its extensive applications in everyday life, Mathematics is a fundamental component of

the curriculum at all educational levels. This significance has been acknowledged by every commission and policy established in Nigeria since independence.

The importance of Mathematics and mathematical reasoning in new research-oriented domains like data science, machine learning, and artificial intelligence is recognized by the National Education Policy. While Mathematics is often viewed as a discipline focused on numeracy and calculation with a tendency to prioritize a single correct answer. It encompasses a broader scope of making assumptions that lead to logical conclusions²⁷. It is the study of abstract systems comprised of theoretical elements. Consequently, Mathematics transcends mere "number work" or "computation"; it emphasizes forming generalizations, recognizing relationships, and cultivating logical reasoning and critical thinking skills²⁸.

The significance of Mathematics is universally acknowledged, particularly within the context of Nigeria's educational system and its technological advancement. This recognition has led to Mathematics being deemed one of the most critical subjects in Nigerian schools, often referred to as the foundation of science and technology²⁹. The advancement of scientific disciplines is largely contingent upon the integration of mathematical methods and principles. Indeed, there is scarcely any field of science that does not employ mathematical concepts to elucidate its theories, models, or frameworks.

Mathematics is widely recognized as a fundamental tool for developing theories in fields such as science, engineering, and economics, among others. Often referred to as the language of science, Mathematics is undeniably the most versatile subject across various disciplines and areas of human endeavor. The significant nature attributed to Mathematics stems from the recognition that Mathematics is foundational to science; science is essential for modern technology; and current technology is crucial for the prosperity of contemporary civilization³⁰.

Mathematics is often referred to as the queen of science and technology, serving as a crucial tool for their advancement. It is described as a communication system encompassing concepts of shape, size, quantity, and order, which are essential for explaining various phenomena. Like English, Mathematics is a language composed of precise concepts, facts, principles, and operations fundamental to human existence³¹. This logical language not only facilitates engaging activities but also finds applications in everyday life, serving as a framework for descriptions and models in science and other fields.

Mathematics is often referred to as the mother or queen of all sciences, as it allows for the communication of various phenomena in physical, biological, and economic contexts through concepts of shape, quantity, size, and order. It serves as both the foundational language of science and a crucial element for thought, logic, reasoning, and overall progress³². As a fundamental discipline, Mathematics is essential for understanding most fields, acting as a cornerstone for all scientific inquiry and exemplifying precision and conciseness.

2.1.3 Mensuration

In Mathematics, the idea of mensuration refers to geometric forms and the computation of their distinct properties. In this article, we will go through the various concepts linked to mensuration and learn their respective formulas. Mensuration as a concept can be directly linked to the 2D and 3D objects such as area, volume, length, and width. The field of mensuration has no set rules as people could use nonstandard units of measurements such as measuring their yard by walking around it and counting the steps.

There are standard units of measurement present which make the topic easier. It's important to remember that while using nonstandard units of measurement there is always a big chance for human error. It's always better to use standard units such as meters, kilometers, liters, etc.

One dimensional figure.

Such shapes which have only one measurement are known as one-dimensional figures. A straight line connecting a point to another point can be seen as a one-dimensional figure.

Two-dimensional figures

Such shapes or figures which have two measurements are known as two-dimensional figures. They are also known as 2D figures. The two measurements that two-dimensional figures have are usually length and breadth. Examples of two-dimensional figures are square, rectangle, triangle, rhombus, etc.

Three-dimensional figures

Such figures or shapes have three measurements and are known as three-dimensional figures. In addition to the length and breadth of the two-dimensional figures, the three-dimensional figures also have another measurement in the form of height or depth. Some examples of three-dimensional objects are balls, tanks, bats, and books. Some of the three-dimensional figures used in geometry are sphere, cube, cone, etc.

Important terminologies in Mensuration

Area: area could be defined as all the space present in a closed section of space. Such spaces could be enclosed by definitive boundaries. The symbol for the area is A. square unit is the measurement unit for the area.

Volume

In a three-dimensional closed shape or object, the space present in such shapes is known as the volume of the object. The unit for volume is cubic-meter and is denoted by the alphabet V.

Perimeter

The whole length of a form or figure's boundaries is known as its perimeter. Perimeter is present only in two-dimensional shapes and figures. The unit used to measure perimeter is square-unit and is represented by the alphabet P.

Surface area

The surface area of a three-dimensional object is the overall area that the thing occupies. Lateral surface area and total surface area are two further forms of surface area.

Important Mensuration formulas

Here are some of the important Mensuration formulas that will come in handy:

Rectangle

Being a 2D shape, a rectangle has 4 sides and the same number of corners. All angles at the corner of the rectangle are right angles.

Perimeter: $2 [L + B]$ where L is length and B is the breadth

Area: $[L \times B]$ where L is length and B is the breadth

Square

Square is a 2D shape, it has equal sides and they are 4 in number. Each angle in a square is 90 degrees.

Area: $[S \times S]$ where S is a side

Perimeter: $4 [S]$ where S is a side

Circle

Another 2D form is a circle, with each point on the circle being equally spaced from the circle's center.

The circle's diameter is $2 \times R$, where R is its radius.

The circle's circumference is equal to $2 \times \pi \times R$, where R is the circle's radius and π is a constant.

The area of the circle is equal to $\pi \times R \times R$, where π is a constant and R is the circle's radius.

Sphere

It is a 3D object, which means it has depth or height. The sphere is a geometric shape and all points on the sphere are equidistant to its center.

The formula for a sphere's volume is $\frac{4}{3} \times \pi \times R \times R \times R$, where π is a constant and R is its radius.

The surface area of a sphere: $4 \times \pi \times R \times R$, where R is radius and π is a constant.

Mensuration is a concept in geometry that deals with various figures and shapes. We looked at the types of figures in single, double, and triple dimensions. Furthermore, we looked at some important terminologies and Mensuration formulas. These were some of the most fundamental concepts of Mensuration. Be sure to conduct a thorough research online to avail more information about this concept.

In the medical industry, mensuration is a crucial technique for figuring out body measurements including height, weight, and body mass index (BMI). On the other hand, these measurements are essential for monitoring the patient's health, assessing growth and development, and measuring the effectiveness of treatment. Furthermore, recognizing disorders and choosing the best course of therapy depend on precise mensuration. For instance, accurate measurement is crucial in the healthcare industry. Mensuration gives doctors precise information about your height, weight, and BMI so they can monitor your health, assess children's growth, and much more.

Mensuration Applications in Sports For accurate measurements of field dimensions, race lengths,

and equipment sizes, mensuration is crucial in sports. However, precise measurements ensure fair competition, safe playing grounds, and rule compliance. However, whether one is measuring the length of a soccer field or the height of a basketball hoop, mensuration is required to maintain fair play in sports. For instance, in athletics, mensuration is comparable to the referee's measuring tape. From the length of a running track for an equitable race to the height of a basketball hoop for fair shooting, it ensures that everything is precisely measured.

Mensuration Applications in Interior Design

In interior design, mensuration is a tool that is used to determine the size of rooms, furniture, and other items. Additionally, accurate measurements ensure that everything fits perfectly, enhancing the design's usability and aesthetic appeal. Whether selecting furniture or creating space layouts, mensuration is crucial for designs that are aesthetically pleasing and harmonious. For instance, it assists designers in determining the precise dimensions of rooms and furniture (length, breadth) to ensure that everything blends together flawlessly. All of the furniture is perfectly situated for a comfortable and fashionable area, and no couches get wedged in doors. In conclusion, Mensuration has many real-world uses, ranging from engineering and architecture to routine chores like budgeting and cooking. Its usefulness is multifaceted, enabling accuracy in design, computation, and measurement. Mensuration is still developing as a result of technology, and it is essential to contemporary creativity and problem-solving.

2.1.4 Mathematics Laboratory:

A Mathematics laboratory is a dedicated space equipped with relevant and up-to-date teaching materials intended for scientific or research activities as well as for the teaching and learning of Mathematics. A certified math teacher follows a set of rules while interacting with students³³. Through a variety of exercises and materials, it may also be seen as a platform where

students can research a wide range of mathematical subjects and validate different mathematical ideas and facts. Furthermore, a Mathematics laboratory is described as a space equipped with hand tools and other resources that students use to experiment, investigate mathematical concepts, and uncover mathematical relationships; this space can be either a dedicated room or a classroom, depending on the nature of the laboratory work undertaken by the students²⁰.

Numerous definitions of the Mathematics Laboratory exist; some experts view it simply as a space where students engage with Mathematics, while others emphasize its various functional roles in facilitating learning. The Mathematics Laboratory is often described as "a specialized room equipped with manuals, computers, educational games, and commercial books necessary for enhancing mathematical understanding, utilized by teachers in diverse ways³⁴. Some educators employ the lab to teach specific lessons or reinforce particular concepts, and it has also served as a venue for various professional development programs."³⁵. It has been defined as "a space equipped with hand tools and other resources that students use to experiment, explore mathematical concepts, and uncover mathematical relationships; this space can either be a standard classroom or a dedicated room, depending on the nature of the laboratory work being conducted by the students." Some scholars view the Mathematics Laboratory as an environment where students engage with Mathematics by recognizing concepts, discovering principles, or applying mathematical abstractions to practical situations, often represented through mathematical models or practical activities like games, allowing students to formulate and apply abstract concepts through concrete examples. Additionally, it is described as "a designated room within a school that is specifically outfitted to teach Mathematics, featuring computers, displays, models, measuring tools, educational aids, and geometric instruments to facilitate mathematical activities and enhance geometric skills and interest in Mathematics."³⁶

Likewise, one scholar describes the Mathematics laboratory as a space where various activities can be conducted, such as storing, counting, ordering, recording, packaging, unpackaging, grouping, rearranging, measuring, and portioning, among many others. The Mathematics laboratory not only brings enjoyment and engagement to students but also enhances their capacity to undertake projects and activities that provide active, sensory experiences in Mathematics³⁷. Thus, it should be the central hub for all Mathematics-related work in schools. However, secondary school teachers often rely on conventional teaching methods for Mathematics concepts, which do not effectively improve students' academic performance in areas like mensuration, where mastering concepts is crucial before computations. Therefore, the instruction and acquisition of Mathematics ought to prioritize practical exploration and experimentation within a Mathematics laboratory, enabling students to recognize their true potential, cultivate a robust work ethic, and comprehend the significance of Mathematics in real-life contexts and national economic development.

The Mathematics laboratory is a dedicated space equipped with a variety of materials and teaching aids essential for helping students grasp mathematical concepts through relevant, meaningful, and hands-on activities³⁸. Both the instructor and the students can lead these activities, which promote inquiry, learning, and the growth of a mathematical interest. As an alternative, a Mathematics laboratory is defined as a dedicated space with up-to-date teaching resources for Mathematics education and scientific or research activities, where a qualified math instructor engages with pupils in accordance with predetermined guidelines. This laboratory is specifically designed for both improvised and original instructional materials that facilitate effective teaching and learning of mathematical concepts. Engaging learners with laboratory equipment reduce the abstraction of concepts, as they actively manipulate tools, conduct

experiments, and record observations. This hands-on approach not only fosters essential scientific skills and attitudes but also enhances student performance and aids in the future application of concepts in everyday life. It has been noted that the challenges of ineffective teaching can be effectively addressed through the strategic use of the Mathematics laboratory.

The following are some ways that a Mathematics Laboratory enhances learning:³⁹

- i. It offers pupils the chance to grasp fundamental mathematical principles through tangible items and scenarios.
- ii. It allows pupils to test or uncover many geometric characteristics and information using models or paper cutting and folding procedures.
- iii. It aids pupils in cultivating interest and confidence in the subject matter.
- iv. The laboratory offers the chance to demonstrate the connection between mathematical principles and everyday life.
- v. It offers enhanced opportunities for individual engagement in the learning process and fosters independent learning,
- vi. It allows for increased engagement of both the intellect and the manual skills, hence enhancing cognition.
- vii. The laboratory facilitates and promotes student engagement in critical thinking, dialogue with peers and instructors, and the successful assimilation of knowledge.
- viii. It prompts the educator to illustrate, elucidate, and reinforce abstract mathematical concepts through the utilization of tangible items, models, charts, graphs, images, posters, etc.
- ix. The quality of the teaching and learning experience in secondary school Mathematics is contingent upon the adequacy of laboratory facilities and the teacher's effectiveness in utilizing these facilities to facilitate meaningful learning experiences for students⁴⁰.

Abacuses, cardboards, tape measures, graphics, workbooks, graphs, flannel boards, flash cards, three-dimensional aids, filmstrips, photographs, constructed mathematical sets (wooden, metal, or plastic), charts, images, computers, software, and audio-visual instructional materials (such as projectors, electronic whiteboards, radios, televisions, tape recorders, and video tapes) are just a few of the materials or kits that are available in the Mathematics laboratory.

The availability of Mathematics Laboratory kits gives teachers a range of tangible teaching tools for various mathematical topics, which, when used, improves the caliber of math education⁴¹. Laboratory kits enhance educational efficiency by elevating the quality of instruction and learning. It provides a diverse array of learning experiences, either singly or in combination, to accommodate various teaching and learning needs, while fostering learners' development into proficient individuals with an enduring love for knowledge acquisition.

By encouraging students to improve their learning, laboratory kit materials provide teachers with interesting and useful venues for sharing knowledge. This helps the teacher overcome physical obstacles that may prevent him from effectively presenting a certain subject. In addition to encouraging teacher-student collaboration, using lab kits in the classroom encourages students to participate in more cooperative learning activities⁴².

The use of Mathematics lab equipment is essential to fostering secondary school pupils' enthusiasm and inventiveness in the subject. When utilized effectively in educational contexts, instructional materials may provide tangible foundations for conceptual thinking and significantly enhance student engagement, hence facilitating more enduring learning experiences⁴³.

The Mathematics Laboratory is a facility that houses a compilation of educational resources, games, puzzles, and assistance for the comprehension of mathematical concepts.

It is a place where students are provided with environment in which they learn mathematical concepts through set of activities. Some of the equipment/tools found in a Mathematics Laboratory are:⁴⁴

1. All 2-dimensional and 3-dimensional shapes.
2. Geo-board designed to contain most plane shapes.
3. Concrete materials. Containing items like beads, pebbles, scissors, razor blade, weights etc.
4. Pictures and charts
5. Mathematical models
6. All carpentry tools
7. Probability kits, also containing, draft game, ludo game, playing cards
8. Mathematical textbooks, past questions, answers and mathematical dictionary.
9. Posters, calendars, journals and newspapers.
10. Computers, cameras, internet facilities, printers, photocopying machines and thermometer.
11. Drawing instruments
12. Weighing and measuring instruments
13. Black board mathematical set.
14. Clinometer for measuring angles of elevation and depression.
15. Wall graph board
16. A world globe
17. Balance beam
18. Polygons of different varieties,
19. Wall clock
20. Paints of different colours, gums and cello tapes.

In a Mathematics laboratory, abstract topics ought to be shown with tangible items. This has the potential to augment pupils' interest in maths. Mensuration is one of these abstract ideas. Mensuration is the discipline of Mathematics that focuses on measuring geometric quantities, including surface areas and solid volumes. It's a practical branch of Mathematics. Simple mensuration and substantial mensuration are its two divisions.

i) Plain mensuration pertains to the measuring of perimeters and areas of two-dimensional figures, including polygons, among others.

(ii) Solid mensuration pertains to the quantification of surfaces, areas, and volumes of geometric figures such as cubes, cuboids, spheres, cones, and cylinders, among others.

Furthermore, the hierarchical structure of Mathematics indicates that information acquired at any level through laboratory materials might enhance students' performance. Consequently, mensuration is the fundamental aspect of comprehensive mathematical knowledge, particularly regarding the measurement, calculation, and estimation of lengths, areas, and volumes, along with the building of three-dimensional things. This study posits that use improvised materials to teach mathematical ideas, particularly in mensuration, might significantly fulfill the expectations for improved accomplishment. A Mathematics laboratory is a designated area for doing mathematical experiments and practical activities. It is a structured environment where students engage informally, navigate freely, converse, select their resources and methods, and independently formulate and uncover mathematical concepts⁴⁵.

The subsequent are some aims of the Mathematics laboratory, as it is intended:⁴⁶

- i. To instill enduring numeracy in the kids.
- ii. To render Mathematics education profoundly significant for the pupils.
- iii. To provide pupils a strong basis for critical and scientific thinking.

- iv. To render Mathematics education engaging and pleasurable for the students.
- v. To facilitate pupils' understanding and assimilation of mathematical information.
- vi. To cultivate enthusiasm in Mathematics and establish a robust basis for mathematical learning.
- vii. To foster and promote creativity among pupils.
- viii. To equip students to function effectively in the scientific and technology-driven world of today.
- ix. To reconcile the enormous divide between mathematical abstraction/theory and tangible/practical application.
- x. To furnish easily available, high-quality manipulative resources to underscore experiential learning.
- xi. To cultivate a mindset of inquiry.
- xii. To eliminate the deficiencies in contemporary Mathematics education.
- xiii. To cultivate interest in the topic.
- xiv. To cultivate alternative thinking in pupils.
- xv. It facilitates the practice of cognitive and psychomotor skills.
- xvi. It serves as a method for experimenting with and validating mathematical theorems, concepts, and axioms that are already familiar to the students. Competencies Developed at the Mathematics Laboratory.

Typically, the subsequent abilities are anticipated to be cultivated in students throughout their Mathematics laboratory experience:

1. The capacity to design an experiment and deconstruct a mathematical issue into its constituent elements.

2. The capacity to do an experiment, improvisation, or demonstration.
3. The capacity to analyse experimental or improvisational outcomes and formulate a potential conclusion.

To get the overarching skills, the subsequent particular mathematical competencies are instilled in pupils throughout Mathematics laboratory work:

1. Observation.
2. Developing hypotheses.
3. Quantification.
4. Categorisation.
5. Formulating an operational definition.
6. Instrument manipulation.
7. Enumeration.
8. Developing mathematical models.
9. Communication.
10. Variable manipulation.
11. Conducting experiments.
12. Forecasting. Inquiry.
13. Formulating conclusions. Mathematical Laboratory Apparatus.

The following supplies are acknowledged as necessary kits that need to be set up in a typical Mathematics Laboratory. They can be carefully created by students and teachers over a predetermined period of time, or they can be purchased from producers of mathematical teaching resources known for their correctness and precision. These include:

1. Geometric figures Fraction kits

Identity kits Geometry Geoboard

Geometry Geosticks Geometry manipulation kits

Two-Dimensional Geometry Kits Three-Dimensional Geometry Kits

Measurement Kits 10. Numerical and block sets

11. Pattern and block sets 12. Kits for Place Value

13. Organise kits 14. Temporal kits

Trigonometry sets 16. Data and financial tools

17. Cube Kits 18. Enumeration kits

19. Board game sets

Laminated board game.

For the enhancement of instructional materials and activities in the Mathematics laboratory, the following equipment is essential. These encompass:

1. A scale or weighing balance.
2. An electric or manual drilling equipment.
3. A drill bit in different diameters.
4. An engraving machine.
5. Pinchers, both little and large.
6. Hammer (various sizes).
7. Scissors in various sizes.
8. Hand saws of different sizes.
9. Cardboard documents.
10. Softwood or plywood.

11. The set of Mathematics.
12. A scientific calculator.
13. Nails in various sizes.
14. The binding wire.
15. Gums and glue.
16. Masking tape and sealer tape.
17. Graph paper.
18. Beads of various colors and sizes.
19. Threads.
20. Pliers.
21. A screwdriver.
22. Red and engine oil.
23. Various colored paint.
24. A tape measure.
25. Hand basin for washing.
26. First aid kit.
27. Wall clock.
28. Counting items (such as bottle caps and sticks).
29. soap and water.
30. A protractor and large meter ruler. Setting of a Mathematics Lab

When establishing an appropriate Mathematics laboratory for schools, the following aspects are crucial for user safety and equipment longevity⁴⁷.

1. Categorise the essential laboratory supplies by affixing name tags to them.

2. Assemble all pertinent equipment or supplies in a single location. For instance, geometric items should not be situated in the vicinity of audio-visual components.
3. Position the bulletin board at the entry door for the display of information.
4. Organise the seats and tables to provide unobstructed circulation throughout the laboratory.
5. Use picture rails and boards to display relevant charts and graphics. The starboard or whiteboard must be placed at a location visible to all students. Shelves can be built for the organisation and delineation of materials. Electronic devices, like projectors, televisions, and computers, must be appropriately exhibited. The laboratory's electrification must be executed by professionals to ensure safe usage.
6. Arrange items on tables systematically. The laboratory must be designed to ensure enough ventilation. Materials that are easily damaged or misplaced should be stored in a cabinet or on a separate shelf.
7. Organise the items in designated locations (on tables, shelves, boards, etc.) to ensure they are readily accessible when required and returned correctly after use. Upkeep of Mathematical Equipment Solutions for storage are crucial in the Mathematics Laboratory. Chemicals and other equipment should have their own shelves:
 - i. Cabinet (for equipment storage that is safe).
 - ii. Engine oil (to keep moving parts lubricated).
 - iii. Cabinets for keeping tools like saws and scissors.
 - iv. Red oil (used and preserved for saws)
 - v. Paints (for different uses).

- vi. Shelves (to display finished mathematical objects).
- vii. Regulations for the Mathematics Laboratory

Regulations are essential to direct the behaviour of Mathematics laboratory participants. The Mathematics laboratory attendant should enforce the following guidelines to advise users of the Mathematics laboratory⁴². These are:

1. Refrain from working in the Mathematics laboratory unless under supervision or granted permission.
2. Do not remove any items from the Mathematics laboratory without explicit permission from the maths instructor, and ensure they are returned promptly after usage.
3. Notify the Mathematics instructor of all mistakes, damages, injuries, or accidents.
4. Refrain from running or hastily entering the Mathematics laboratory.
5. Adhere to all directives or instructions as they are articulated.
6. Refrain from doing any unauthorised experiments or improvisations in the Mathematics laboratory.

