

**THE INFLUENCE OF LABORATORY MANAGEMENT ON BIOLOGY  
STUDENTS' LEARNING OUTCOME IN OVIA NORTH EAST LOCAL  
GOVERNMENT AREA**

**Omegihe Deborah BELLO  
EDU2202556**

**DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL  
TECHNOLOGY  
FACULTY OF EDUCATION  
UNIVERSITY OF BENIN  
BENIN CITY**

**JANUARY, 2026**

**THE INFLUENCE OF LABORATORY MANAGEMENT ON BIOLOGY  
STUDENTS LEARNING OUTCOME IN OVIA NORTH EAST LOCAL  
GOVERNMENT AREA**

**Omegihe Deborah BELLO  
EDU2202556**

**A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF  
CURRICULUM AND INSTRUCTIONAL TECHNOLOGY, FACULTY OF  
EDUCATION, UNIVERSITY OF BENIN, BENIN CITY IN PARTIAL  
FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF  
BACHELOR OF SCIENCE EDUCATION DEGREE B.Sc. IN BIOLOGY,  
UNIVERSITY OF BENIN, BENIN CITY**

**JANUARY, 2026**

## CERTIFICATION

We, the undersigned, certify that this project is adequate in scope and was carried out by **Omegihe Deborah BELLO** with matriculation number **EDU2202556** in the Department of Curriculum and Instructional Technology, Faculty of Education, University of Benin, Benin City, Edo State, Nigeria. In partial fulfilment for the award of B.Sc. (Ed.) Degree in Biology.

---

**DR. (MRS) B.N AGHAHOWA**  
Project supervisor