Consequently, due to the incidence of injuries and fire hazards, first aid kits and fire extinguishers must be supplied. The first aid pack must have provisions for the treatment of prevalent ailments such as cuts, burns, and bruises. The subsequent items are anticipated to be present in the first aid kit of a Mathematics laboratory:

1. Adhesive bandage.
2. A pair of scissors.
3. Three different-sized bandages.
4. Pads made of sterile cotton wool.

5. Bath for the eyes.
6. Safety pins.
7. A mild antiseptic container.
8. Salve that is antiseptic.
9. Solution for ocular irrigation .

It is essential to ask a medical officer to instruct the students on the contents of the first aid bag, its proper usage, and the appropriate circumstances for its application. The Mathematics instructor and students must be aware of how to ensure the laboratory is safe from various hazards that may occur during their work, as both parties are at risk. Injuries, both internal and external, may arise from the use of improper techniques or equipment in the laboratory. The safety regulations encompass:

1. Students may enter the Mathematics laboratory just during mathematical practicals or improvisations, in the presence of the teacher; any other exceptions must be authorised by the math instructor.
2. Play and jokes are not allowed in the Mathematics Laboratory. This is a venue for serious individuals, hence the focus should be on engagement rather than amusement or jest.
3. To comprehend the tasks and the equipment or supplies needed for execution, the students must carefully go over each component of the laboratory experiments or improvisations.
4. Students are cautioned from using broken or fractured apparatus or materials, since they may sustain further harm during experimentation or improvisation.
5. The students must review the background information pertinent to the laboratory activity they want to do. They must understand the objectives of the laboratory work and the experiences they need to acquire prior to entering the laboratory.

An ideal Mathematics laboratory should be having the following properties:

Design and overall arrangement:

A perfect Mathematics Laboratory can hold around 32 pupils at once. The overall layout and design may be altered by the schools to meet their own needs.

Physical facilities and supplies: It is intended that each school will have a Mathematics lab with the overall layout and design shown, with appropriate modifications made to fit the needs of the school if required. Furniture, all necessary equipment, raw materials, and other items needed to complete the tasks may be among the bare minimum of supplies that must be kept in the laboratory. Depending on the size of the group, different schools may have varied amounts of various resources.

2.1.5 Class Size

Class size denotes the quantity of pupils allocated to a teacher during a designated instructional interval⁴⁷. It might represent the average number of students in a school, district, or other educational establishment, or it could represent the total number of students taught by certain teachers in a particular course or classroom. In many underfunded schools, increasing class sizes has become a necessary compromise to remain operational amid rising populations and decreasing funding. Overcrowded classrooms can create frustrating and stressful environments for both teachers and students, posing significant challenges that can hinder effective teaching and diminish teacher productivity. To ensure quality education and enhance academic performance, especially as students approach the end of their secondary education, it is crucial to facilitate effective teaching and learning within a manageable class size⁴⁸.

Class size denotes the quantity of pupils for whom a teacher holds primary responsibility over an academic year⁴⁹. It may be thought of as the typical number of pupils in each class in a school, which basically represents the student-teacher ratio. This ratio serves as a tool for measuring the performance of the education system and assessing work productivity. While a class may be considered large if it exceeds 25 students, it has been noted that mere numbers are insufficient to establish a universally accepted definition of class size, even within a single country. Furthermore, research indicates that class size significantly influences student performance, suggesting that defining a large class requires consideration of various additional factors beyond just the number of students.

Class size refers to the quantity of pupils for whom a teacher holds primary responsibility over an academic year. This may be regarded as an educational instrument that illustrates the mean student count per classroom inside an educational institution. Class size denotes the precise number of students instructed by a teacher at a given moment, indicating the student-to-teacher ratio⁵⁰. This ratio functions as an indicator of the education system's efficacy and overall production. Research indicates that reduced class sizes frequently result in enhanced academic performance, with studies demonstrating that students in smaller classrooms outperform their counterparts in bigger classes. Reduced class sizes enhance contact between educators and students, leading to superior performance, especially in examination results. In fact, a comprehensive review of randomized experiments has demonstrated that smaller classes tend to enhance test scores. Conversely, larger class sizes limit opportunities for meaningful one-on-one interaction between students and teachers, ultimately hindering academic performance. It has been concluded that class sizes exceeding 40 negatively impact student achievement, as larger

groups packed closely together for extended periods are less likely to perform efficiently on challenging learning tasks and interact harmoniously⁵¹.

The investigation of the correlation between class size and student academic performance originates from the early establishment of the American educational system⁵². One of the initial motivations for this research was the need for educational administrators to optimize the use of funds allocated for education. In the early twentieth century, superintendents sought to implement Frederick Taylor's principles of scientific management in education, analyzing per-pupil costs and adjusting class sizes to improve cost-effectiveness⁵³. William McAndrew, a superintendent in Chicago, exemplified this approach by evaluating the staffing efficiency of smaller class sizes and conducting empirical studies to support larger classes. His efforts contributed to the development of formulaic methods for determining appropriate instructional workloads, establishing class size norms in many districts. As educational leaders sought to justify increasing class sizes, numerous descriptive analysis studies emerged through the mid-twentieth century, typically revealing a positive correlation between smaller class sizes and enhanced student academic performance in elementary grades. Subsequently, researchers employed survey methodologies to further investigate the extent of the relationship between class size and academic achievement⁵⁴. Survey research offered qualitative insights into stakeholders' perceptions of class size; however, the findings were often inconclusive. Factors such as socio-economic status and peer influence were frequently identified as more significant determinants of student academic achievement than class size. Consequently, scholars began to critically analyze previous research on class size, arguing that any observed positive effects of smaller classes stemmed from methodological flaws. Some researchers contended that smaller class sizes had minimal to no impact on student academic performance, citing their own studies

to support this view⁵⁵. Additionally, the reliance on a student-to-teacher ratio as a measure of class size, rather than the actual number of students assigned to each teacher, faced criticism from other academics.

A large class size is defined as having 41 or more students per teacher, while a small class size typically consists of 15 to 40 students per teacher⁵⁶. There has been considerable debate regarding the impact of class size on student performance, with many attributing the decline in educational standards, particularly at the junior secondary level in Nigeria to overcrowded classrooms⁵⁷. Researchers and educational scholars largely agree that student achievement diminishes as class size increases. Studies have shown that teachers can devote more time to individual students in smaller classes, ensuring that each learner comprehends the material being taught. Rubin emphasized that the individual attention provided in smaller classes enhances teaching quality and facilitates the learning process. Conversely, larger classes present numerous challenges, including difficulties in classroom management, student control, grouping, excursions, experiments, marking, planning, and effectively assessing student progress⁵⁸. The size of a class directly affects the quality of teaching and learning; smaller classes reduce the time spent on classroom management, leading to improved academic outcomes. In contrast, overcrowded classrooms can increase the likelihood of mass failure and diminish student interest in learning, as large class sizes inhibit individual student engagement and prevent meaningful teacher-student interaction, ultimately resulting in frustration and poor performance⁵⁹.

A study conducted at both primary and secondary levels revealed that in larger classes, student interaction with teachers significantly decreased, leading to lower levels of student engagement⁶⁰. Logically, as class size increases, the time teachers spend on procedural matters also increases, which reduce the time available for instruction and individual student support.

Consistent evidence indicates that smaller classes foster more interaction between students and teachers, facilitating one-on-one engagement that can enhance students' interest and improve academic performance. In Nigeria, growing class sizes are becoming increasingly unmanageable, making it difficult for teachers to provide the individual attention necessary for effective learning. As a result, teachers' eye contact with students has diminished, allowing poorly motivated students to disengage and engage in non-academic discussions during lessons. Class size has been shown to have a significant impact on the amount of individualized attention provided, the speed and responsiveness of teachers to students' needs, the quality of long-term, purposeful interactions between teachers and students, and the teachers' awareness of each student's needs.

Class Size and Classroom Management

Educational leaders may learn more about the need to defend per-pupil spending by looking at the historical context of class size in our country⁶¹. Class size affects instructional practices, as demonstrated by prior studies that looked at the connection between instructors' instructional strategies and class size. To comprehensively assess the impact of class size on the instructional environment, educational leaders must evaluate the time instructors dedicate to classroom management, since this directly influences their ability to concentrate on instruction. Data from teacher surveys and interviews indicate that larger classes are more challenging for teachers to manage in terms of student discipline, often shifting the classroom focus from academic achievement to behavior management⁶². Students in smaller courses (average of 19 students) were reported to participate more in instructional activities and less in non-academic

contacts than those in bigger classes (average of 32 students). The increased number of students in larger classes limited teachers' ability to cover content in depth due to lost instructional time spent addressing behavioral issues. Additionally, teachers noted that smaller class sizes led to fewer discipline problems, as the more personal environment allowed them to build stronger relationships with students, thus preventing potential behavior management issues from arising⁶³.

Classroom management entails governing the classroom environment to promote significant learning. It includes the techniques and tactics utilised by educators to establish an environment conducive to effective teaching⁶⁴. However, observations indicate that teachers often struggle to maintain a well-managed classroom due to large class sizes, leading to distractions among both students and teachers, which negatively impacts the learning process. Research has concluded that improving teacher performance is linked to having a sufficient number of qualified educators in overcrowded schools. Given the known relationship between teacher credentials and student learning results, reducing class numbers without taking into account the qualifications and performance of the teachers may negate the potential gains in student attainment. Smaller class sizes, on the other hand, have been associated with lower levels of stress among teachers, which is crucial for preserving their consistency and retention. This indicates that decreasing class size may improve student performance over time when teachers attain greater stability in their roles. Research has demonstrated that overcrowded classrooms in Lagos State substantially hinder the instruction and comprehension of Mathematics⁶⁵.

Large class size is a significant issue facing the education sector in developing nations like Nigeria⁶⁶. The country grapples with this challenge at both pre-tertiary and tertiary levels, with most schools, colleges, and universities experiencing overcrowded classrooms. Educators have often linked these large classes to lower test scores, particularly in Mathematics, as they

pose serious challenges for teachers, school authorities, and other stakeholders. The reality is that student enrollment often exceeds the available facilities, infrastructure, and teaching staff in these institutions⁶⁷. A big class in the United States or the United Kingdom may be viewed as tiny by both teachers and students in the majority of African educational contexts, according to the idea of class size and the discussion around student-teacher ratios⁶⁸. It was further explained that large class can vary from twenty-two (22) in US elementary schools to one hundred and fifty (150) in an Africa classroom. The United States Agency for International Development (USAID) indicated that a class size of thirty (30) is deemed excessive in Western nations and should be decreased. The decrease should encompass physical circumstances in the classroom, including available space and human resources. In Nigeria, there is appropriate class size in learning and has a policy that guides the ratio of teacher to student in classroom environment. The standard ratio of teachers to students in junior secondary school is 1: 35. Although, some schools observed it, but most schools do not observe the policy due to inadequate learning facilities.

Overpopulation is a key factor contributing to large class sizes. It refers to a situation where the number of people in a given area surpasses the available resources, leading to increased competition for these resources and a generally low standard of living. This imbalance indicates a deficiency in resource development relative to the population size, which adversely affects the overall progress of the education sector. Education encompasses the knowledge and skills that a country's population should acquire; however, the ability to meet the educational needs of a growing population remains a long-term challenge. This situation is particularly evident in urban areas with increasing secondary school populations, such as in the Oyo educational zone, which is in need of significant reform⁶⁹.

Educational policies in Nigeria often fail to address the specific needs of its citizens, particularly in the context of an ever-growing number of educational institutions⁷⁰. This misalignment negatively impacts the standard of education, as many students struggle to engage with their teachers in overcrowded classrooms, where fear and discomfort may lead them to disengage. Overpopulation is especially prevalent in urban schools, which tend to accommodate far more students than their physical structures can support. Academic attainment may be hampered by the lack of learning tools, poor library collections, and a lack of storage space for educational resources that are common in schools with large class numbers, according to research. Furthermore, the challenge of insufficient teachers, learning materials, and classrooms is a complex, global issue. In Nigeria, particularly in major urban areas, classes often exceed 50 to 100 students, exacerbating shortages of qualified teachers and diminishing students' performance. Urban schools are grappling with increasing enrollments and overcrowded classrooms, leading to inadequate learning and teaching resources, which ultimately affects the quality of education provided to students⁷¹.

The center of any educational establishment is the classroom. Since most learning activities take place in the classroom, curriculum design is not complete without the implementation and evaluation of curricular results there. For pupils, the classroom setting becomes a crucial component of their education. Classrooms that are warm and friendly are essential for effective student performance⁷². Large class sizes are a result of many schools' inability to handle the growing number of pupils, according to a research conducted in urban schools in New York⁷³. "The bridge between a good physical environment and effective students' learning" is removed in this case (74). On the other hand, a solid foundation for an efficient learning environment may be established with proper classroom management and sensible handling of suitable strategies for

big class numbers. According to it, schools have to be able to offer pupils individual counseling and testing areas that are peaceful and secure⁷⁵. A well-organized classroom offers a solid basis for high-quality instruction. According to their research, schools with lower noise levels had better learning results than those with greater noise levels. Generally speaking, pupils in larger class sizes tend to create more noise than those in smaller ones⁷⁵. For students to learn well and to be able to hear and comprehend what is being said in order to complete assigned activities, they require a peaceful setting. Students perform poorly when this capacity is compromised by superfluous noise. Teachers claim that overcrowded schools impede learning, produce more paperwork and non-instructional responsibilities, and are louder. According to these research, pupils learn more effectively in a calm setting⁷⁵.

Educational policies in Nigeria often fail to meet the specific needs of its citizens, particularly amidst the growing number of educational institutions⁷⁶. This misalignment negatively impacts educational standards, as many students find it difficult to engage with teachers in overcrowded classrooms, where fear and discomfort can lead to disengagement. Overpopulation is especially prevalent in urban schools, which often accommodate far more students than their physical structures can support. Research indicates that schools with large class sizes frequently face shortages of learning materials, inadequate library resources, and limited storage for educational materials, all of which can hinder academic achievement. Additionally, the challenges of insufficient teachers, learning resources, and classrooms represent a complex global issue. In Nigeria, particularly in major urban areas, classes often exceed 50 to 100 students, exacerbating shortages of qualified teachers and diminishing student performance. Urban schools are grappling with rising enrollments and overcrowded classrooms,

resulting in inadequate teaching and learning resources, which ultimately affects the quality of education provided to students.

Small classes can enhance student engagement when instruction emphasizes discussion, enabling greater participation and recognition among students compared to traditional lectures and seatwork⁷⁷. While all students can benefit from smaller class sizes, research indicates that these advantages are particularly pronounced for minority students and those in inner-city schools. For these populations, smaller classrooms can mitigate the achievement gap, diminish grade retention, minimise disciplinary problems, cut dropout rates, and enhance the proportion of students participating in college admission examinations. Positive effects of small classes were observed in areas such as time spent on tasks, personalized instruction, classroom behavior, and teacher satisfaction. However, findings regarding academic achievement were inconsistent, with small classes sometimes showing better outcomes while, at other times, larger classes performed equally well or better.

Moreover, several studies have highlighted the direct effects of large class sizes on student outcomes, discipline, and classroom management. Overcrowded classrooms can negatively influence students' learning experiences⁷⁸. Affected students may struggle with academic performance, while teachers encounter various challenges, including discipline issues, behavioral problems, poor health, increased stress, and higher dropout rates. Quality learning becomes unattainable when too many students are crammed into small classrooms. The researcher observed this issue firsthand in various schools, particularly in locations such as Florida, Santiago, and Dallas' Escuela Hogar, where classrooms designed for a maximum of 35 students often accommodated over 40, leaving little room for movement or individual work. An indigenous researcher noted a weak positive correlation between teachers' and students'

perceptions of classroom overcrowding. Findings indicated that overcrowding significantly diminished the effectiveness of teaching and learning, leading to serious implications for achieving educational objectives. It was recommended that educational planning prioritize the construction of additional buildings and the provision of adequate furniture at all levels.

Additionally, several studies have demonstrated the direct impact of large class sizes on student outcomes, discipline, and classroom management. Overcrowded classrooms can significantly hinder students' learning experiences. Students' academic performance suffers, and teachers face numerous challenges, including discipline issues, behavioral problems, poor health, heightened stress levels, and increased dropout rates⁷⁹. Achieving quality learning becomes difficult when too many students are crammed into small classrooms. The researcher visited various schools and found this to be a significant issue, particularly in schools located in Florida, Santiago, and Dallas' Escuela Hogar. He reported that more than 40 students were often squeezed into classrooms meant for no more than 35, leaving them so close together that they struggled to work or move effectively.

Problems of Overcrowded Classes

Enumerating all the issues associated with overpopulated classes is quite challenging. Nevertheless, there are specific issues that may appear minor from a broad perspective but might adversely impact the teaching-learning process. Indeed, there are specific issues associated with the overcrowded Mathematics teaching courses that must be overlooked at any moment.

Discipline: Educators encounter challenges in managing their pupils, who generate noise particularly during activities or upon completing tasks ahead of their peers, rendering it difficult for teachers to regain control. An orderly classroom is the best setting for a teacher to impart knowledge. Only when a class has an average level of strength is discipline possible. It is

impossible to maintain discipline in a class of more than 40 students. Even if a teacher is extremely skilled in his subject, well-prepared, quick-witted, and clever, he may find it difficult to maintain order in large classes“...it is noisy, some students who aren’t interested in class will disturb the others...when we have the activities in class, it will be difficult to control or to solve their problems”⁷⁶.Discipline issues frequently arise in overcrowded classrooms, necessitating that the instructor have the expertise to prevent such problems from arising.

Discomfort:

Numerous educators and students may experience discomfort in an overcrowded classroom, perhaps leading to feelings of unhappiness and hopelessness due to the prevailing hostile environment. Educators are unable to maintain adequate eye contact with the class. They are unable to maintain a continuous high-pitched vocalisation. They are unable to engage their students in educational activities. If they are unable to do so, they become anxious, thereby disrupting the natural flow of the teaching-learning process. “Large size of class makes me frustrated and tired and I feel hopeless to manage the class successfully⁷⁶.” Therefore, it is essential for the classroom to have a conducive environment for effective engagement.

Individual attention:

Owing to the substantial student population and the limited time available, educators are unable to attend to each individual student in the classroom. I am unable to familiarise myself with and monitor the development of all the students in my class due to their overwhelming number and diverse characteristics⁷⁷.”

Instructors assert that they cannot attend to every student, which implies that there is insufficient support to motivate everyone to engage in various activities.Participants in a study commented that "due to the size of the class they do not have enough time to pay attention to each and give

every student a chance to speak and participate"⁷⁸. This setting causes certain pupils, particularly the timid or less capable, to be overlooked and marginalised. They contend that it is challenging to address all occurrences in class when the student count beyond a specific threshold.

Evaluation of students' progress:

Various studies have demonstrated that it is exceedingly challenging for instructors to conduct effective evaluations in big classrooms. The educators find it exceedingly problematic to oversee and provide enough feedback to a class exceeding forty pupils; furthermore, it is difficult to assess all the assignments completed by each student in the classroom. Rectifying their errors becomes nearly unfeasible. Collaborative activities in pairs, groups, and trios become unfeasible. The teacher finds it burdensome to evaluate an excessive number of homework submissions. Nonetheless, this judgement is crucial in the educational framework.

Teaching-learning process:

In an overcrowded classroom, the teaching-learning process becomes very sluggish. Numerous diversions and interruptions exist. The teacher is inaudible to the students. The lesson is noisy due to congestion. The pupils find it simpler to converse with one another than to enquire of the teacher and listen to him. The class suffers from an inadequate teacher-student interaction, disrupting the teaching-learning process. '...I am not sure that my students get what I have taught exactly. It is difficult to control the students and I don't know what they have learned because there are a lot of students. Some may understand, but some may be not understood and the teacher does not know what to do'⁷⁶.

Teaching through lecture method only:

Teachers are forced to use the lecture method exclusively in large class sizes. Methodology and class size are almost intertwined. As a result, research on lecture vs discussion and class size overlap. Compared to small courses, large classrooms are more likely to use lecture techniques and less likely to participate in discussions. This raises the question of how learning results from courses delivered only through lectures in large class settings compare to those attained in smaller classrooms, when discussion methods are more frequently utilised. The lecture technique is unsuitable for teaching Mathematics. Through the lecture technique, educators serve as the conduit for the oral transmission of knowledge, which students acquire and assimilate. The figure subsequently enlarges and advances. In the lecture technique, the instructor must ensure that the student's interpretation of material is accurate and that the comprehended message is retained. The teacher's dissemination of material is predicated on its presumed validity. The lecture approach requires modification and, under some circumstances, replacement with alternate methodologies. Consequently, we can ascertain that the lecture approach is not universally applicable to all mathematical tasks and classes.

Methods and strategies of teaching Mathematics in overpopulated classes

In the context of scientific disciplines, instructing large students may not pose significant challenges. In these disciplines, students can be effectively instructed in groups. Teaching Mathematics in a big class is a challenging endeavour. The below tools and ideas can assist Mathematics educators in instructing big classes.

Managing pair and group work:

Pairing work is an activity wherein two pupils collaborate. When the number of pupils exceeds two, it is referred to as group work. These two categories are crucial when instructing a large class. For instance, the educator can optimise engagement, provide explicit instructions,

and deliver feedback using these strategies. Pair and group activities will encourage reticent pupils to engage in conversation. When accompanied by one, two, or three peers, they experience less pressure than when required to address the entire class. Effective management of pair and group work is essential in some tasks; yet, educators may encounter challenges in other instances. Thus, even when chairs and desks remain stationary, there are methods to do this: first rows rotate to face second rows, and third rows turn to confront fourth rows. Consequently, educators must be innovative in devising various methods for group formation.

Managing discipline:

Discipline is vital in any classroom. Managing discipline in an overcrowded classroom is a challenging endeavour that necessitates explicit regulations. Formulating a code of conduct collaboratively developed by educators and students. It should articulate explicit fundamental conduct guidelines that learners comprehend, such as: they must work quietly; they may converse, but not noisily; and pupils who have completed the lesson duties may read a book to occupy themselves. Furthermore, educators ought to engage with students and cultivate a positive learning environment in big classrooms. Collaboration is essential in big courses, since many students like the 'secure' learning environment they provide. Consequently, educators of extensive classrooms should capitalise on this opportunity to foster a collaborative and dynamic learning environment.

Moreover, educators should capitalise on the benefits presented by the size of big classrooms. It was contended that when we regard a large class as a more advantageous chance for the instructor, we focus solely on the positive attributes of such a class. Experience and practice among educators in big courses demonstrate that it is not only possible to cultivate a positive

learning environment but also advantageous to leverage the size of the class. Furthermore, several researchers assert that educators ought to consistently interact, deliberate, and exchange classroom management strategies with their colleagues engaged in big class instruction⁷⁷.

Managing students' anonymity:

The teacher must be familiar with the names of at least some of his students through various methods. He may explore methods to enhance personal accessibility to students through various strategies, such as arriving early to engage in conversation with those present, greeting students upon their arrival, remaining briefly after class to address individual enquiries, and considering lecturing or facilitating discussions from diverse locations within the classroom to foster a sense of active participation rather than mere observation. When the instructor poses questions, he may begin on a personal level, inviting pupils to share their individual experiences related to a concept, before transitioning to a more abstract discussion. Students should familiarise themselves with one another to avoid feelings of neglect and isolation.

Managing teaching method:

The management of pedagogical strategies is a strategy that can assist Mathematics educators in enhancing interaction and attaining improved learning results. Selecting the optimal approach for instructing Mathematics in a big classroom may alleviate several challenges associated with overcrowded environments. For instance, recalling the attributes of the most ineffective lectures experienced by instructors during their student years and endeavouring to avoid replicating them. This may encompass reading directly from the required book, delivering 60 minutes of uninterrupted teaching, and presenting obsolete or inaccurate information. Furthermore, audio-visual aids should be delivered in an engaging manner that maintains students' attention on the subject. Conclude the lesson by summarising the key themes discussed

throughout the lecture and providing students with an overview of what to anticipate for the next session.

2.1.6 Parent Socio Economic background

A person's socioeconomic background or status, as indicated by their money, employment, level of education, and social class, indicates where they stand within a certain group, society, or culture. Children whose cognitive development is impeded by adverse socio-economic, cultural, and linguistic conditions, as well as inadequate schooling and familial instability, exhibit higher deficiencies in some abstract non-verbal abilities than in their actual academic performance⁸⁰.

Parental education

The educational attainment of parents significantly influences the value they assign to education, which in turn affects their educational practices at home. Educated parents are more likely to pass on the academic culture they experienced, positively impacting their children's learning and performance. According to research, parents with higher levels of education are more likely to help their kids develop positive self-perceptions about their academic skills and to support intellectual pursuits, which reduces the likelihood of behavioral problems that might obstruct learning. Furthermore, compared to their classmates whose parents have lesser educational attainment, children of highly educated parents frequently exhibit statistically significant academic increases. Additionally, parents with more education are more likely than parents with less education to include their kids in literacy-related activities.

According to research, parents' expectations and opinions about their children's education are indirectly related to their reading and math proficiency. Parents with greater levels of education

typically have higher expectations for their kids, and they frequently modify these expectations in response to how well their kids do⁸¹. Furthermore, the educational level of mothers is found to have a stronger correlation with children's math achievement than that of fathers. One study indicated that the years of schooling completed by mothers accounted for 9% of the inequality in children's reading achievement and 8% in math achievement. Additionally, research has demonstrated that parents' overall education, as measured by the number of years of schooling, relates to their language experiences, which affects how they communicate with their children, ultimately influencing children's performance on vocabulary and linguistic competence tests. Researchers have looked at how parental education affects early school departure at age 16, especially when it comes to differences in permanent income. Their results show that parental education levels are positively correlated with beneficial child outcomes, with mother education having a stronger influence than father education, particularly for sons.

Additionally, Studies show that while parental goals for their children's education are connected to the children's professional aspirations by age 16, children of highly educated parents tend to succeed in social-behavioral characteristics, like self-regulation and pro-social conduct. Furthermore, Children whose parents have at least a degree or vocational equivalent often show six months ahead in language and reading abilities than their counterparts whose parents lack educational background⁸².

Similar findings have emerged from African countries, where parental education significantly influences student achievement. For instance, a study on Moroccan students reported total effects of parental education on achievement as 0.19 in Mathematics, 0.19 in science, and 0.24 in reading. In Botswana, the reported effects were even higher, with parental

education correlating to total achievement effects of 0.41 in Mathematics, 0.45 in science, and 0.48 in reading.

Parental income

The potential social and financial resources available for a child's education are reflected in parental income. While children from lower-income homes have inferior cognitive, social-behavioral, and health outcomes, children of wealthy parents may grow up healthier, more behaved, and better educated⁸³. Richer parents can afford to provide their kids more and better chances, but kids from low-income families experience ongoing stress, which hinders their ability to learn⁸⁴. Moreover, Poor parents are more likely to be raising their kids alone, work irregular hours, or have rigid job schedules, which leaves them with less time to devote to their kids⁸⁵. Child outcomes (such as cognitive test scores, socioemotional functioning, behavioral issues, physical health, educational achievement, and future economic standing) are strongly correlated with parental income, with the greatest impact shown in cognitive test scores and educational attainment⁸⁶. It has been discovered that parental income significantly affects children's reading and arithmetic proficiency. Children from more affluent homes were projected to be more affected⁸⁷. Another study examined the relationship between parental income and education and children's reading and math success using structural equation models, or SEM. The author discovered a slight, indirect relationship between money and reading and math proficiency⁸⁸. Similarly, A research sought to determine whether financial resources are the cause of differences in child outcomes. They looked at studies that used instrumental variable approaches, randomized controlled trials, natural experiments, longitudinal data, and the United States, United Kingdom, Canada, Norway, and Mexico. According to their findings, children

from lower-income families do badly in terms of their cognitive, social-behavioral, and health skills⁸⁹.

What policy solutions can address the issue if, as previously said, low parental income is a risk factor for children's academic performance? According to the investment model, parents buy more child-specific products and services when their income increases, which might improve the results for their children⁸³. The author claims that children's cognitive test results would typically rise by around 10% of a standard deviation if parental wealth were doubled.

2.2 Theoretical Review

2.2.1 Activity Theory

Activity Theory (AT) originates from the work of Vygotsky, Leont'ev, and Engeström and is rooted in the understanding that human activities are systemically organized around the use of tools (both physical and symbolic) and are mediated by social and cultural contexts. It emphasizes the dynamic and systemic interactions between individuals and their environment. An action invariably involves an item. The object serves as the focal point of the activity inside the system that individuals are required to do. The objective of the action may manifest in either physical or mental form, serving as its intended purpose. The objective of the action serves as the impetus that drives the subject to alter the item, transform it into a product, or assimilate it mentally, so establishing a new psychological framework. The subject of an activity is a student or students participating in the activity, and the object is owned by the subject. The activity is aided by a tool⁹⁰. Activity theory states that an object (the activity's object) is what motivates an activity (or occasionally an activity system) and what sets one activity apart from another. This goal is known as the motivation of activity in certain books. Even if the motivation isn't always obvious, it drives every action. It is called a motive-goal when it is stated⁹⁰.

In the context of Mathematics education, a Mathematics laboratory can be considered a tool that mediates students' learning activities. The laboratory provides concrete, hands-on experiences that facilitate deeper understanding of abstract mathematical concepts.

Key Concepts of Activity Theory:

1. Subject: The students engaging in learning activities.
2. Object: The academic achievement and understanding of mathematical concepts.
3. Tools: The Mathematics laboratory equipment and resources.
4. Community: The classroom or school environment, including teachers and peers.
5. Rules: The guidelines and pedagogical approaches governing the use of the lab.
6. Division of Labor: The roles of students and teachers in the learning process.

Application of the theory to Academic Achievement:

1. Mediation by Tools: Mathematics Lab: Serves as a mediating tool that transforms abstract mathematical problems into tangible tasks. This hands-on manipulation helps in conceptual understanding and retention of mathematical concepts, thus improving academic performance.

Enhanced Engagement**: The interactive and exploratory nature of lab activities increases student engagement and motivation, leading to better academic outcomes.

2. Collaborative Learning: Community and Division of Labor: Activity theory emphasizes the social aspect of learning. In a Mathematics lab, students often work in groups, facilitating collaborative learning. This interaction helps in the exchange of ideas, peer teaching, and collective problem-solving, which enhance understanding and achievement.

3. Systemic Approach: Holistic View: By considering the entire activity system, including the interplay of tools, community, rules, and division of labor, educators can design more effective

learning environments. This holistic approach ensures that all elements of the learning process are aligned to support students' academic achievements.

4. **Dynamic and Iterative Learning: Continuous Feedback:** The iterative nature of lab activities allows for continuous feedback and adjustment. Students can experiment, make mistakes, and learn from them in a supportive environment, leading to incremental improvements in their understanding and academic performance.

Research has indicated that students' academic performance is positively impacted by the utilization of Mathematics labs. In contrast to pupils without access to such facilities, students who participated in practical activities in Mathematics laboratories shown a notable improvement in their problem-solving abilities and general mathematical ability. Activity Theory provides a robust framework for understanding the impact of Mathematics laboratories on students' academic achievements. By highlighting the importance of tools, social interaction, and systemic organization, AT underscores the value of hands-on, collaborative, and dynamic learning environments in enhancing students' understanding and performance in Mathematics.

2.2.2 Cognitive Psychology

Understanding how individuals think, learn, and remember is the main goal of cognitive psychology. It examines internal mental processes such as perception, memory, and problem-solving. Key theories within cognitive psychology, such as Piaget's stages of cognitive development, Vygotsky's social constructivism, and information processing theory, offer insights into how students learn and process mathematical concepts.

A Mathematics laboratory serves as an interactive environment where students can engage with mathematical concepts through hands-on activities. This aligns with cognitive psychology

principles that emphasize active learning, sensory engagement, and the development of cognitive structures.

Key Concepts of Cognitive Psychology

1. Active Learning:

- Engagement: Cognitive psychology posits that active engagement with material leads to better learning. In a Mathematics lab, students manipulate objects and experiment with mathematical concepts, making learning more interactive and effective.

2. Knowledge Construction: According to Piaget and Vygotsky, learners construct knowledge through experiences. The Mathematics lab provides concrete experiences that help students build and refine their understanding of abstract concepts.

3. Memory and Retrieval: Cognitive psychology explains learning in terms of how information is encoded, stored, and retrieved. Lab activities, through repetitive and varied practice, enhance memory retention and retrieval of mathematical concepts.

1. Enhancing Cognitive Processes: Using physical objects in a lab helps students visualize and understand abstract concepts, which improves comprehension and problem solving skills, this aligns with Bruner's theory of representation, where enactive (hands-on) learning precedes iconic and symbolic understanding.

2. Zone of Proximal Development (ZPD) and scaffolding: Vygotsky's ideas about ZPD and scaffolding can be used in Mathematics Laboratories. Students get help from teachers and friends when they are working on difficult tasks, but as students get better, they get less help.

3. Simplified Learning: Mathematics labs help in reducing cognitive load by breaking down complex problems into simpler, manageable tasks. This fits with Sweller's Cognitive Load

Theory, which says that getting rid of unnecessary mental stress can help people learn and solve problems better.

4. Reflective Thinking: Cognitive psychology emphasizes the role of metacognition—thinking about one’s own thinking. Lab activities encourage students to reflect on their problem-solving strategies and outcomes, promoting deeper understanding and self-regulation.

Research supports the cognitive benefits of using Mathematics labs. For instance, a study found that students who engaged in laboratory-based activities showed improved mathematical reasoning and problem-solving skills compared to those who learned through traditional methods⁹².

Cognitive psychology provides a comprehensive framework for understanding how Mathematics laboratories enhance students’ academic achievements. By engaging students in active, hands-on learning, facilitating knowledge construction, reducing cognitive load, and promoting metacognitive awareness, Mathematics labs align with key cognitive principles, thereby improving comprehension, retention, and application of mathematical concepts.

2.3 Empirical Review

2.3.1 Mathematics Laboratory and Students Academic Achievement

A study looking at how many tools are available in the Mathematics Laboratory and how that affects the math skills of senior high school students in southwestern Nigeria³⁸. The study found that 75% of the 1,750 senior secondary school students and 123 Mathematics teachers from two schools in the congressional districts agreed that a Mathematics classroom was important. Also, students who used the Mathematics Laboratory did better (65%) than students who didn't use it. Using a Mathematics Laboratory as a way to teach and figure out what problems students are having with Mensuration has worked out well. There was another study

that showed that using a Mathematics laboratory was better than lectures for teaching and understanding math in terms of students' achievement⁴⁰.

Another expert looked into how the Montessori method (Mathematics classroom approach) could be used to get students more interested in measuring things. The results of this study showed that gender was statistically significant, with boys doing better than girls ($F=10.248$, $p < 0.05$). The study found that when looking at how active learning affected students' progress in Mensuration, male students did not do much better than female students⁹⁵. However, in a study of geometry and measurement using the Mathematical Laboratory (games and simulations) in Eastern Nigeria with 158 boys and 129 girls in SSS1, the boys did better than the girls⁹⁶. Furthermore, another researcher looked into what happens to the math achievement of students when they use a Mathematics laboratory to teach math⁹⁶. The study looked at what happens to students' grades in Junior Secondary School Mathematics when they use a Mathematics Laboratory as part of their lessons. One hundred kids in math took part in the study. The study was kind of like an experiment. The mean, the standard deviation, and analysis of covariance (ANCOVA) were used to look at the results. The results showed that using a Mathematics Laboratory made math skills better. The data showed that there was no significant difference between how well male and female math students did when they were taught in a math classroom.

A study was conducted to assess how well a laboratory teaching method affected eighth-grade students' mathematical proficiency. Examining how a laboratory teaching method affected students' performance in Mathematics and examining the effects of factors like gender, IQ, and socioeconomic status on achievement were the main goals of. This study employed an experimental technique. Two hundred twenty children were recruited from Standard VIII of

GurukrupaVidyalay, Ahmedabad for the experiment. The instruments employed in the study included an achievement exam, an IQ test, a socioeconomic status (SES) test, and a Laboratory Teaching Programme. The statistical method known as ANOVA was used in the investigation. The study's main finding is that male and female math students who get instruction in a Mathematics laboratory⁹⁶ do not significantly differ in their performance. According to another study, students who received instruction in a Mathematics lab outperformed those who did not. In a similar spirit, a team of researchers studied the value of Mathematics Laboratorys at the advanced school level. The primary goals are to compare the performance of male and female math students taught in Mathematics labs and investigate the impact of employing Mathematics labs in the classroom. The study employed an experimental methodology. The Designed Mathematics Laboratory (DML), the Mathematics Achievement Test (MAT), and lesson plans served as the study's instruments. The study's sample consisted of 100 pupils. For the research, two schools from Ekwusigo Local Government were chosen. The pupils were split up into two equal groups, group A consisting of 17 males and 33 girls and group B consisting of 23 boys and 27 girls. Group B was taught Mathematics in a typical classroom setting, while Group A received instruction in Mathematics with the use of the Mathematics laboratory. A post-test was administered to both groups after four weeks, and the findings were compiled. The main conclusions were that there was a notable difference in the mathematical achievement of students who received instruction utilizing a laboratory and those who received instruction through lectures. There is no significant difference in the achievement of boys and girls in the subject Mathematics who are taught with the help of Mathematics laboratory⁹⁶.

A pilot study was carried out to investigate the use of Mathematics laboratories in secondary school Mathematics instruction. The study's primary goals were to gather feedback from math

instructors about the presence of challenging areas in the secondary school curriculum and to examine the explanations provided by the teachers for these areas. In essence, the study used a survey technique with a focus on investigating opinions to determine their origins and putting them into practice. In order to conduct educational study, the researcher employed a hybrid strategy. Three retired math instructors and fourteen active math teachers made up the study's sample. The researcher has employed a questionnaire style that she created in order to identify difficult⁹⁷.

Similarly, a study conducted in Bayelsa State's Yenagoa Local Government Area looked at how the Laboratory Method affected students' mathematical inventiveness. This study looked at how laboratory methods affected junior secondary school students' mathematical inventiveness in Yenagoa, Bayelsa State. Three questions and three hypotheses guided the investigation. Pretest-Posttest non-randomized control group design was used in the study. For the study, a sample of 122 students drawn at random from two full classrooms was used. The Students' Attitude towards Mathematics Questionnaire (SAMQ) and the Mathematics Creativity Test (MCT) were the instruments used to gather data. The mean, standard deviation, and Analysis of Covariance (ANCOVA) were used to assess the acquired data. The results showed that students' mathematical inventiveness is significantly increased while learning in a laboratory setting⁹⁸. Both male and female students' mathematical inventiveness was equally improved by the strategy. The way that students approached Mathematics also had a big impact on mathematical innovation. Among other things, it was suggested that math teachers investigate using the laboratory technique to teach different ideas at the junior secondary school level.

An investigation of the use and accessibility of lab kits for the hands-on teaching of mathematical concepts in chemistry. The availability and use of laboratory kits for the hands-on

teaching of chemistry math in the Ahoada West local government area of Rivers State were investigated in this study. The research methodology used in this study was descriptive. All public senior secondary I (SS1) chemistry students in Rivers State's Ahoada West school zone made up the research population. A sample of 200 chemistry students was included in the study; 120 of them were male and 80 were female. Four research questions guided the investigation. Frequency counts and percentages were used to analyze the data. The data was gathered using a standardized questionnaire that was face-validated by three experts. The test-retest method produced a reliability coefficient value of 0.76. The results showed that there were not enough laboratory kits available or being used in the senior secondary schools that were assessed. It is advised that the government make sure there are enough laboratory kits available for the hands-on teaching of chemistry and Mathematics at all educational levels. During practical sessions, chemistry teachers should also help students become acquainted with the restricted equipment that is accessible⁹⁹.

A related investigation on the effects of Mathematics Laboratorys on schoolchildren was carried out¹⁰⁰. The study's primary goals were to determine if mathematical labs were physically available in schools and to ascertain how they affected pupils in various classes. For the study, a descriptive survey approach was used. Ten randomly chosen schools with Mathematics Laboratorys were chosen. 300 pupils from classes 6–12 were chosen at random; 100 were from classes 6–8, 100 from classes 9–10, and 100 from classes 11–12. Students completed a self-made questionnaire. The collected data was evaluated after being transformed to a percentage. The study's main conclusions included the fact that most students find using the Mathematics Laboratory to be simple. The development of confidence, interest, and efficacy in Mathematics is greatly aided by Mathematics laboratories.

Another research work was conducted on Use of Mathematics laboratory for teaching Mathematics¹⁰¹. The primary aims of the study were to examine different techniques of teaching Mathematics in conventional classrooms and to assess instructors' perceptions of the Mathematics laboratory. This study employed a survey approach. The questionnaire and interview schedule served as the instruments utilised in the study. The study employed the interview approach. Two samples were selected for this investigation. The study sample comprised 80 pupils from class X at Kendriya Vidyalaya, Ojar, and 100 instructors employed in and around Nasik. A questionnaire and interview were conducted with 100 instructors. Students were segregated into two equal cohorts, with one group receiving instruction in a Mathematics laboratory environment and the other in a conventional classroom setting. Following a 10-week period, a post-test was administered to both groups to assess student performance. The primary finding indicated that the technique of instructing Mathematics in a Mathematics laboratory proved to be more effective than conventional teaching methods.

The relative effectiveness of the Mathematics Laboratory Method can also be attributed to its activity-oriented design⁴⁵. Learning that is activity-oriented helps students comprehend and remember material. Through laboratory experiments, question-answering, and chances to investigate, clarify, and expand on their opinions, it guarantees that students actively participate in classes. Consequently, increase the student's profound comprehension of the material. Therefore, the results of this study suggest that teaching transformation via the Mathematics Laboratory Method can improve senior high school students' performance and retention of transformation. A notable disparity exists in the mathematical success of pupils instructed using a laboratory-based education program compared to those taught through traditional methods. The disparity in accomplishment levels is attributable to the 'Mathematics laboratory-based teaching

and learning approach'; otherwise, both groups had equivalent foundational understanding of Mathematics. Students instructed using the Mathematics laboratory-based education approach outperformed those educated through conventional methods. It turns out that the reality of using the Mathematics lab from the perspective of secondary school teachers in Nigeria has generally appeared to a moderate degree. This is because some schools do not have a Mathematics laboratory, which has made teachers less aware of how to use the lab and take advantage of its resources. Teachers understood the value of the Mathematics Laboratory's components and the need of having one in classrooms. According to the instructors' replies, the Mathematics Laboratory has a beneficial influence as it helps to improve teaching methods. The findings showed that the absence of labs, tools, and equipment was the main source of the Mathematics lab's challenges.

Using collaborative and demonstrative techniques, the study looked at how a Mathematics lab may help senior high school students in Rivers State better grasp mensuration. A 4x2 factorial quasi-experimental design with a pre-test, post-test control group was used. Eight hundred (800) senior secondary two (SS2) students from six (6) government secondary schools in the Okrika Local Government Area made up the research population. Based on certain criteria, 105 students were specifically chosen to participate in the study. To gather data, a researcher used a tool called the Test on Understanding of the Concept of Mensuration (TOUCM). Experts in Mathematics education validated the tool's look and content. Using the Kuder-Richardson Formula, the reliability coefficient for TOUCM was found to be 0.86. Two research topics and two hypotheses guided the investigation. The study concerns were addressed using means and standard deviations, and the hypotheses were examined using Analysis of Covariance (ANCOVA). The results showed that students who received instruction in Mathematics utilizing

a laboratory technique that relied on demonstrations outperformed their counterparts in understanding mensuration concepts. By using interactive and practical techniques, the Mathematics lab significantly improved students' understanding of mensuration topics. Students' understanding of the concept of mensuration was not substantially impacted by the gender component. Among other suggestions, it was suggested that math teachers incorporate a Mathematics lab that uses collaborative and demonstrative approaches to teach mensuration ideas.

This study looked at how the Mathematics Laboratory affected female students' performance in the subject as well as how they perceived Mathematics. The research had 150 SSS1 students in total. The mean, standard deviation, and analysis of covariance (ANCOVA) were used to analyze the study's findings. The findings showed that SSS1 female students' attitudes toward Mathematics were positively impacted by the use of a Mathematics Laboratory. The findings also showed that female students' performance differs significantly from that of students taught Mathematics in a laboratory. The following are the recommendations made by this study: NERDC and NABTEB should incorporate the Mathematics Laboratory into the curriculum; teachers of Mathematics should receive instruction on how to use the laboratory in their methodology class; and all schools, from elementary to tertiary, should have a Mathematics laboratory. For the study's conclusion, it suggests that math teachers be encouraged to use Mathematics Laboratory to teach algebraic expression and planar geometry.

The study looked at how students' geometric performance in a few secondary schools in Ekiti State, Nigeria, was affected by the mathematical laboratory teaching method. Using a quasi-experimental approach, the study included control, post-test, and pre-test groups. In Ekiti State, 2,483 SS II students made up the population. 200 SS II students were selected at random from

four designated secondary schools in the Moba Local Government Area of Ekiti State to make up the study sample. The study used the Geometric Achievement Test (GAT) to collect data. The test-retest method was used to evaluate the instrument's dependability. The collected data was considered enough for this study. At a significance threshold of 0.05, two hypotheses were developed and assessed using t-test analysis. The pre-test and post-test mean scores for the experimental and control groups, respectively, showed a significant difference, according to the results. The performance of male and female students in Mathematics differed significantly. Numerous suggestions were made in light of these findings, including the following: By providing the resources needed for the best possible implementation, math teachers should be encouraged to use the lab teaching method. The attitude of students towards Mathematics should be favourably transformed by engaging them in active participation in the learning process.

The purpose of this study was to evaluate the state of the Mathematics Laboratorys in Ekiti State's secondary schools. In order to accomplish these goals, six research questions were formulated and addressed. A survey research approach was employed for the study, and six item structured questionnaires were created and utilized to gather data. After 200 respondents completed the survey, 180 copies were deemed suitable for data analysis. The study's conclusions showed that not all secondary schools in the chosen senatorial area had Mathematics Laboratorys, and not all pupils enjoyed taking Mathematics laboratory courses. Most likely as a result of the lab's tools and teaching resources, which helped the students approach Mathematics as tangible phenomena rather than abstract concepts. Inadequate equipment, a lack of qualified math teachers, and an epileptic electrical supply are among issues that the investigation discovered. It was suggested that in order to encourage students' interest in Mathematics, the government should supply all secondary schools with enough equipment for their Mathematics

Laboratorys and power. A professional in Mathematics should be hired to help pupils study the subject more effectively.

2.3.2 Class Size and Students' Academic Achievement

An empirical study on class size and performance indicated that class size significantly influences performance in the Secondary School Certificate Examination (SSCE)¹⁰². The researchers noted that pupils in smaller classes achieved superior test scores compared to those in larger classes. A separate study indicated that educators in smaller classes encounter fewer disciplinary issues, delve deeper into subject matter, engage in more individualised interactions with students, and monitor student progress more effectively, ultimately resulting in superior academic performance compared to their counterparts in larger classes. Another study revealed that school administrators indicated that reduced class sizes facilitated the establishment and maintenance of improved relationships with kids, parents, and families, leading to enhanced academic achievement¹⁰³.

A study concluded on large class and students' learning outcomes¹⁰⁴. The study indicated that big class sizes adversely affected the quality of teaching and instructional delivery, as well as students' learning results. In other words, big class sizes augment the likelihood of widespread failure and cause pupils to lose interest in education. The researchers explained that big class sizes inhibit individual student attention from professors, potentially resulting in diminished reading scores, dissatisfaction, and subpar academic performance. The research found that classroom size substantially affects the academic performance of children across all levels. The correlation between classroom size and academic achievement was determined to be negatively proportional. Students in expansive classes had inferior academic performance, whilst those in smaller classroom settings demonstrated superior achievement.

However, a different research found no statistically significant differences in the performance of students in smaller vs larger classrooms¹⁰⁵. In a similar vein, There is little information on how large class sizes affect academic achievements, according to a different research on the subject of how enormous class sizes affect students' academic performance in basic, secondary, and a few postsecondary institutions in Ghana's Central Region¹⁰⁶. Using a similarly cluster analysis technique that grouped studies of a similar kind together, another study examined 100 class size research papers that were carried out between 2000 and 2015. The study found that smaller classrooms have less of an effect on students' learning, attitudes, and behavior as they go up the grade levels. The most noticeable positive effects were shown in elementary school, namely from kindergarten to third grade. The results of the study showed that minority and disadvantaged students benefit more from smaller class sizes¹⁰⁷. In addition, They articulated that if the educator did not modify their pedagogical strategies and classroom management in the smaller courses, the beneficial outcomes might be diminished. Reduced class numbers can yield a safer environment for kids, a more favourable atmosphere, enhanced academic performance, increased graduation rates, less disciplinary issues, and better satisfaction among families, students, and educators.

A similar study was conducted in Nigeria¹⁰⁸ to look into how classroom size affected secondary school students' academic performance. The specific goals under examination include the following: to determine the extent to which class size affects the facilitation of teaching and learning in secondary education and to investigate the effect of class size on secondary school students' academic performance. A survey design was used for the study. Seven hundred sixty-one (761) teachers from public secondary schools in the Enugu North Local Government Area make up the research population. The study comes to the conclusion that big class sizes result in

inefficient teaching strategies and inappropriate use of instructional resources, which both contribute to poor academic achievement. It is particularly challenging for the teacher to effectively present instructional materials to students seated at the back of the classroom.

Additionally, another research looked into how class size affected social studies instruction and learning in Bwari Area Council, FCT-Abuja¹⁰⁹. A descriptive survey method was used in the investigation. Using a multi-stage selection process, 200 teachers were chosen as a sample from 10 wards in the Bwari Area Council. Data was gathered using a single validated instrument. A self-created survey with 25 items called the "Teachers' Class Size Questionnaire" (TCSQ) was used. There are two components to the questionnaire: The biodata of the respondents is included in Section A, while information on the class size is included in Section B. A four-point rating system is used for each item: Strongly Agree (SA) = 4, Agree (A) = 3, Disagree (D) = 2, and Disagree (SD) = 1. The validity and reliability of the instrument were guaranteed. Research hypotheses and a comprehensive investigation were formulated and addressed. Chi-square tests and simple percentages were used to analyze the data. The findings indicated a substantial disparity in the educational experiences of students in small vs big courses. It was advised that policymakers and the government ensure the construction of more classrooms and that class sizes do not exceed 30 children. The Parent-Teacher Association (PTA), philanthropists, and other philanthropic organisations are urged to support the government's initiative to enhance the teaching and learning of social studies by constructing additional classrooms and facilities.

Furthermore, in Ogbomoso Education Zone, Oyo State, Nigeria¹¹⁰, a related research examined the impact of class size on pupils' mensuration performance. An ex-post-facto design was used in the investigation. Thirty-one thousand seven hundred and six (31,706) SS II students

make up the study's target population. A sample of 274 individuals was chosen using a purposeful selection technique: this number represents the study's sample size. Two research questions served as the study's compass, and two hypotheses were developed and assessed at the 0.05 level of significance. To collect data for the study, a single research tool—the Mathematics Performance Test on Mensuration (MPTM)—was created, approved by two math education experts, and used. Using the test-retest method to confirm internal consistency, the instrument yielded a reliability value of 0.85. The mean, standard deviation, and t-test were used to analyze the collected data. The results of the study showed a significant difference in the average performance scores of students taught in big and small class sizes. Depending on class size, there is no discernible difference in the average performance scores of SS II students taught Mensuration in rural and urban settings. The results showed that the number of students to be accepted and the resources available should be taken into account by school administrators and other pertinent stakeholders in charge of student admissions.

Additionally, a study looked at how class size affected basic science education and understanding in junior secondary schools in the Port Harcourt metropolitan area. The study used a survey design that was descriptive. Purposive sampling was used to choose 17 Basic Science professors and 223 Basic Science students. Four research questions were answered. The data collecting tool employed was a self-constructed closed-ended questionnaire entitled “Class Size Influence on Teaching and Learning of Basic Science Questionnaire,” with four parts corresponding to each study issue. The mean and standard deviation were employed to address the study issues. The research indicated that smaller class sizes positively affect the instruction and comprehension of Basic Science, but larger classes adversely impact the teaching and learning of the subject at educational institutions. The findings advised, among other measures,

that fewer students be accepted to courses to enhance collaborative and communicative learning experiences between students and professors. A separate research sought to gather perspectives from both professors and students about the impact of large class sizes on teaching and learning at tertiary institutions in Ekiti State, Nigeria. All instructors and students at the College of Education in Ikere-Ekiti, Ekiti State; the University of Nigeria, Nsukka, Ikere Campus; and Ekiti State University, Ado Ekiti, Ekiti State, participated in the study, which used a survey design. Five hundred and twenty (520) final-year students and thirty (30) professors made up the randomly chosen sample. A questionnaire was used as the study technique for data collecting. The results of this study show that large class sizes have a negative impact on postsecondary institutions' ability to teach and learn business education effectively. There is no evidence linking large class sizes to good instruction and learning. In order to accommodate a bigger student intake for budgetary concerns, the authors recommended that management engage more academics for Business Education in tertiary institutions. Institutions should also work harder to provide more facilities and resources to support efficient business education instruction.

Previous studies have looked at how class size and time management affect students' academic success in certain subjects, but there doesn't seem to be any study on how these characteristics affect academic performance at public tertiary institutions¹¹³. This sparked an investigation on the relationship between academic success, time management, and class size at public tertiary schools in Lagos State¹¹³. A survey-based descriptive design was used in the study. Seven public tertiary institutions, along with their faculty and students, made up the study's population for the 2017–2018 academic year. The sample size consisted of 1800 respondents after being stratified by faculties/schools and using a simple random sampling technique. After validating their validity, the other two instruments used for data collection—

aside from the Record Observation Formats I and II—went through a reliability evaluation. The reliability of the "Time Management Questionnaire for Lecturers (TMQL)" and the "Time Management Questionnaire for Students (TMQS)" was shown using the Cronbach Alpha test. While time management did not significantly correlate with students' academic achievement at public tertiary institutions in Lagos State, the results showed a substantial negative link between class size and academic performance. In conclusion, while time management has no bearing on students' academic achievement at public tertiary institutions in Lagos State, class size does. Through the Federal and State Ministries of Education, the government is recommended to maintain ideal class sizes at postsecondary institutions in order to improve efficiency, as large class sizes can be harmful.

A study investigated class size as a determinant of academic success in Mathematics among senior secondary school pupils¹¹⁴. It employed a pretest-posttest experimental design. Ninety Senior Secondary pupils were intentionally picked from three Secondary Schools in the Port Harcourt metropolis of Rivers State, Nigeria. The data collection tool employed was the Mathematics Achievement Test (MAT), with multiple-choice options, which was verified and shown a reliability value of 0.72. A research topic and three hypotheses were established to direct the investigation. The T-test technique was employed to evaluate the hypotheses at a significance level of 0.05. The study's findings indicated a considerable disparity in the achievement of the experimental group compared to the control groups. Gender did not significantly affect the performance of pupils on the Mathematics achievement exam when comparing small and large class sizes. It is recommended that the National Policy on Education, which mandates a maximum teacher-to-student ratio of one teacher for every forty students, be implemented in schools. Furthermore, it is recommended that schools use a class reduction

strategy and construct additional classrooms equipped with sufficient teaching and learning resources to enhance student accomplishment.

Another similar study's main goal was to assess how class size and school location affected the academic achievement of upper basic 9 students in Cross River State, Nigeria¹¹⁵. An ex-post facto research design was used in the study. Using stratified and basic random selection techniques, a sample of 1,600 upper basic 9 students was chosen from 81 of 464 secondary schools in Cross River State. One-way analysis of variance and the independent t-test were the data analysis techniques used. The results showed that school location had a significant effect on upper basic nine students' academic performance: urban students fared better than their rural counterparts in core subjects including basic science and Mathematics. For students in upper basic nine, class size had a big impact on their academic performance. Among other things, it was suggested that schools should have relatively small class sizes to promote efficient learning and that rural children who do not have access to metropolitan life and educational opportunities should be given access to contemporary facilities and educational resources. Additionally, regardless of whether they attend urban or rural schools, all upper basic nine students should have access to a conducive learning environment that includes large classrooms, well-equipped labs, accessible library resources, recreational opportunities, etc.

Additionally, a research looks at the relationship between students' academic success in the English language¹¹⁶ and the size of the class. The study's main goal is to determine how students' English language proficiency and class size relate to one another. Survey and correlation research designs were combined in this study. 2003 SS II pupils from several public schools in Maiduguri Metropolis, Borno State, Nigeria, made up the research population. For the study, four hundred students were selected at random. Proformas and structured questionnaires

were used in the data collecting process. Self-reported data was collected using the questionnaire. Students' English language final test scores were obtained using a proforma. Using multiple regression analysis, the collected data were examined. The study found a strong correlation between students' academic success in English and the size of the class. It is recommended that schools have a large number of classrooms in order to accommodate the rapidly increasing number of students. Research on how class size affects student achievement has been conducted in 18 different countries⁵⁸. They assessed each country separately. The authors concluded that a weak relationship between middle-grade test scores and class size could be ruled out in six of the eighteen countries, including Canada. Furthermore, the effects of large class sizes might be mitigated in five school systems, but not necessarily those of smaller ones. Smaller courses showed greater student success only in Greece and Ireland. These findings are consistent with descriptive data in Canada, showing that high school students' performance is not significantly impacted by class size. A group of researchers evaluated the differences in children's performance on reading, writing, and math tests between kindergarten classrooms of different sizes. The students were randomly allocated to both large and small classes. According to the study, students who were placed in smaller classes during kindergarten or first grade benefited in every topic. The benefits were diminished by the end of grades two and three; in particular, the difference between kindergarten students in small classrooms and those in traditional courses had no discernible effect on their performance or scores on standardized tests at the end of those years.

A researcher looked at the relationship between large class sizes and pupils' academic achievement in math and English. Ten secondary schools were selected by the researcher using a

stratified proportional random selection technique. The school-based WASSCE scores served as a tool. Chi-square was used to analyze the data. The study found that student achievement was unaffected by class size. Student progress⁵³ is influenced by a number of factors, including the calibre of instructors, the financial status of the parents, the availability of school resources, the location of the school, the availability of libraries, and the supervision of educational inspectors. According to a survey on congested schools in New York City, 75% of teachers said that traffic affected classroom activities, and 70% said it affected their teaching strategies⁶². Teacher absenteeism rose as a result of stressful working conditions brought on by overcrowding and excessive workloads.

Several courses were overcrowded, according to a survey done by an independent researcher in 14 African countries⁶³. In this set of countries, there were an average of sixty-three students per primary school classroom every shift. While Uganda (1:112) and Malawi (1:86) experienced the serious problem of overcrowded classrooms, Niger (1:38) and Ghana (1:37) had the least average class sizes. In order to reduce the amount of grading required while teaching large courses, Ugandan researchers found that teachers provided fewer exercises and practice⁶⁵. There wasn't enough space to support group projects that would enhance thorough topic coverage. In a similar vein, another researcher examined the relationship between academic achievement and class size among 3,812 third-graders in 204 classes in nine rural, low-income school districts in southeast Georgia⁶⁶. Academic performance and class size were shown to be significantly correlated by preliminary correlation analysis. According to regression analysis, reading success levels were significantly predicted by class size, the percentage of gifted kids, and the prevalence of children from low-income families. The main issue facing the teachers is crowded classrooms. Both quantitative and qualitative analyses were performed on the data. The

results of the study showed that most teachers had difficulties with instruction, discipline, physical conditions, and assessment, and that effective education was impossible in overcrowded classrooms.

At a particular university, a different research looked at how class size affected students' academic achievement¹¹⁷. With an emphasis on survey and phenomenological methodologies, the research strategy for this study mostly used a quasi-mixed methods approach. Class size and school attributes, such as teacher effectiveness, may have an impact on student achievement, according to the descriptive findings that triangulate the data gathered from many instruments in the current study. In Ekiti State⁷¹, a number of researchers looked on how class size affected students' academic performance. The t-test and mean were used to analyze the data. According to the results, there was no discernible difference in the academic achievement of students in large versus small classes in rural areas ($t = 0.58$; $p < 0.05$) or in small versus large classrooms within urban schools ($t = 1.49$; $p < 0.05$). A other research looked at academic results and class size, focusing on kids from economically, linguistically, and culturally marginalized groups⁷². A comprehensive review of 112 research conducted between 1979 and 2014 assessed the reliability of the findings regarding the effects of smaller class sizes. Beginning with Australian research, the examination covers a broader range of studies and takes into account education systems in England, Canada, New Zealand, and non-English speaking European countries. Reduced class sizes in the first four years of school have been shown to have a substantial and long-lasting impact on student achievement, especially for kids from economically, linguistically, and culturally marginalized families. This is particularly true when appropriate teaching strategies catered to fewer students are combined with reduced course sizes. Additionally, several specialists looked at how class size affected senior secondary school

students' English language¹¹⁸ essay writing abilities. A quasi-experimental pretest-posttest one-equivalent group design was used in the investigation. The mean and standard deviation were computed to address the research issues, and analysis of covariance (ANCOVA) was used to assess the null hypotheses at a 0.05 significant level. There is a significant difference between students who are taught in large class sizes and those who are taught in small ones, with the latter group showing benefits. Students' essay writing performance was not significantly influenced by their gender. It is clear that gender has minimal bearing on students' essay-writing ability. There was no discernible relationship between pupils' essay writing success and class size or gender. Using technology-enhanced instruction and assessment, a study examined how class size affected students' performance in math classes⁷. The study looked at how the effects of large class sizes on student achievement and engagement were affected by instructional software, computer labs with tutoring, and improved electronic communication between students and teachers. By comparing students in large classes with those in medium courses using the Mann-Whitney two-sample rank-sum and Kolmogorov-Smirnov tests, the study used the students' final exam scores to gauge their knowledge at the end of the course. The null hypothesis was not rejected since the Mann-Whitney test revealed no discernible difference between the distributions of the College Algebra and Applied Calculus courses.

The effect of class size and student population density on the academic achievement of public secondary school students in Cross River State¹¹⁹ was examined by a group of researchers. The inquiry was conducted using the expofacta research design. A stratified random sampling technique was used to choose 450 students and 150 teachers for the sample. The results of the study showed that large class sizes and dense student populations had a negative effect on

instruction and learning, making it more difficult for teachers to administer and grade homework and exams.

At Kebbi State Polytechnic Dakin-Gari, Nigeria¹²⁰, a different study looked at how class size affected students' academic performance in an introductory computer science course (CMP 111). Using an experimental and control group, the study used a quasi-experimental research technique to address the research question (RQ). The National Diploma I (ND I) students in the experimental group (small class size) and control group (larger class size) were enrolled in an introductory computer science course at Kebbi-State Polytechnic Dakin-gari's school of applied sciences, department of Computer Science and Science Laboratory Technology. The study's population consisted of 150 students who took the course as the control group (larger class size) and 50 students who took the course as the experimental group (lower class size). Thus, two hundred (200) students in all took part in the study. 20 essay exam questions with reliability coefficients of 0.76 were used to gather data, and SPSS-V21 was used for independent sample t-test analysis. A single study topic and a single null hypothesis (H_0) with a significance level of $\alpha.05$. guided the investigation. Students in smaller courses performed better academically than those in bigger ones, according to the study, which showed that class size affected students' academic performance. As a result, it was shown that the size of the classroom had a significant impact on the academic achievement of the pupils. It was found that there was a negative proportionality between classroom size and academic success. While students in smaller classrooms showed greater academic accomplishment, those in larger courses performed worse academically. In order to improve communication between instructors and students and guarantee greater academic success, small class sizes are crucial. In order to encourage the best

possible academic achievement, the study suggests that the management of the universities under investigation give priority to class sizes.

A research found that students' and teachers' opinions of overcrowding⁶⁹ were somewhat positively correlated. The results showed that overcrowding had a negative impact on teaching and learning quality, which had serious consequences for reaching educational goals. It was considered imperative that educational planning at all levels be given top priority in any additional buildings and furnishings. A research on large class sizes and students' academic achievement in Mathematics and English 121 was conducted. Ten secondary schools were selected by the researcher using a stratified proportional random selection technique. The school-based WASSCE scores served as a tool. Chi-square was used to analyze the data. The study found that student achievement was unaffected by class size. However, a number of factors impact children's development, including the caliber of instructors, family financial status, school resources, library availability, school location, and educational inspector supervision. A study conducted between 2010 and 2017 looked at the relationship between class size and students' academic performance in Ekiti State, Nigeria. The results of the West African School Certificate Examinations (WASCE), which were administered to 50 secondary schools in the state's rural and urban areas between 2010 and 2017, made up the study population. The Students' Class Size Questionnaire (SCSQ), a validated instrument, was used to gather data. A theory was developed and discussed. The t-test and mean were used to analyze the data. The results showed that students in urban schools who attended small vs large classes did not significantly differ in their academic performance ($t=1.49$; $p<0.05$); similarly, students in rural schools who attended large or small classes did not significantly differ in their performance ($t=0.58$; $p<0.05$). Government representatives and policymakers are urged to guarantee the

building of new classrooms and to restrict class sizes to no more than thirty pupils. By building more classrooms and facilities, the government hopes to improve student performance in the SSCE. The Parent Teacher Association (PTA), philanthropists, and other charitable organizations are encouraged to help this effort. ¹²². A study looked on the math proficiency and classroom environment of senior secondary school (SS2) students in Calabar, Cross River State, Nigeria¹²³. quasi-experimental post hoc Two hypotheses about the effects of two classroom variables—class size and instructional materials—on students' academic performance in Mathematics were assessed using a study technique. Stratified and basic random sampling techniques were used to choose 700 students from public secondary schools for the study. Two tools were used in the data collection process: test items measuring mathematical proficiency and a questionnaire evaluating the classroom atmosphere. Using the Cronbach Alpha and Kuder-Richardson K-R-20 formulae, the instrument's dependability was assessed; reliability indices ranging from 0.75 to 0.78 were obtained. The statistical technique used to assess the hypotheses at a significance level of 0.05 was the independent t-test. According to the study, SS 2 students' academic achievement in Mathematics in Calabar, Nigeria, was significantly influenced by class size and the availability of instructional facilities. It is suggested that funding be made available by the government to establish a welcoming learning environment with ideal class sizes. A study looked at how gender, class size, and classification affected academic performance¹²⁴. In particular, The purpose of the study was to evaluate how senior secondary school students' academic performance in Mathematics and English was affected by their class categorization, size, and gender. All 189 Grade II (SSS II) students who took the Unified Promotion Examination (UPE), which was given by the Osun State Ministry of Education in May 2017, were chosen for the study using a stratified intentional sampling strategy and an ex post facto

research design. In this case, Grade II students' English language and math scores were used as a stand-in for academic performance, and they were divided into three groups based on their gender (male and female), class size (large and small), and class stream (science, arts, and commerce). The generated data was examined using inferential statistics, such as t-statistics. The results of the study showed that students in the Science and Art, Science and Commercial, and Art and Commercial streams did not significantly differ in their academic performance. The Science and Art classes were favoured, respectively, and there was a notable disparity in English language proficiency between the Science and Commercial streams as well as between the Art and Commercial streams. Class size and gender did not significantly affect students' performance in Mathematics and English language, according to the study. According to the research, explanatory variables such as gender, class size, and categorization are crucial in predicting students' academic performance and work in concert with other elements to guarantee successful academic results. Among other things, the study recommended that school officials step up their efforts to monitor students' classwork, assignments, and punctuality as well as teachers' evaluations of their teaching methods.

A study conducted in the Ogbomoso South Local Government Area of Oyo State, Nigeria¹²⁵, looked at how gender and class size affected pupils' performance in Mathematics. 135 randomly chosen SS II students from the three geo-educational zones of Ogbomoso-South Local Government Area in Oyo State participated in a pretest-posttest quasi-experimental control group design to evaluate the effect of class size on academic performance. There were two treatment groups and one control group. A class of 25 students got Mathematics education in one treatment group, a class of 65 students in another, and a class of 45 students in the control group. A consistently verified objective and essay achievement test ($r=0.86$) served as the study's main

tool. Analysis of Covariance (ANCOVA), mean, and standard deviation were used to examine three study hypotheses ($p < 0.05$). The results showed that the 25 students in the treatment group outperformed the other two groups, indicating a significant main impact of therapy on student success ($F(2,128) = 560.35; p < 0.05$). Furthermore, male students outperformed female students by a substantial margin ($F(1,128) = 111.10; p < 0.05$). After considering the implications for teaching Mathematics, it was suggested that more appropriate classrooms be built in Nigerian schools, that trained math teachers be hired, and that math classes have a limit of 25 students. Additionally, another study aimed to determine the effects of several aspects of the school atmosphere and class size on senior secondary school¹²⁶ students' academic performance in Mathematics. The study was guided by five research questions. Five secondary schools in Ibadan South West Local Government, Oyo State, Nigeria, were chosen using a straightforward random selection procedure. To choose 45 pupils from each school, the same sampling strategy was used. 225 respondents in all made up the study's sample size. The Student Inventory Scale (SIS) and Mathematics Achievement Test (MAT), two instruments designed for the study, have reliability coefficient values of 0.75 and 0.76, respectively. Inferential statistics like multiple regression and the Pearson moment-correlation coefficient, as well as descriptive statistics like frequency count, percentages, mean, and standard deviation, were used to examine the collected data. About 150 (66.70%) of the sampled students reported that they did not lack tables as an educational resource in their respective schools, and almost 158 (70.2%) of them said that there were adequate chairs in the school. However, only 105 of them (46.70%) noted that there aren't many libraries with pertinent math textbooks in many schools. Additionally, the results indicate that there was no significant linear correlation between students' accomplishment scores and the classroom environment. Despite being positive and negligible, the Pearson moment-correlation

coefficient was extremely low ($r = 0.076$, $p = 0.254$). It was suggested that frequent capacity-building workshops on Mathematics teaching methods, classroom management, and control be held for math instructors.

The impact of class variables, including class size, student space, and class utilization rate, on secondary school students' performance in the Senior Certificate Examinations (SSCE), which are given by the West Africa Examinations Council (WAEC) in Oyo State, Nigeria, between the academic years of 2017 and 2022, was also investigated in another study. 200 of the state's 336 secondary schools were chosen at random to participate in the study, which was conducted ex post facto using a descriptive survey research methodology. To analyze the data, one-way analysis of variance and multiple regression analysis were used. A minimum significance threshold of 0.05 was used to evaluate the dual research hypothesis that guided the study. The results showed that, taken together, the three factors—class size, student classroom space, and class utilization rate—had a significant effect on secondary school students' academic performance in Oyo State between 2017 and 2022. When taken into account separately, these traits have a significant impact on the state's secondary school pupils' academic performance. Educational planners, legislators, and the federal and state governments should take note of these facts. Secondary education planning and delivery must take these factors into account. For several years, research has focused on how class size and school climate affect students' academic achievement in Mathematics¹²⁸. The purpose of this study was to determine how specific aspects of the school environment and class size affected the academic performance of senior secondary school students in Mathematics. The study was guided by five research questions. Five secondary schools in Ibadan South West Local Government, Oyo State, Nigeria, were chosen using a straightforward random selection procedure. To choose 45 pupils from each

school, the same sampling strategy was used. There were 225 responders in the study's entire sample. The Student Inventory Scale (SIS) and the Mathematics Achievement Test (MAT), two tools developed for the study, have reliability coefficients of 0.76 and 0.75, respectively. Inferential statistics like multiple regression analysis and the Pearson moment-correlation coefficient, as well as descriptive statistics like frequency counts, percentages, means, and standard deviations, were used to analyze the data that had been gathered. About 150 (66.70%) of the sampled students reported that they did not lack tables as an educational resource in their respective schools, and almost 158 (70.2%) of them said that there were adequate chairs in the school. However, only 105 of them (46.70%) noted that there aren't many libraries with pertinent math textbooks in many schools. Additionally, the results indicate that there was no significant linear correlation between students' accomplishment scores and the classroom environment. Despite being positive and negligible, the Pearson moment-correlation coefficient was extremely low ($r = 0.076$, $p = 0.254$). It was suggested that frequent capacity-building workshops on Mathematics teaching methods, classroom management, and control be held for math instructors.

2.3.3 Parent Socio Economic Status and Students Academic Achievement

Numerous studies investigating the relationship between academic achievement and socioeconomic status have shown a connection between the two. One research looked at the relationship between adolescents' academic achievement and the socioeconomic status of their parents⁷⁸. The socioeconomic status of parents and secondary school students' academic performance were shown to be statistically significantly correlated by the researcher. Family finances may have an impact on academic success in both genders, according to a study that similarly looked at the relationship between parents' socioeconomic status and academic achievement⁸⁰. At whatever educational level, pupils' academic performance is influenced by

their socioeconomic situation and family education. Students who have college-educated parents often perform at the highest levels. Students who came from well-educated households were statistically far more likely to pursue higher education⁸⁵. A recent study was carried out to determine the effect of parents' socioeconomic situation on their children's academic achievement¹²⁹. The goal of the study is to determine this impact objectively. The researchers looked at how students' academic performance was affected by a number of socioeconomic factors, such as family background, maternal and paternal education, the number of children enrolled in school, government-funded educational facilities, and decisions about a child's future. The results of the study show that teenagers' academic success is favorably influenced by both parents' educational attainment and paternal wealth. Compared to dads, moms' educational achievement has a greater impact on students' academic success. Additionally, the government's extensive educational resources and strong family support greatly raised the academic achievement of the students in the sample under study. There is a correlation between parents' socioeconomic level, education, and reading habits.

A study looked into the relationship with students' academic achievement and socioeconomic level at Adamawa State 130's Colleges of Education. 312 NCE students were chosen at random from two state-run institutions of education to participate in the study. The study's design was correlational. To collect relevant data, a survey called the "Questionnaire on Socio Economic Status" was used. The instrument was suitably assessed by experts. The Cronbach alpha approach was used to evaluate the instrument's dependability, yielding a reliability rating of 0.83. At a significance level of 0.05, the null hypotheses were assessed using linear regression analysis. The findings showed a significant relationship between parents' educational attainment and the academic achievement of physics students in educational

institutions, as well as a significant relationship between parents' income levels and academic achievement. According to the findings, the government should create initiatives like soft loans for parents and scholarships for students from low-income families to guarantee that these children have equal access to school as children from higher-income families.

Additionally, a different research looks into how parents' socioeconomic status affects their children's academic achievement in secondary school. 131 in Mathematics. Students in the ninth grade who attend several secondary and higher secondary schools in the Karbi Anglong region of Assam, India, make up the research population. Nine hundred students and their parents from thirty different schools took part in the study and answered the questionnaires. The obtained data is analyzed using the Stepwise Multiple Regression Analysis technique. The study's main goal is to determine the relationship between parents' socioeconomic status and how it affects secondary school students' academic achievement in Mathematics. The information shows a strong relationship between children's scholastic achievement in Mathematics and the socioeconomic status of their parents.

In a study conducted in a few secondary schools in the Ibarapa East Local Government Area of Oyo State, Nigeria, the effect of parental socioeconomic position on the academic achievement of Mathematics students was examined⁸⁴. The variables in this study were analyzed retrospectively, unmanipulated, and in accordance with their natural occurrence, using a descriptive research technique. All secondary school math students in the specified area, regardless of gender, were included in the study's demographic. Using random selection techniques, a sample of sixty (60) senior secondary school (SSS) Mathematics students was chosen for the study from this population. A self-structured questionnaire with twenty-two items served as the study's data gathering instrument. The chi-square statistical approach was used in

the study to create and assess four hypotheses. At a 5% significance level, each test result was compared to its critical values. The results of the study suggest that the socioeconomic status of parents influences the mathematical performance of secondary school students. Since these homes make up the children's immediate surroundings, the research suggests that non-governmental organizations offer scholarship possibilities and direct financial aid to households in order to empower and maintain them economically. Thus, it was suggested that more research be done in areas like "Effects of parental involvement in Mathematics in secondary school" and "Family issues and their impact on the academic performance of Mathematics students in secondary school."

One significant factor influencing children's learning results is the socioeconomic status (SES) of their households. A research adds to the discussion of how SES affects learning outcomes (132). This report investigates how SES affects children's academic performance in Mathematics as part of a long-term study on the efficacy of instruction in Ghana. Written assessments in Mathematics were given to all grade 6 students in a representative sample of 73 Ghanaian primary schools at the start and finish of the 2013–2014 academic year. Additionally, information on background characteristics for students was gathered. The factors that stood out more clearly as important for achievement were mothers' educational level, fathers' occupational status, and prior mathematical knowledge. Our analytical techniques (i.e., multilevel modeling) take into account the hierarchical structure of schools (i.e., students nested within classes, and within schools). Implications of the findings are drawn.

A team of scholars conducted a study to investigate the impact of parental socioeconomic status on children's academic performance in order to empirically determine this impact. The researchers looked at the effects of a number of socioeconomic factors, such as family

background, maternal and paternal education, the number of children enrolled in school, government-provided educational facilities, and decisions about a child's future, on students' academic performance. The study's conclusions show that paternal income and both parents' educational attainment positively influence adolescents' academic performance, that mothers' educational attainment has a greater impact on students' academic performance than fathers, and that strong family support and government-provided educational resources significantly improved the performance of the students in the sample under analysis.

A descriptive survey research methodology was used for the study, which looked at how family socioeconomic status affected the academic performance of secondary school students in Mathematics¹³⁴. Three research questions were developed and examined in accordance with the study's objective, and three null hypotheses were constructed and evaluated at a significance level of 0.05. The study population consisted of 16,886 SS2 students from the Owerri Education Zone in Imo State, and a sample of 866 students was obtained using a proportionate sampling technique. The Socio-economic Status Scale and the Mathematics Achievement Test (MAT) were used to collect data. Two experts in measurement and evaluation and one in Mathematics education assessed the instruments' validity. According to the test-retest approach, the instruments' reliability was found to be 0.81 and 0.72. ANOVA and t-tests were used to evaluate the hypotheses, and mean and standard deviation were used to analyze the gathered data in order to answer the study questions. The results of the study showed that children's mathematical ability was not substantially impacted by parental profession, family structure, or educational level. Therefore, it is advised that parents take an active role in their children's education by keeping an eye on their behavior both inside and outside of the classroom, ensuring that

homework is completed, supplying necessary school materials, and corresponding with teachers when necessary.

A related study looked at how family socioeconomic status affected secondary school students' mathematical performance¹³⁵. Based on the goals of the study, three research questions were developed and answered, and three null hypotheses were generated and assessed at a significance level of 0.05. A descriptive survey research methodology was used in the study. 16,886 SS2 students from Imo State's Owerri Education Zone made up the research population. A proportionate sampling technique was used to get a sample of 866 students. The Socioeconomic Status Scale and the Mathematics Achievement Test (MAT) are the instruments used to collect the data. Two measurement and evaluation specialists and one Mathematics education expert evaluated the validity of the instruments. The test-retest process determined that the instruments' reliability was 0.81 and 0.72. ANOVA and t-tests were used to assess the hypotheses, and mean and standard deviation were used to analyze the collected data for the study questions. The findings of the study showed that children's achievement in Mathematics was not much impacted by the kind of household, the work status of the parents, or the educational attainment of the parents. Therefore, it is recommended that parents continue to be involved in their children's academic development by monitoring their actions both inside and outside of school, making sure that homework is completed, providing required school supplies, and speaking with instructors as needed.

Additionally, a study examined how socioeconomic status, gender, and self-perception affected senior secondary school pupils' performance in Lagos State, Nigeria¹³⁵. To perform the study, a descriptive survey approach was used. In this study, three hypotheses were formulated and assessed. For the study, three hundred students were chosen at random from 10 secondary

schools in Lagos State's Education District II. The researchers used a questionnaire with thirty items to collect data. The test-retest reliability of the instrument is 0.76. The data that was acquired was analyzed using the Chi-square (X^2) technique. The results of the study showed that gender had no discernible effect on senior secondary school students' academic achievement in scientific courses. Additionally, it was shown that socioeconomic and self-concept characteristics had a major impact on senior secondary school students' success in scientific courses. According to the study, teachers and counsellors should be aware of each student's unique self-concept and help those who have a negative self-concept develop a positive one in order to improve academic performance.

In Rivers State, Nigeria, a study looked at the relationship between students' mathematical proficiency at the senior secondary school level and their parents' socioeconomic status (SES)¹³⁶. In order to analyze the results of the students' prior Mathematics exams, this study used an ex post facto research methodology. The Socioeconomic Status and Students' Achievement in Mathematics Questionnaire (SESASMQ) was another tool used to collect data. This survey consists of twelve (12) questions about students' mathematical performance and socioeconomic status (SES). Using Yarrow Yamen's technique, 4,510 of the 10,120 students that took part in the survey were chosen for the sample. Simple percentages, means, and the Z-test statistic were used to analyze the data. The results showed a weak relationship between children's mathematical achievement and the socioeconomic level (SES) of their parents. However, the results of the hypothesis test showed a strong relationship between children's mathematical performance and the socioeconomic level (SES) of their parents. On the basis of these findings, recommendations were developed.

Similarly, another study examines how teachers in Ogun State's Odeda Local Government Area (LGA) evaluate the influence of parents' socioeconomic level on their students' academic performance (137). A self-made questionnaire with two parts was used to gather data from 200 respondents as part of a descriptive survey research strategy. The data was then analyzed using the Statistical Package for Social Sciences (SPSS) software. Chi-square statistics were used to create and assess three null hypotheses. According to research, there may be a strong correlation between children' academic success and the socioeconomic status, educational level, and family size of their parents. It is therefore advised that the government offer some incentives to encourage more students to enroll in formal education, such as scholarships, free school transportation, adult education institutions, and family planning education for couples.

Additionally, a research looked into how Nigerian students' success in Integrated Science¹³⁸ was affected by their gender, socioeconomic status, and school geography. Three independent variables, each with two levels, and one dependent variable were included in the study's three-variable analysis of variance experimental design. For the study, 600 junior secondary school three (JSS III) students were chosen at random from eight secondary schools located in Delta State, Nigeria's Okpe, Warri South, and Uvwie Local Government Areas. Eight groups of seventy-five pupils each were randomly selected from among them. The findings of the study show a strong correlation between gender and school location in terms of Integrated Science achievement. The study found that socioeconomic position and school location had a significant interaction, but that students' performance in Integrated Science was not significantly impacted by the combined effects of gender and socioeconomic status. It was shown that the interaction between socioeconomic position, school location, and gender was significant.

Therefore, in order to improve their instruction and the learning of their secondary school pupils, scientific teachers are encouraged to take into account how these factors affect science education. Additionally, a research conducted in the Education Zone of Cross River State, Nigeria, examined the connection between students' motivation to learn Mathematics and the socioeconomic status of their parents. To direct the inquiry, two hypotheses were developed¹³⁹. A correlational survey research methodology was used in the study. Stratified and proportionate simple random selection techniques were used to choose 792 SS 2 students from a population of 3,941 students in 28 public secondary schools. For data collection, a single tool was used: a questionnaire named "Parental Socioeconomic Status and Students' Motivation in Studying Mathematics." The Cronbach Alpha approach was used to determine the questionnaire's reliability estimate, and the results showed values of .75 and .77. The use of the instrument for the inquiry was justified since the estimations met the stability requirements. Pearson Product-Moment Correlation The statistical technique used to assess the hypotheses at a significance threshold of 0.05 was the Correlation Coefficient. According to the study, pupils' motivation to learn Mathematics in Cross River State is highly correlated with their parents' educational attainment and financial level. It was suggested that the government provide low-income parents more authority so they may help their kids with basic needs. Encourage children to pursue Mathematics as a result.

A different study looked at the relationship between students' home environments and their arithmetic performance in senior secondary school in Rivers State, Nigeria⁹⁶. An ex-post-facto research methodology was used in this study, analyzing the students' scores from prior math exams. The Home Background and Students' Achievement in Mathematics Questionnaire (HBSAMQ) was another tool used to collect data. Using Yarrow Yamen's technique, 4,510 of

the 10,120 senior secondary II students who took part in the survey were chosen for the sample. The Z-test statistic, means, and simple percentages were used to analyze the data. The findings showed a strong relationship between children's arithmetic performance, socioeconomic status, and parental support for the subject. A similar study looked at how children' math anxiety was affected by their socioeconomic position and the classroom setting in the Nsukka Local Government Primary Education Authority in Enugu State, Nigeria¹⁴⁰. Three research questions and three null hypotheses served as the study's compass. Using a sample of 103 public primary schools with a total enrollment of 12,628 primary five students in the Nsukka Local Government Primary Education Authority of Enugu State, Nigeria, an ex post facto research technique was used. There were 432 fifth-graders in the sample. A questionnaire with three clusters—MAS, CCS, and SES—was the instrument used for the study. The reliability coefficients for Cronbach's Alpha were 0.89, 0.79, and 0.82, in that order. The mean and standard deviation were used to analyze the study themes, and analysis of variance (ANOVA), post-hoc tests, and t-tests at a significance level of 0.05 were used to assess the hypotheses. The classroom environment and socioeconomic background have a significant impact on children's math anxiety. It was suggested that in order to promote successful teaching and learning and raise children's interest in all topics, especially Mathematics, caregivers, parents, teachers, and school administrators create a classroom atmosphere that is supportive on all levels—physical, emotional, intellectual, and social.

Another study examined the effects of body weight, the number of siblings living in the home, and parental education on children's academic achievement in Mathematics¹⁴¹. Data from the Department of Economics at Anambra State University's Igbariam Campus in Nigeria was used in the study. In particular, the study used information from the 2009–2010 Academic

Session's Year One Class, which had 173 pupils. The Ordinary Least Squares (OLS) estimator was used to estimate three interrelated multiple regression equations. To account for heteroscedasticity, White's heteroscedasticity-adjusted standard errors of the OLS estimates were created and used. Estimates using regression equations show that while the number of siblings in a household has a detrimental impact on youngsters' academic achievement in Mathematics, parents' educational level has a favourable impact. Overweight and obesity have a detrimental impact on pupils' academic performance in Mathematics, but normal weight has a good impact. To successfully improve children's academic performance in Mathematics, policies must be put in place to increase parents' educational attainment, reduce the number of families, and make sure children maintain healthy weights.

In Niger State, Nigeria, a study looked at how socioeconomic class and school location affected math students' performance¹⁴². An ex-post facto design was used for the study. During the 2020–2021 academic year, a multi-stage selection technique was used to choose 198 students from a population of 11,275 senior secondary two Mathematics students spread over 240 coeducational public schools. Two research objectives guided the investigation, and two null hypotheses were developed and assessed at the 0.05 significance level. Two tools were used in the data collecting process: the Socio-Economic Status questionnaire (reliability coefficient of 0.81), which was established using Kuder Richardson, and the Mathematics Achievement Test (reliability coefficient of 0.83). Means and standard deviations were used to solve research concerns, and a z-test was used to assess the hypotheses. The findings showed that kids with parents of higher socioeconomic class outperformed those with parents of lower socioeconomic status, and that students in urban schools did noticeably better than those in rural ones. Among

other things, it was suggested that the government improve rural schools to the level of metropolitan ones, where pupils in such schools performed better in Mathematics and had better facilities and staff.

A different study conducted in Northern Nigeria examined the relationship between students' academic achievement and socioeconomic level at Adamawa State¹⁴³'s colleges of education. 312 NCE students were chosen at random from two state-run institutions of education to participate in the study. The study's design was correlational. To collect relevant information, a survey called the "Questionnaire on Socio Economic Status" was used. The instrument was suitably assessed by experts. The Cronbach alpha approach was used to evaluate the instrument's dependability, yielding a reliability rating of 0.83. At a significance level of 0.05, the null hypotheses were assessed using linear regression analysis. The results showed that there was a significant relationship between parents' educational attainment and the academic achievement of physics students in educational institutions, as well as a significant relationship between parents' income levels and academic performance. According to the findings, the government should set up initiatives like soft loans for parents and scholarships for students from low-income families to guarantee that these children have equal access to school as children from higher-income families.

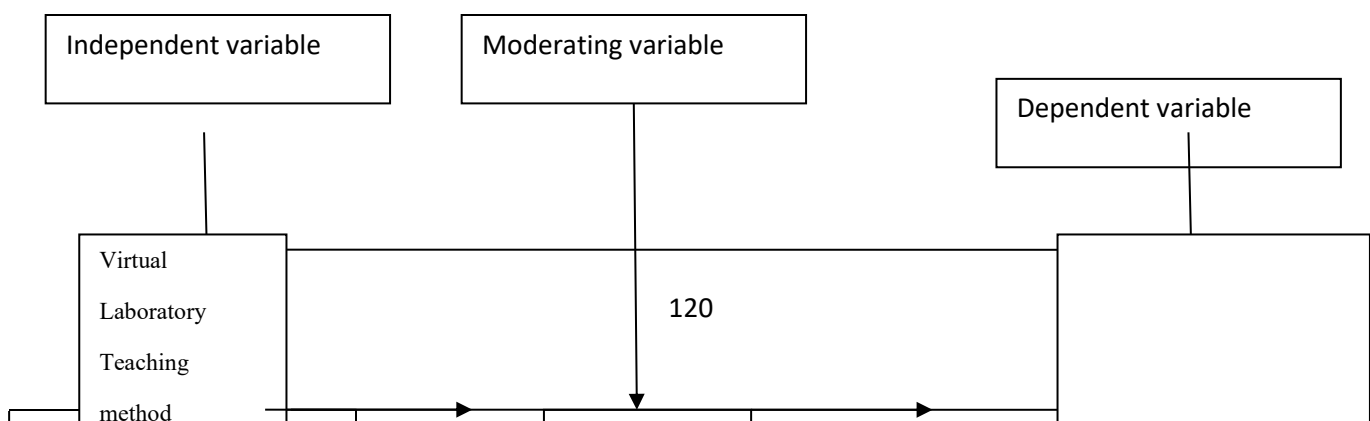
In Niger State, Nigeria, a research looked into how socioeconomic status and school location affected math students' academic performance¹⁴⁴. An ex-post facto design was used for the study. During the 2020–2021 academic year, a multi-stage selection technique was used to choose 198 students from a population of 11,275 senior secondary two Mathematics students spread over 240 coeducational public schools. Two research objectives guided the investigation,

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In a similar vein, a research conducted in North-central Nigeria¹⁴⁵ looked at the socioeconomic factors influencing pupils' academic development in building technology. The goal was to look at the recurring cases of students performing poorly in building technology in order to identify the factors affecting their performance. A survey research design was used in the study. 113 students provided information on their academic achievement and socioeconomic traits. Descriptive and inferential statistics, such as frequency, percentage, mean, and multiple regression analysis, were used to assess the data. According to the study's findings, the majority of college students in North-central Nigeria are under 20, and men make up the majority of those enrolled in technological education in Nigeria. The socioeconomic elements that affect students' academic success in building technology include health status, SSCE credit passes, truancy, gender, age, study hours, family size, monthly stipends, and group study. The lack of a functional building technology workshop, inconsistent power supplies, and inadequate ICT resources are some of the challenges facing building technology students in the study area.

Lastly, a study looked at how pupils' achievements in Senior Secondary School Mathematics in Ogun State, Nigeria¹⁴⁶, were influenced by their parents' jobs, educational backgrounds, and academic motivation. A survey design approach is used in the study. The multistage sampling approach, which incorporates random, proportional, and purposive selection processes, was used to choose the sample. 28,796 Senior Secondary School One pupils from 147 schools spread throughout nine LGAs in Ogun State made up the study's target group. 2,400 pupils were chosen at random from 60 specified schools spread throughout nine Local Government Areas in Ogun State, Nigeria, to make up the research sample. The Students' Questionnaire on Parental Socio-economic Status ($r=0.81$) and the Mathematics Achievement Test ($r=0.84$) were the two study instruments used. Multiple regression analysis was performed on the data at the significance level of 0.05. The results show that of the key factors influencing pupils' advancement in Mathematics, academic motivation has the least impact, while parental education has the most impact on children's academic achievement.

2.4 Conceptual Model



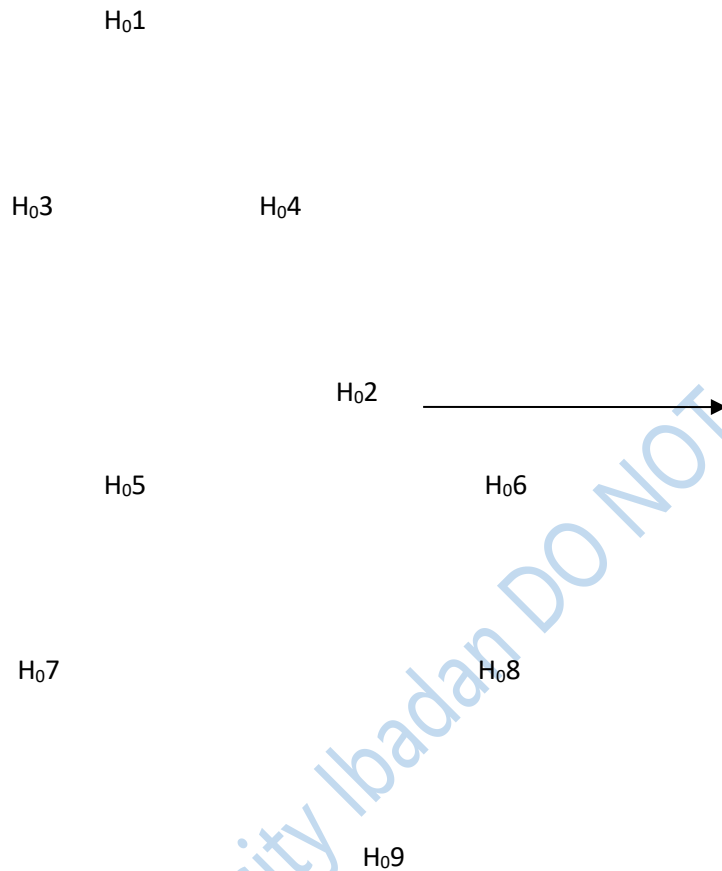


Fig.1: Conceptual Model showing the relationship between independent variables, moderating variable and dependent variable

Independent Variables: Mathematics lab availability and class size.

Dependent Variable: Students' academic achievements in Mensuration.

Moderating Variable: Socio-economic background.

1. Mathematics Lab: Access to a well-equipped Mathematics lab provides hands-on learning experiences, fostering better understanding and engagement, which can enhance achievement in Mensuration.

2. Class Size: Smaller class sizes often result in more personalized attention from teachers, facilitating better comprehension and retention of complex topics like Mensuration.

3. Socioeconomic Status (SES): SES can moderate the effects of both the Mathematics lab and class size. For instance, students from higher SES backgrounds might benefit more from a Mathematics lab due to better prior preparation, while those from lower SES backgrounds might need smaller class sizes to overcome educational disparities.

This framework suggests that the positive effects of Mathematics labs and smaller class sizes on academic achievement in Mensuration might be amplified or diminished based on the students' SES. The relationship between a Mathematics lab, class size, students' academic achievements in Mensuration, and socioeconomic status (SES) as a moderating variable can be outlined as follows:

Direct Effects:

Mathematics Lab: A well-equipped Mathematics lab enhances experiential learning, leading to improved understanding and academic performance in Mensuration.

Class Size: Smaller class sizes allow for more individualized instruction, which can improve students' comprehension and performance in Mensuration.

2. Moderating Effect of SES:

High SES: Students from higher SES backgrounds may benefit more from Mathematics labs due to better prior knowledge and resources, enhancing their achievements further.

Low SES: Students from lower SES backgrounds may need smaller class sizes to receive the additional support required to bridge educational gaps, potentially leading to greater improvements in their academic achievements in Mensuration when provided with individualized attention.

Combined Effects:

-The presence of a Mathematics lab and smaller class sizes are generally associated with higher academic achievements in Mensuration.

- SES moderates these relationships, meaning the extent to which Mathematics labs and class size impact academic achievements in Mensuration varies depending on the students' SES. High SES students might leverage these resources more effectively, whereas low SES students might show more significant improvements with smaller class sizes due to the increased support and attention they receive.

2.5 Summary of the Gap in the Literature Reviewed

From the reviewed literature, it was observed that there is substantial research on the impact of Mathematics laboratories and class size on student achievement globally, specific studies focusing on Oyo State secondary schools are scarce. Also, there is a gap in research specifically addressing the academic achievement in mensuration as opposed to general Mathematics. Mensuration, with its reliance on spatial reasoning and practical application, might uniquely benefit from hands-on learning and smaller class sizes. However, the unique socio-economic, cultural, and educational contexts of Oyo State may yield different results and insights. Few studies explicitly consider how socioeconomic status (SES) moderates the relationship between Mathematics lab usage, class size, and academic achievement in Mensuration. Understanding these interactions in the context of Oyo State could provide a more nuanced view of how educational interventions affect diverse student populations.

Chapter Three

Methodology

This chapter discusses the methodology adopted in carrying out this study. These includes; Research Design; Population of the Study; Sample and Sampling Techniques; Description of Research Instruments; Validity of Research Instruments; Reliability of Research Instruments; Data collection; Data Analysis and Ethical Approval

3.1. Research Design

This study adopts a 3 x 2 x1 factorial matrix Quasi-experimental design of pre-test, post-test, non- randomizes and non-equivalent experimental control groups. It focuses on treatments at (3) three levels (Traditional Mathematics Laboratory, Virtual Mathematics Laboratory, and control group), moderating variable at (2) two levels (socio economics status and class size) and dependent variable at (1) one level (academic achievement). Traditional Mathematics Laboratory and Virtual Mathematics Laboratory are independent variables which serve as treatments for the experimental groups, while the conventional teaching method is used for control group. Students' academic achievement in Mathematics Achievement Test (MAT) at the pre-test and post-test levels will be dependent variable while socio economic status and class size will be serving as moderating variable.

Table 3.1: Factorial Design for the Study

Groups	Pretest	Treatment	Socio Economic Status	Post Test
E ₁	O ₁	X ₁	High/low	O ₂
E ₂	O ₃	X ₂	High/low	O ₄
E ₃	O ₅	X ₃	High/low	O ₆

E₁ = Experimental group 1. (Traditional Mathematics Laboratory)

E₂ = Experimental group 2 (Virtual Mathematics Laboratory)

E₃ = Control Group

O₁ = pretest for Experimental Group 1

O₂ = Post test for Experimental Group 1

O₃ = Pretest for Experimental Group 2

O₄ = Post test for Experimental Group 2

O₅ = Pretest for Control Group

O₂ = Posttest for E₃ Control Group

X₁ = Treatment for Experimental Group 1

X₂ = Treatment for Experimental Group 2

X₃ = Treatment for Control Group

Table 3.2: Schematic Representation of 3x2x1 Factorial Matrix

Treatment	Socio Status and class size	Economic	Academic Achievement
Traditional Mathematics Laboratory	High/ Low		High / Low
Virtual Mathematics Laboratory	High/ Low		High / Low
Conventional method	High/ Low		High / Low

3.2 Population of the study

The population of this study consists of five thousand seven hundred and fifty eight (5,758) students which represents all the 2023/2024 academic year Senior Secondary School two (SSS 2) students of government owned secondary schools in Ibadan North Local Government Area of Oyo State, Nigeria¹. There are forty-two schools (42) Senior Secondary schools in the study area.

Table 3.3: Tabular presentation of the population of the study

Selected	Name of schools	No of students
Educational Zone		
Zone 2	United Secondary School, Ijokodo	66
	Ebenezer African Church Grammar School, Nalende	52
	Humani Alaga High School, Sango	34

3.3. Sample size and Sampling Techniques

The sample for this work consists of three (3) intact classes which was purposively selected from the forty-two (42) senior secondary schools in Ibadan North Local Government Area of Oyo State, The reason for selection of the schools is (1) government owned schools (2) schools that have at least two (2) Qualified Mathematics teachers senior classes (3) schools that have Mathematics teachers with at least six (6) years of experience of being an examiner to external bodies (4) schools that have graduated students in external exams for more than 15 years (5) the availability of Laboratory for teaching and learning of Mathematics in these schools. Three (3) secondary schools will be selected randomly from different areas of the Local government area. United Secondary School Ijokodo with 66 students offering Mathematics in Senior Secondary Schools II and Ebenezer African Church Grammar School Nalende with 52 students offering Mathematics in Senior Secondary School II were randomly selected for experimental groups and

one (1) school Humani Alaga High School Sango was selected for control group. The study adopted SSS II students because Mensuration is been taught in SSS II

Table3.4: Sample distribution

Selected Educational Zone	Nos. of Local Government	No. of Local Government Selected	No. of Public Secondary Schools	No. of Selected Schools
TESCOM	06	01	42	03
Zone 2				

3.4. Research Instrument

Mathematics Achievement Test (MAT) was the main instrument used in this study, (MAT 1 pre-test), Mathematics Achievement Test(MAT 2 post-test), lesson note format for Virtual Mathematics Laboratory, lesson note format for traditional laboratory and control group.

3.4.1 Description of Research Instruments

3.4.1.1 Mathematics Achievement Test (MAT 1- Pre-test)

Mathematics Achievement Test (MAT) is the researcher – made instrument that consists of two sections. Section A consists of students’ Demographic data while section B consists of 25 items objectives questions coined from SSS 2Mathematics curriculum on Mensuration to test the students’ academic achievements. The 25 items were multiple-choice objective questions with four options (A, B, C, and D). MAT will be scored 100% .

Table 3.3: Table of specification for Mathematics Achievement Test (MAT)

S/N	Topic	Sub Topic	Objectives	No of Questions	%
1.	Mensuration	Length of arc of a circle Perimeter of sector and segment	Students would be able to (i) find the length of arcs practically (ii) find the length of arcs using formula. Determine the perimeter of sectors of circles. Determine the perimeter of segments of circles	7	14
2.	Mensuration	Area of sectors of a circle Area of a segment of a circle	Students would be able to (i) Find the area of a circle (ii) Determine the area of a segment	7	14

3.	Mensuration	Relationship	Students would be able to determine the relationship between the sector of a circle and the surface area of a cone.	7	14
4.	Mensuration	Surface area	Students would be able to find the surface areas and volume of cube, cuboids, cylinder – cone, persons, pyramid	9	18
5.	Mensuration	Surface area	Students would be able to find the surface area and volumes of frustrum of a cone and pyramid of a cone and pyramid	12	24

6.	Mensuration	Surface area	Students would be able to find the surface area and volume of compound shapes	8	16
7.	Total			50	100

3.4.1.2 Mathematics Achievement Test (MAT 2- Post-test)

MAT2 was re-arranged version of MAT1. At the end of the experiment, the pre-test items were re-arranged and administer to the three groups.

3.4.1.3. Lesson Note Format for Traditional Laboratory and Control Group

The researcher wrote a lesson note on Mensuration for the use of research assistant. The research assistant taught with the lesson note in the traditional laboratory with laboratory materials such as can of beverages, cartoon of biscuits plain sheets. Ruler, pencil and gum also the other research assistant taught in the classroom with the same lesson note without laboratory materials.

3.4.1.4. Lesson Note Format for Virtual Laboratory

The researcher wrote a lesson note on Mensuration for use of research assistant. The research assistany taught with the use of projector as treatment to support learning. It was demonstrated by projecting 3D Objects for the students

3.5 Validity of Research Instruments

The instruments was validated by the supervisor and two (2) experts in the Department of Science Education, Lead City University, Ibadan for face validity, Content validity and

Construct validity. All corrections and modifications will be affected before producing the final draft for the study.

3.6 Reliability of the Instruments

Kuder-Richardson 20 (KR-20) was used to test the reliability of the instrument after the test instruments was tried on sample of the population who will not participate in the main study to test the internal consistency of the instrument

3.7 Method of Data Collection

The consent and cooperation of the principals, three (3) research assistants and students of the three (3) selected schools were sought for before administration of the instruments to students.

The regular Mathematics teachers of the three (3) secondary schools selected for the study were trained to assist in the study. This will took a week before the actual study. The training was based on the purpose of the study, the topics to be taught, the use of the lesson plan, the use of Traditional Mathematics Laboratory and the use of Virtual Mathematics laboratory. The three trained teachers taught both the two experimental and control groups. The study lasted for 8 weeks. For the experimental groups, the teacher used Traditional Mathematics Laboratory to teach the students in one school with their intact classes and considering socio economic status, in the second school the teacher use projector to teach in Virtual Mathematics Laboratory to teach the students in their intact class and socio economic status would be considered while the Mathematics teacher used conventional method to teach the control group which is the third school with their intact class and also considering the socio economic status. Before the commencement of the experiment, the researcher administered the pre-tests (MAT) to all the students in all groups. The scores were collated for use after experiment, and then the post-tests (MAT) was administered to all the students in all groups. However, in these post-tests the items

of the MAT were re-arranged to avoid familiarity with the items of the instrument by the students. Data for the pre-tests and post-tests were recorded separately for each of the groups.

Below is the schedule of the activities;

- Week 1 – Training of research assistants
- Week 2 – Administration of pretest
- Week 3-7 – Treatment of experimental and control group
- Week 8 – Administration of post test

3.8 Method of Data Analysis

The research question were answered using mean (X) and standard deviation (S.D) while the Hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA).

Endnotes

1. Oyo State Ministry of Education (2024), Agodi Gate Secretariat, Ibadan.

Chapter Four

Results and Discussion of Findings

The Results and Discussion of Findings of the investigation are presented in this chapter. The findings were based on the research questions and hypotheses that were raised in accordance with the study's objective.

4.1 Demographic Data Analysis

Table 4.1: Demographic Data

Variable	Frequency	Percentage
Gender		
Male	73	48.0%
Female	79	52.0%
Total	152	100.0%

Source: Field Survey Report, 2024

Table 4.1 presents gender distribution of the participants. Out of the total participants, 73 (48.0%) were male, while 79 (52.0%) were female. This shows a relatively balanced representation of both genders in the study.

4.2 Presentation of Data

Table 4.2: Descriptive Statistics of the Dependent Variable – Students Performance in Mensuration

	Pretest	Posttest
N	152	152
Missing	0	0
Mean	30.92	50.57
Median	32.00	46.00
Standard deviation	9.139	17.346
Minimum	10.00	17.00
Maximum	56.00	88.00

Source: Field Survey Report, 2024

Table 4.2 provides descriptive statistics for the dependent variable, students' academic performance in Mensuration as measured by the Mathematics Achievement Test (MAT). For pretest, the sample size (N) is 152, indicating the number of learners that took part in the pretest. There are no missing values, meaning that all participants had scores for the pretest. The mean value of the pretest is 30.92, indicating that, on average, the pretest in the sample scored relatively below the average which is 50.00. The median score of 32.00 suggests that half of the students scored below this value. The standard deviation of 9.139 suggests moderate spread of scores around the mean in the pretest scores. Furthermore, the least and the maximum scores are 10 and 56 respectively.

Similarly, for posttest, the sample size is also 152, and there are no missing values. The mean value for posttest is 50.57, indicating a relatively high average score. The median value of 46.00 suggests that the distribution of responses is slightly skewed towards higher performance score. The standard deviation is 17.35, indicating a moderate amount of variability in the responses for the posttest score. While the least and the maximum scores are 17 and 88 respectively. This implies there is an improvement in the performance of students after the intervention (use of new teaching strategies) but the magnitude of the improvement will be determined with the below Analysis of Covariance (ANCOVA).

Table 4.4: Descriptive Statistics of Students' Scores Considering Students' Socio-Economic Background

SES	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
High	53.004 ^a	2.853	47.363	58.644
Low	47.317 ^a	1.660	44.034	50.599

a. Covariates appearing in the model are evaluated at the following values: Pretest Scores = 31.05.

4.2.2 Research Hypotheses

Table 4.5: Summary of main effects Analysis of Covariance (ANCOVA) on the Post-test Achievement Scores in Mensuration Topics.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	7617.495 ^a	5	1523.499	4.497	.001
Main effects					
Intercept	403019.043	1	403019.043	1189.557	0.000
Traditional	2896.651	1	2896.651	12.020	0.000
Virtual	2776.194	1	2776.194	10.018	0.003
Conventional	993.959	1	993.959	2.542	0.094
SES	1195.417	1	1195.417	3.528	0.062
Class	2839.008	1	2839.008	8.380	0.004
Error	49464.446	146	338.798		
Total	559977.000	152			
Corrected Total	57081.941	151			

a. R Squared = 0.133 (Adjusted R Squared = 0.104)

H₀₁: There is no significant main effect of Traditional Mathematics Laboratory method on Senior Secondary School students' achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

Table 4.5 shows that there was a significant main effect of traditional Mathematics laboratory on the academic achievement of senior secondary school students in Mensuration topics in Ibadan North local government area, Oyo state. [$F_{(1;146)} = 12.020$; $P < 0.05$]. Therefore, the H_0 is rejected. This implies that traditional Mathematics laboratory contributes significantly to the mean difference of student's performance in Mensuration topics.

H₀₂: There is no significant main effect of Virtual Mathematics Laboratory on senior Secondary School students' achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

From table 4.5 above, the results show that there was significant main effect Virtual Mathematics Laboratory on the academic achievement of senior secondary school students in Mensuration topics in Ibadan North local government area, Oyo state. [$F_{(1;146)} = 10.018$; $P < 0.05$]. Since $P < 0.05$, the H_0 is therefore rejected.

H₀₃: There is no significant main effect of Conventional Teaching Method on senior Secondary School students' achievement in Mensuration topics in Ibadan North local Government Area, Oyo State.

The result from table 4.5 above revealed that there was no significant effect of conventional teaching method on the academic achievement of senior secondary school in Mensuration topics in Ibadan North local government area, Oyo state. [$F_{(1;246)} = 2.542$; $P > 0.05$], the H_0 is therefore not rejected. This implies that conventional teaching methods without the use of Mathematics laboratory are not effective in teaching Mensuration topics.

Ho4:There is no significant main effect of Socio-economic Status on senior Secondary School students' achievement in Mensuration topics in Ibadan North local government area, Oyo state.the ANCOVA results from the table 4.5 above shows that there is no significant main effect of Socio-economic Status on senior Secondary School students' achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State. [$F_{(1;246)}=3.528$; $P >0.05$]. Hence, the Ho is not rejected. This implies that students' socio-economic background has no significant effect on their performance in Mensuration topics.

Ho5:There is no significant main effect of class size on senior Secondary School students' achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.Again, from the table 4.5, the ANCOVA results revealed that class size has significant main effect of class size on senior Secondary School students' achievement in Mensuration topics in Ibadan North local government area, Oyo state; [$F_{(1;246)}=8.380$; $P <0.05$]. Going by this result, the Ho is therefore rejected. This indicates that class size contributes to the students' performance in Mensuration topics.

Table 4.6: Summary of 2-Ways interactions Analysis of Covariance (ANCOVA) on the Post-test Achievement Scores in Mensuration

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	8928.722 ^a	9	992.080	2.926	0.003
2-Ways interactions					

Intercept	390490.078	1	390490.078	1151.524	0.000
Traditional * Virtual	17643.296	2	17643.296	8.128	0.000
Traditional *	11693.106	2	11693.106	5.993	0.008
Conventional					
Traditional * SES	722.083	2	722.083	2.129	0.123
Traditional * Class	1870.991	2	1870.991	4.517	0.005
Error	48153.218	142	339.107		
Total	559977.000	152			
Corrected Total	57081.941	151			

a. R Squared = .556 (Adjusted R Squared = 0.503)

H₀₆: There is no significant interactive effect of Traditional Mathematics Laboratory and Virtual Mathematics Laboratory method on Senior Secondary School students' achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

Two – ways interactions ANCOVA was conducted to test for the interaction effects of Traditional Mathematics Laboratory and Virtual Mathematics Laboratory method on Senior Secondary School students' achievement in Mensuration topics and the result from table 4.6 shows that there exist interaction effect of Traditional Mathematics Laboratory and Virtual Mathematics Laboratory method on Senior Secondary School students' achievement in Mensuration topics: [$F_{(1;246)}=8.128$; $P <0.05$]. This implies that when that Traditional Mathematics Laboratory and Virtual Mathematics Laboratory methods adopted simultaneously, students perform better in Mensuration topics.

H₀₇: There is no significant interactive effect of Traditional Mathematics Laboratory and Conventional teaching method on Senior Secondary School students' achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State. [$F_{(2;142)}=8.128$; $P < 0.05$]. From table 4.5 above, it was observed that there is significant interactive effect of Traditional Mathematics Laboratory and Conventional teaching method on Senior Secondary School students' achievement in Mensuration topics in Ibadan North local government area, Oyo state: [$F_{(2;142)}=5.993$; $P < 0.05$]. With this result, the H_0 is rejected. This implies that when traditional Mathematics laboratory is combined with the conventional teaching method, students performed better in Mensuration topics.

H₀₈: There is no significant interactive effect of Traditional Mathematics Laboratory and students' socio-economic background on their academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

The H_{08} is tested using ANCOVA as shown in table 4.5 above. The result shown that There is no significant interactive effect of Traditional Mathematics Laboratory and students' socio-economic background on their academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State. [$F_{(2;142)}=2.129$; $P > 0.05$].

H₀₉: There is no significant interactive effect of Traditional Mathematics Laboratory and class size on students' academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

The ANCOVA result revealed that There is significant interactive effect of Traditional Mathematics Laboratory and class size on students' academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State. [$F_{(2;142)}=4.517$; $P < 0.05$]. This result

implies that Traditional Mathematics Laboratory and class size contributes significantly to the students' academic achievement in Mensuration topics.

Table 4.7: Summary of 3-Ways interactions Analysis of Covariance (ANCOVA) on the Post-test Achievement Scores in Mensuration

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	9858.933 ^a	11	896.267	2.657	0.004
3-Ways interactions					
Intercept	379558.965	1	379558.965	1125.262	0.000
Traditional * Virtual * SES	406.420	4	101.605	.301	0.877
Traditional * Virtual * Class	7917.590	4	1979.398	5.868	0.000
Error	47223.008	140	337.307		
Total	559977.000	152			
Corrected Total	57081.941	151			

a. R Squared = 0.173 (Adjusted R Squared = 0.108)

H₀10: There is no significant interactive effect of Traditional Mathematics Laboratory method, Virtual Mathematics Laboratory method and students' socio-economic background on their academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

Three–ways ANCOVA was conducted to determine the interactive effects of Traditional Mathematics Laboratory method, Virtual Mathematics Laboratory method students' socio-economic background on their academic achievement in Mensuration topics. The result as depicted by table 4.6 above revealed that there is no significant interactive effect of Traditional Mathematics Laboratory method, Virtual Mathematics Laboratory method and students' socio-economic background on their academic achievement in Mensuration topics in Ibadan North local government area, Oyo state: [$F_{(4,140)} = 0.301$; $P > 0.05$]. Considering this result, H_0 is not rejected.

H₀₁₁: There is no significant interactive effect of Traditional Mathematics Laboratory method, Virtual Mathematics Laboratory method and class size on students' academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

The 3–ways ANCOVA in table 4.6 depicts that there is significant interactive effect of Traditional Mathematics Laboratory method, Virtual Mathematics Laboratory method and class size on students' academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State. [$F_{(4,140)} = 5.868$; $P < 0.05$]. The H_0 is therefore rejected.

4.3 Discussion of Findings

The findings of this study are discussed based on the objectives of the study as guided by five (5) research questions and ten (10) research hypotheses. The five research questions were answered with the use of descriptive statistics. While ten (10) hypotheses were tested with the use of inferential statistics, specifically, Analysis of Covariance (ANCOVA).

The first objective of this study is to investigate the achievement of Senior Secondary School students in Mensuration topic when taught using conventional method of teaching in Ibadan North Local Government Area, Oyo State. The finding of the study revealed that the sampled

students scored below average when taught with conventional teaching method. The results indicate that students struggle to comprehend and apply Mensuration concepts, leading to poor academic achievement. This conclusion is in tandem with previous research which criticized traditional teaching methods for being ineffective in promoting deep understanding and critical thinking^{1,2,3}

The second objective is to investigate the achievement of Senior Secondary School student in Mensuration topic when taught using Virtual Laboratory method in Ibadan North Local Government Area, Oyo State. Result from the descriptive statistics indicates that students performed averagely better in Mensuration topics when taught with Virtual Laboratory method. This is shown by the posttest mean score (49.21) which is higher than the pretest mean score (31.05).

The third objective is to examine the achievement of Senior Secondary School student in Mensuration topic using Traditional Laboratory in Ibadan North local government area, Oyo state. Finding of this study shown that students performed reasonably better in Mensuration topics when taught with Traditional Laboratory method, as their posttest test mean score (58.32) is greater than the pretest mean score (31.05).

The fourth objective is to examine the achievement of senior secondary school students in Mensuration topic considering socio-economic background of students in Ibadan North Local Government Area, Oyo State?

Finding of this study revealed that students from higher socio-economic background performed better than their counterparts in low socio-economic background. Higher SES students have better access to educational resources, technology, and tutoring. Also, Higher SEB parents tend

to be more involved in their children's education and these aid their academic achievement in Mensuration.

The fifth objective is to examine the main effect of Traditional Mathematics Laboratory method on Senior Secondary School students' achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

The study's findings have revealed a significant main effect of the Traditional Mathematics Laboratory (TML) method on Senior Secondary School students' achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State. This result is in agreement with past studies conducted on the effects of traditional Mathematics laboratory^{3,4}. This outcome underscores the effectiveness of hands-on learning experiences in enhancing students' understanding and retention of Mensuration concepts. The TML method's superiority can be attributed to its emphasis on practical application and experimentation. By engaging with physical materials and measuring instruments, students develop spatial reasoning, critical thinking, and problem-solving skills essential for mastering Mensuration.

In contrast to theoretical instruction alone, TML provides tangible experiences, enabling students to visualize and internalize complex concepts. This experiential learning fosters deeper comprehension, improved retention, and enhanced academic achievement. The significance of this study's findings is accentuated by the context of Ibadan North Local Government Area of Oyo State, where practical learning experiences may be limited. TML's effectiveness in this setting highlights its potential as a valuable resource for improving Mathematics education.

Educators and policymakers should consider integrating TML into Mathematics curriculum, ensuring adequate resources and facilities. Teacher training programs should prioritize TML's effective implementation.

The sixth objective of this study is to examine the main effect of Virtual Mathematics Laboratory method (VML) on method on Senior Secondary School students' achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

The study's findings have revealed a significant main effect of the Virtual Mathematics Laboratory (VML) method on Senior Secondary School students' achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State. This outcome underscores the efficacy of VML in enhancing students' understanding and retention of Mensuration concepts. The VML method's superiority can be attributed to its interactive and immersive nature, which facilitates active learning and engagement. By providing a simulated environment, VML enables students to explore and experiment with Mensuration concepts, fostering deeper comprehension and improved spatial reasoning skills.

In contrast to traditional teaching methods, VML offers personalized learning experiences, adapting to individual students' pace and learning styles. This tailored approach likely contributed to the significant improvement in students' achievement. The findings also suggest that VML can bridge the gap between theoretical knowledge and practical application. This finding aligns with previous research that has consistently advocating for integration of virtual Mathematics laboratory in teaching Mathematics because it provides^{5,6,7} real-world contexts and visual representations, VML helps students connect abstract concepts to tangible problems, enhancing their problem-solving skills.

The significance of this study's findings is amplified by the context of Ibadan North Local Government Area, where access to quality education and resources may be limited. The VML method's effectiveness in this setting underscores its potential as a viable solution for improving Mathematics education in resource-constrained environments. The implications of this study are far-reaching. Educators and policymakers should consider integrating VML into Mathematics curriculum, particularly in areas where resources are scarce. Additionally, teacher training programs should prioritize VML's effective implementation.

The seventh objective is to investigate the main effect of conventional teaching method on Senior Secondary School students' achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

The study's findings revealed a surprising outcome: conventional teaching methods have no significant main effect on students' academic achievement in Mensuration in Ibadan. This suggests that traditional teaching approaches, long considered the cornerstone of education, do not directly impact students' performance in this critical area of Mathematics. This result is in agreement with the submission of past researchers who had criticize the efficacy of conventional teaching methods to teach Mathematics, especially, Mensuration topics.^{3,8,9}

The implications are profound. Educators must rethink their instructional strategies, moving beyond familiar methods to explore innovative approaches that genuinely enhance Mensuration learning. Furthermore, the study highlights the importance of contextual factors, such as student motivation, resource availability, and teacher quality, which may play a more significant role in shaping academic achievement.

Several factors contributed to this lack of main effect. Conventional methods may fail to engage students, leading to limited interest and participation. Additionally, inadequate hands-on practice hindered understanding, while inconsistent teaching quality affected outcomes. To address these challenges, future research should investigate alternative teaching methods, comparative studies, and contextual factors influencing Mensuration learning. Longitudinal studies can provide valuable insights into the long-term impacts of conventional teaching methods. Ultimately, this study serves as a call to action, urging educators to develop more effective strategies that cater to diverse learning needs and foster genuine understanding.

The eighth objective is to determine the moderating effects of students' socio-economic background on their academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

The study revealed a remarkable finding that socioeconomic background does not significantly impact academic achievement in Mensuration among students in Ibadan. This suggests that family income, parental education, and occupation do not directly influence performance. This result is not in conformity with few past studies which established significant relationship between students' socio-economic background and academic performance^{10, 11}. The lack of impact can be attributed to several factors provision of adequate resources by the school which, bridge socioeconomic gaps, and effective teaching transcends socioeconomic boundaries, engaging students. This outcome has profound implications for education. It underscores the potential for schools to provide equal opportunities, highlighting teacher quality as a key driver of academic success. Inclusive education strategies focusing on individual potential, rather than socioeconomic status, are essential¹². Intrinsic motivation, such as interest and self-efficacy, drives achievement.

The ninth objective is to determine the moderating effect of class size on students' academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

The tenth objective of this study is to examine the interactive effect of Traditional Mathematics Laboratory Method and Virtual Mathematics Laboratory on students' academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

This study explored the interactive effect of traditional and virtual Mathematics laboratories on senior secondary school students' academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

The findings revealed a significant interaction between laboratory methods and student achievement. Notably, the traditional laboratory method excelled in developing hands-on skills, while the virtual laboratory method enhanced conceptual understanding. These results have significant implications for education. A blended approach combining traditional and virtual laboratories can optimize learning outcomes. Contextual learning, leveraging technology for real-world applications, is also essential. Furthermore, teacher training should focus on developing expertise in both laboratory methods. Several factors contributed to the interactive effect: Hands-on experience in traditional laboratories fostered practical skills. Visualization in virtual laboratories enhanced conceptual grasp. Interactive technology in virtual laboratories boosted student engagement.

Eleventh objective of this study is to examine the interactive effect of Traditional Mathematics Laboratory and students' socio-economic background on their academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

This study examined the interactive effect of traditional Mathematics laboratory and students' socioeconomic background on senior secondary school students' academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State. The findings revealed no significant interaction between laboratory exposure and socioeconomic background, indicating that these factors independently influenced academic achievement. This suggests that laboratory-based instruction benefits students regardless of socioeconomic status. The lack of interaction can be attributed to equitable laboratory access for all students; effective teaching that transcends socioeconomic boundaries and student motivation which is a catalyst to academic achievement.

Twelfth objective is to explore the interactive effect of Traditional Mathematics Laboratory and class size on students' academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

This study explored the interactive effect of traditional Mathematics laboratory and class size on senior secondary school students' academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State. The findings revealed a significant interaction between laboratory exposure and class size, underscoring the importance of classroom dynamics in Mathematics education. This finding is agreed with past studies on class size and students' academic achievement^{12,13}. Notably, small classes with fewer than 30 students derived the most benefit from laboratory instruction, exhibiting enhanced understanding and retention.

In contrast, medium-sized classes with 30-40 students showed moderate benefits, while large classes exceeding 40 students had diminished benefits. This suggests that personalized attention and teacher-student interaction play pivotal roles in leveraging laboratory instruction.

These results have significant implications for education policy and practice:

Optimize class size for effective laboratory instruction.

Prioritize small classes for hands-on Mathematics learning.

Teacher training should focus on managing diverse class sizes.

The thirteenth objective of this study is to investigate the interactive effect of Traditional Mathematics Laboratory method, Virtual Mathematics Laboratory method and students' socio-economic background on their academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

This study examined the interactive effect of traditional Mathematics Laboratory, virtual Mathematics laboratory, and students' socioeconomic background on senior secondary school students' academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State. The research yielded a surprising outcome: no significant interaction between laboratory type, socioeconomic background, and academic achievement. This implies that traditional and virtual laboratories are equally effective in enhancing student understanding of Mensuration topics.

Furthermore, socioeconomic background did not influence laboratory effectiveness, suggesting that students from diverse backgrounds benefited equally from both laboratory types. Instead, factors such as teacher effectiveness, student motivation, and access to resources played a more significant role in determining academic achievement. The study's findings have important implications of this finding for education policy and practice include; developing quality laboratory experiences that cater to diverse learning styles, addressing socioeconomic disparities through targeted support and emphasizing inclusive pedagogy in teacher training.

The fourteenth objective of this study is to measure the interactive effect of Traditional Mathematics Laboratory method, Virtual Mathematics Laboratory method and class size on students' academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

This study explored the interactive effect of traditional Mathematics laboratory, virtual Mathematics laboratory, and class size on senior secondary school students' academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State.

The research revealed a significant interplay between laboratory type and class size, influencing student performance. Notably, traditional laboratories proved most effective in small classes with fewer than 30 students, fostering personalized attention and enhanced teacher-student interaction. In contrast, virtual laboratories showed greater benefits in medium-sized classes of 30-40 students, leveraging technology to facilitate engagement. However, large classes exceeding 40 students struggled with both laboratory types, underscoring the challenges of managing diverse learning needs. These findings have significant implications for education policy and practice:

1. Optimize class size for laboratory instruction to ensure personalized attention.
2. Leverage technology in virtual laboratories for larger classes.
3. Teacher training should focus on managing diverse class sizes and adapting instructional strategies.

Endnotes

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Chapter Five

Conclusion

5.1 Summary of Findings

Finding of this study were deduced from both the descriptive and inferential statistics. From descriptive statistics, the following were statistically obtained; Students scored relatively low when taught with conventional teaching method. This is represented with the mean vale of 42.96 which is below the average. There is moderate improvement in the students' academic achievement in Mensuration when taught with virtual laboratory. The post-test mean score is 49.21 which is greater than the pretest score of 31.05. more so, there is high improvement in academic performance in Mensuration students when taught with traditional Mathematics laboratory, the posttest mean score of 58.32 is higher than the pre-test mean score 31.05 Finally, there is difference in the academic performance of students in Mensuration based on socio economic background.

From the inferential statistics, the results of the ANCOVA, as shown in Table 4.4, indicate a significant main effect of Traditional Mathematics Laboratory on the academic achievement of Senior Secondary School students in Mensuration topics in Ibadan North Local Government Area, Oyo State. [$F_{(1;146)} = 12.020$; $P < 0.05$]. Similarly, from the same table, the results show that there was significant main effect Virtual Mathematics Laboratory on the academic achievement of senior secondary school students in Mensuration topics in Ibadan North Local Government Area, Oyo State. [$F_{(1;146)} = 10.018$; $P < 0.05$]. However, there no significant effect of

conventional teaching method on the academic achievement of senior secondary school in Mensuration topics in Ibadan North Local Government Area, Oyo State. [$F_{(1;246)} = 2.542$; $P > 0.05$]. in the same vein, there was no significant main effect of Socio-economic Status on senior Secondary School students' achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State; [$F_{(1;246)} = 3.528$; $P > 0.05$]. finally, from table 4.4, class size has significant main effect of class size on senior Secondary School students' achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State; [$F_{(1;246)} = 8.380$; $P < 0.05$].

Furthermore, results from table 4.5 shows that there exist interaction effect of Traditional Mathematics Laboratory and Virtual Mathematics Laboratory method on Senior Secondary School students' achievement in Mensuration topics: [$F_{(1;246)} = 8.128$; $P < 0.05$]; there is significant interactive effect of Traditional Mathematics Laboratory and Conventional teaching method on Senior Secondary School students' achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State: [$F_{(2;142)} = 5.993$; $P < 0.05$]; There is significant interactive effect of Traditional Mathematics Laboratory and class size on students' academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State: [$F_{(2;142)} = 4.517$; $P < 0.05$]. However, no significant interactive effect was not established between Traditional Mathematics Laboratory and students' socio-economic background on their academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State: [$F_{(2;142)} = 2.129$; $P > 0.05$].

Moreover, result from table 4.6 shows that was there is no significant interactive effect of Traditional Mathematics Laboratory method, Virtual Mathematics Laboratory method and students' socio-economic background on their academic achievement in Mensuration topics in

Ibadan North Local Government Area, Oyo State: [$F_{(4;140)} = 0.301$; $P > 0.05$]. Similarly, there is significant interactive effect of Traditional Mathematics Laboratory method, Virtual Mathematics Laboratory method and class size on students' academic achievement in Mensuration topics in Ibadan North Local Government Area, Oyo State: [$F_{(4;140)} = 5.868$; $P < 0.05$].

5.2 Conclusion

In conclusion, the findings indicate a significant interactive effect of both Traditional Mathematics Laboratories and Virtual Mathematics Laboratories, alongside class size, on students' academic achievement in Mensuration topics within the Ibadan North Local Government Area of Oyo State. This suggests that the mode of instruction—whether traditional or virtual—coupled with the size of the class, plays a crucial role in influencing students' understanding and performance in Mathematics. As educators and policymakers seek to enhance academic outcomes, these insights highlight the importance of considering both instructional methods and class size in the design and implementation of effective teaching strategies. Tailoring learning environments to optimize these factors could lead to improved student engagement and achievement in Mathematics, particularly in challenging areas such as Mensuration.

5.3 Recommendations

Based on the findings regarding the interactive effects of Traditional Mathematics Laboratories, Virtual Mathematics Laboratories, and class size on students' academic achievement in Mensuration topics, the following recommendations are proposed:

1. **Enhancement of Instructional Methods:** Schools should invest in training teachers to effectively utilize both Traditional and Virtual Mathematics Laboratories. This dual approach can cater to diverse learning preferences and enhance student engagement.
2. **Optimizing Class Size:** Educational authorities should consider implementing smaller class sizes, particularly in Mathematics, to facilitate more personalized instruction and interaction. This can lead to better academic outcomes as students receive more individualized attention.
3. **Integration of Technology:** Incorporating technology into Mathematics education is essential. Schools should provide adequate resources for Virtual Mathematics Laboratories, ensuring that students have access to digital tools that can enhance their understanding of Mensuration and other topics.
4. **Regular Assessment and Feedback:** Implement regular assessments to monitor student progress and provide timely feedback. This will help identify areas where students are struggling and allow for adjustments in teaching strategies to address their needs.
5. **Encouraging Collaborative Learning:** Foster a collaborative learning environment where students can work together in both Traditional and Virtual settings. Group activities can promote peer learning and reduce anxiety around complex topics like Mensuration.
6. **Parental Involvement:** Encourage parents to engage with their children's learning process, especially in using virtual tools. Workshops or informational sessions can help parents understand how to support their children's Mathematics education at home.

By implementing these recommendations, educational stakeholders can create a more effective and supportive learning environment for students, ultimately improving their academic performance in Mathematics

5.4 Contribution to Knowledge

The findings from this study on the effects of Mathematics Laboratories on students' academic achievement in Mensuration topics contribute significantly to the body of knowledge in several ways.

Firstly, this research provides valuable insight into the effectiveness of blending traditional and virtual instructional methods in Mathematics education. The evidence supporting the benefits of a combined approach informs educators about effective strategies for enhancing student understanding and performance in this subject area.

Secondly, the study sheds light on the dynamics of class size in relation to academic achievement. By demonstrating that smaller class sizes can lead to improved learning outcomes, it adds to the ongoing discourse regarding optimal classroom environments for effective teaching and learning. Additionally, this research underscores the important role of technology in Mathematics education. By illustrating the positive impact of Virtual Mathematics Laboratories, it encourages further exploration into the integration of digital tools in teaching practices, thereby influencing curriculum development in Mathematics education.

The practical implications of the findings are also noteworthy. Educators are provided with actionable recommendations for enhancing student engagement and achievement in Mensuration, guiding them toward innovative pedagogical practices that cater to diverse student needs.

Moreover, this study serves as a framework for future research, inviting further investigations into the relationships between teaching methods, class sizes, and academic performance in Mathematics. Such explorations can enrich the educational research landscape by examining various subjects and contexts.

Lastly, the insights gained from this research can inform policymakers in making data-driven decisions regarding class size regulations and funding for educational technology. By focusing

on these areas, policymakers can ultimately work toward improving student outcomes on a broader scale.

In summary, this study enriches existing literature on Mathematics education and offers practical insights aimed at enhancing teaching practices and learning experiences in this critical subject.

5.5 Suggested Areas for Further Research

Based on the findings of this study regarding the interactive effects of Traditional Mathematics Laboratories, Virtual Mathematics Laboratories, and class size on students' academic achievement in Mensuration topics, several areas for further research can be suggested:

1. Longitudinal Studies: Conducting longitudinal studies to assess the long-term impact of Traditional and Virtual Mathematics Laboratories on students' academic performance across various Mathematics topics, beyond Mensuration.
2. Comparative Studies: Exploring comparative studies between different educational settings (urban vs. rural) or between various socioeconomic backgrounds to determine how these factors influence the effectiveness of different teaching methods in Mathematics.
3. Student Engagement and Motivation: Investigating how Traditional and Virtual Mathematics Laboratories affect student engagement, motivation, and attitudes toward Mathematics, especially in different class size contexts.

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APPENDIX I
Mathematics Achievement Test (MAT)

Instruction:

In section A: Please provide an appropriate answer to the following questions

In section B: Please shade only one answer at a time from the given options

Duration: 40 minutes

SECTION A
Demographic Characteristics of Participant

School name: _____

Gender **Male** **Female**

Parents Occupation: Civil Servant **Public Servant**

Private Sector **Business Trading**

Test type: **pretest** **post test**

SECTION B

1. A Chord subtends an angle of 72° at the centre of a circle of radius 24.5m. Calculate the perimeter of the minor segment.

A. 59.6cm
B. 58.6 cm
C. 70.6 cm
D. 55.6 cm

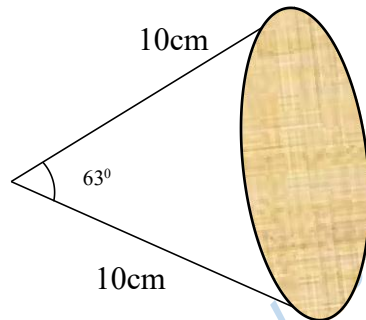
2. The diameter of a cylinder closed at both ends 7cm. if the total surface area is 209cm^2 . Calculate the height [Take $\pi = \frac{22}{7}$]

A. 6 cm

- B. 10 cm
C. 3 cm
D. 5cm
3. A cone has a base radius of 8cm and height 11cm. calculate curved surface area correct to two decimal places (Take $\pi = \frac{22}{7}$)
A. 314.98cm^2
B. 276.57cm^2
C. 201.14cm^2
D. 477.71cm^2
4. The ratio of the radius to the slant height of a right circular cone is 2.5. if the total surface area of the cone is $224\pi\text{cm}^2$, calculate the slant height
A. $\frac{5r}{2}$
B. $\frac{5r}{4}$
C. $\frac{r}{2}$
D. $5r$
5. The dimensions of a rectangular base of a right pyramid are 9cm by 5cm. if the volume of the pyramid is 105cm^3 how is the height of the pyramid?
A. 10cm
B. 6cm
C. 8cm
D. 7cm
6. A solid cuboid has length 7cm, width 5cm and height 4cm. calculate its total surface area.
A. 280cm^2
B. 166cm^2
C. 140cm^2
D. 83cm^2
7. A sector of a circle with radius 6cm subtends an angle of 60° at the centre. Calculate its perimeter in terms of π
A. $2(\pi + 6)\text{cm}$
B. $2(\pi + 3)\text{cm}$
C. $2(\pi + 2)\text{cm}$
D. $(\pi + 12)\text{cm}$
8. The dimensions of a rectangular tank are 2m by 7m by 11m. if its volume is equal to that of a cylindrical tank of height 4cm. calculate the base radius of the cylindrical tank. [Take $\pi = \frac{22}{7}$]
A. 14cm
B. 7m
C. $3\frac{1}{2}\text{m}$
D. $1\frac{3}{4}\text{m}$

9. The slant height of a cone is 5cm and the radius of its base is 3cm. find correct to the nearest whole number, the volume of the cone. (Take $\pi = \frac{22}{7}$)
- 38 m^3
 - 33 m^3
 - 28 m^3
 - 23 m^3
10. A cylinder with base radius 14cm has the same volume as a cube side 22cm. calculate the ratio of the total surface area of the cylinder to that of the cube [Take $\pi = \frac{22}{7}$]
- 73:77
 - 77; 74
 - 63: 77
 - 73:73
11. The volume of a cuboid is 54 cm^3 . If the length, width and height of the cuboid are in the ratio 2:1:1 respectively, find its total area
- 108 cm^2
 - 90 cm^2
 - 80 cm^2
 - 75 cm^2
12. A sector of a circle with radius 6cm subtends an angle 60° at the centre. Calculate its perimeter in forms of π
- $2(\pi + 6) \text{ cm}$
 - $2(\pi + 3) \text{ cm}$
 - $2(\pi + 8) \text{ cm}$
 - $2\pi(\pi + 6) \text{ cm}$
13. The volume of a cone of height 3cm is $38\frac{1}{2} \text{ cm}^3$. Find the radius of its base
- $r = 3\frac{1}{2}$
 - $r = 2\frac{1}{2}$
 - $r = 3\frac{1}{4}$
 - $r = 3\frac{2}{3}$
14. The radii of the base of two cylindrical tins, P and Q are r and 2r respectively. If the water level in P is 10cm high. What would be the height of the same quantity of water.
- 2.5 cm
 - 2.3 cm
 - 2.8 cm
 - 3.5 cm
15. The volume of a cuboid is 54 cm^3 . If the length, width and height of the cuboid are in the ratio 2:1:1 respectively, find its total surface area.
- 96 cm^2
 - 90 cm^2
 - 86 cm^2
 - 94 cm^2
16. A sector of a circle of radius 14cm containing an angle 60° is folded to form a cone. Calculate the radius of the base of cone
- 3.5cm
 - 3 cm
 - 7 cm

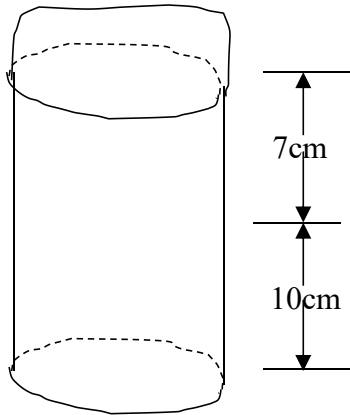
- D. 3.3 cm
17. The angle of a sector of a circle of radius 8cm is 240° . This Sector is bent to form a cone. Find the radius of the cone.
- A. $\frac{16}{3} \text{ cm}$
 B. $\frac{17}{3} \text{ cm}$
 C. $\frac{16}{5} \text{ cm}$
 D. $\frac{18}{3} \text{ cm}$
18. The angle of a sector of a circle radius 7cm is 180° calculate the perimeter of the sector (Take $\pi = \frac{22}{7}$)
- A. 27.2 cm
 B. 27 cm
 C. 28cm
 D. 27.5cm
- 19.



- Calculate the area of the shaded segment of the circle shown in the diagram (Take $\pi = \frac{22}{7}$)
- A. 10.45 cm^2
 B. 11.4 cm^2
 C. 10.5 cm^2
 D. 13.48 cm^2
20. The angle of a sector of a circle radius 10.5cm is 120° . find the perimeter of the sector (Take $\pi = \frac{22}{7}$)
- A. 43 cm
 B. 42 cm
 C. 41 cm
 D. 44 cm
21. A sector of a circle radius 6cm had an angle of 105° at the centre calculate its (i) Perimeter (ii) Area (Take $\pi = \frac{22}{7}$)
- A. 33 cm
 B. 54 cm
 C. 50 cm
 D. 25 cm
22. The angle of a sector of a circle of radius 35cm is 288° . Find the perimeter of a sector [Take $\pi = \frac{22}{7}$]
- A. 246 cm

- B. 357 cm
 C. 462 cm
 D. 200 cm
23. Calculate the total surface area of a solid cone of slant height 15cm and base radius 8cm in terms of π
- A. $184\pi \text{ cm}^2$
 B. $164\pi \text{ cm}^2$
 C. 123 cm^2
 D. $176\pi \text{ cm}^2$

24.



The solid is a cylinder surmounted by a hemispherical bowl calculate its (a) total surface area (b) volume ($\pi = \frac{22}{7}$)

- A. 2258.67 cm^3
 B. 2345.21 cm^3
 C. 3567.34 cm^3
 D. 5743.87 cm^3
25. A solid cylinder of radius 7cm, is 10cm long. Find its total surface area
- A. $238\pi \text{ cm}^3$
 B. $84\pi \text{ cm}^3$
 C. $184\pi \text{ cm}^3$
 D. $254\pi \text{ cm}^3$

APPENDIX II
MATHEMATICS ACHIEVEMENT TESTS

Instruction:

In section A: Please provide an appropriate answer to the following questions

In section B: Please shade only one answer at a time from the given options

Duration: 40 minutes

SECTION A
Demographic Characteristics of Participant

School name: _____

Gender	Male	<input type="checkbox"/>	Female	<input type="checkbox"/>
Parents Occupation:	Civil Servant	<input type="checkbox"/>	Public Servant	<input type="checkbox"/>
	Private Sector	<input type="checkbox"/>	Business Trading	<input type="checkbox"/>
Test type:	pretest	<input type="checkbox"/>	post test	<input type="checkbox"/>

SECTION B

- The dimensions of a rectangular base of a right pyramid are 9cm by 5cm. if the volume of the pyramid is 105cm^3 how is the height of the pyramid?
E. 10cm
F. 6cm
G. 8cm
H. 7cm
- A solid cuboid has length 7cm, width 5cm and height 4cm. calculate its total surface area.
E. 280cm^2
F. 166cm^2
G. 140cm^2
H. 83cm^2
- A sector of a circle with radius 6cm subtends an angle of 60° at the centre. Calculate its perimeter in terms of π
E. $2(\pi + 6)\text{cm}$
F. $2(\pi + 3)\text{cm}$
G. $2(\pi + 2)\text{cm}$
H. $(\pi + 12)\text{cm}$
- The slant height of a cone is 5cm and the radius of its base is 3cm. find correct to the nearest whole number, the volume of the cone. (Take $\pi = \frac{22}{7}$)
E. 38 m^3

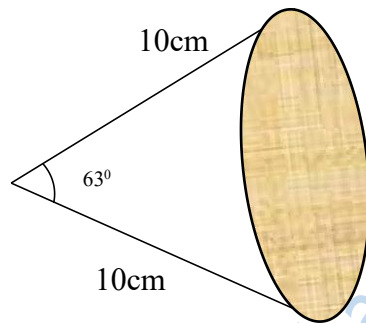
- F. 33 m^3
 G. 28 m^3
 H. 23 m^3
5. A cylinder with base radius 14cm has the same volume as a cube side 22cm. calculate the ratio of the total surface area of the cylinder to that of the cube [Take $\pi = \frac{22}{7}$]
 E. 73:77
 F. 77; 74
 G. 63: 77
 H. 73:73
6. The volume of a cuboid is 54 cm^3 . If the length, width and height of the cuboid are in the ratio 2:1:1 respectively, find its total area
 E. 108 cm^2
 F. 90 cm^2
 G. 80 cm^2
 H. 75 cm^2
7. A Chord subtends an angle of 72° at the centre of a circle of radius 24.5m. Calculate the perimeter of the minor segment.
 E. 59.6cm
 F. 58.6 cm
 G. 70.6 cm
 H. 55.6 cm
8. The diameter of a cylinder closed at both ends 7cm. if the total surface area is 209 cm^2 . Calculate the height [Take $\pi = \frac{22}{7}$]
 E. 6 cm
 F. 10 cm
 G. 3 cm
 H. 5cm
9. A cone has a base radius of 8cm and height 11cm. calculate curved surface area correct to two decimal places (Take $\pi = \frac{22}{7}$)
 E. 314.98 cm^2
 F. 276.57 cm^2
 G. 201.14 cm^2
 H. 477.71 cm^2
10. The ratio of the radius to the slant height of a right circular cone is 2.5. if the total surface area of the cone is $224\pi \text{ cm}^2$, calculate the slant height
 E. $\frac{5r}{2}$
 F. $\frac{5r}{4}$
 G. $\frac{r}{2}$
 H. $5r$
11. The angle of a sector of a circle of radius 8cm is 240° . This Sector is bent to form a cone. Find the radius of the cone.

- E. $\frac{16}{3}cm$
- F. $\frac{17}{3}cm$
- G. $\frac{16}{5}cm$
- H. $\frac{18}{3}cm$

12. The angle of a sector of a circle radius 7cm is 180° calculate the perimeter of the sector (Take $\pi = \frac{22}{7}$)

- E. 27.2 cm
- F. 27 cm
- G. 28cm
- H. 27.5cm

13.



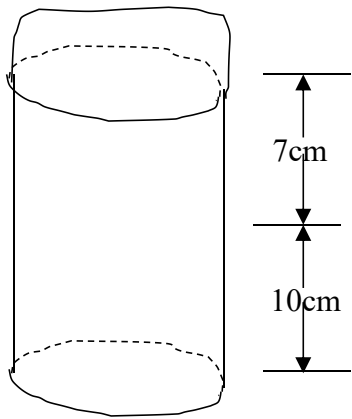
Calculate the area of the shaded segment of the circle shown in the diagram (Take $\pi = \frac{22}{7}$)

- E. 10.45 cm^2
 - F. 11.4 cm^2
 - G. 10.5 cm^2
 - H. 13.48 cm^2
24. A sector of a circle with radius 6cm subtends an angle 60° at the centre. Calculate its perimeter in forms of π
- E. $2(\pi + 6)cm$
 - F. $2(\pi + 3)cm$
 - G. $2(\pi + 8)cm$
 - H. $2\pi(\pi + 6)cm$
25. The volume of a cone of height 3cm is $38\frac{1}{2}cm^3$. Find the radius of its base
- E. $r = 3\frac{1}{2}$
 - F. $r = 2\frac{1}{2}$
 - G. $r = 3\frac{1}{4}$
 - H. $r = 3\frac{2}{3}$
26. The radii of the base of two cylindrical tins, P and Q are r and $2r$ respectively. If the water level in P is 10cm high. What would be the height of the same quantity of water.
- E. 2.5 cm
 - F. 2.3 cm
 - G. 2.8 cm
 - H. 3.5 cm

27. The angle of a sector of a circle radius 10.5cm is 120° . find the perimeter of the sector (Take $\pi = \frac{22}{7}$)
- E. 43 cm
F. 42 cm
G. 41 cm
H. 44 cm
28. A sector of a circle radius 6cm had an angle of 105° at the centre calculate its (i) Perimeter (ii) Area (Take $\pi = \frac{22}{7}$)
- E. 33 cm
F. 54 cm
G. 50 cm
H. 25 cm
29. The angle of a sector of a circle of radius 35cm is 288° . Find the perimeter of a sector [Take $\pi = \frac{22}{7}$]
- E. 246 cm
F. 357 cm
G. 462 cm
H. 200 cm

A solid cylinder of radius 7cm, is 10cm long. Find its total surface area

- E. $238\pi \text{ cm}^3$
F. $84\pi \text{ cm}^3$
G. $184\pi \text{ cm}^3$
H. $254\pi \text{ cm}^3$
30. The volume of a cuboid is 54cm^3 . If the length, width and height of the cuboid are in the ratio 2:1:1 respectively, find its total surface area.
- E. 96 cm^2
F. 90 cm^2
G. 86 cm^2
H. 94 cm^2
31. A sector of a circle of radius 14cm containing an angle 60° is folded to form a cone. Calculate the radius of the base of cone
- E. 3.5cm
F. 3 cm
G. 7 cm
H. 3.3 cm
32. Calculate the total surface area of a solid cone of slant height 15cm and base radius 8cm in terms of π
- E. $184\pi \text{ cm}^2$
F. $164\pi \text{ cm}^2$
G. 123 cm^2
H. $176\pi \text{ cm}^2$



The solid is a cylinder surmounted by a hemispherical bowl calculate its (a) total surface area (b) volume ($\pi = \frac{22}{7}$)

- A. 2258.67 cm³
- B. 2345.21 cm³
- C. 3567.34 cm³
- D. 5743.87 cm³

25 The dimensions of a rectangular tank are 2m by 7m by 11m. if its volume is equal to that of a cylindrical tank of height 4cm. calculate the base radius of the cylindrical tank. [Take

$$\pi = \frac{22}{7}]$$

- E. 14cm
- F. 7m
- G. 3¹/₂m
- H. 1³/₄m

APPENDIX III

Pre test answers

1. A
2. A
3. A
4. A
5. D
6. B
7. A
8. C
9. A
10. A
11. B
12. A
13. A
14. A
15. B
16. A
17. A
18. A
19. A
20. A
21. A
22. A
23. B
24. B
25. B

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APPENDIX IV

Post Test Answers

1. D
2. B
3. A
4. A
5. A
6. B
7. A
8. A
9. A
10. A
11. A
12. A
13. A
14. A
15. A
16. A
17. A
18. A
19. A
20. B
21. B
22. A
23. B
24. B
25. C

Lead City University Ibadan DO NOT COPY

Bio-data

A. Personal Data

Name in full: Islamiyat, ABDUS-SALAM

Address: Plot75 Apete layout Agboolaleye street, Academy Iwo Road, Ibadan

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Educational institutions attended	Qualification	Year
Ayeye Community Primary School, Ibadan.	Pry. Sch. Leaving certificate	1995
Muslim International school, Iwo Osun State.	WAEC &NECO	2002
Mufutau Lanihum College of Education. Ibadan.	NCE	2006
Ekiti State University, Ado Ekiti, Ekiti State.	Bsc.Ed	2010

C. Work Experience with Date

Oyo state teaching service commission

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D. Awards and Fellowship: nil

E. Membership

Nigeria Union of Teachers (NUT)

F. Publication

I. ABDUS-SALAM & C. O. SAM-KAYODE, ph.d (2024), Effects of Mathematics Laboratory on Students' Academic Achievement in Ibadan North Local Government Area, Oyo State, Nigeria

G. Major Conference Attended with Date: nil

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The University Compliance Form

This is to certify that this thesis by ABDUS-SALAM, Islamiyat in the Department of Mathematics Education Faculty of Education, Laedcity University, Ibadan, Oyo State is in full compliance with the approved university format and style

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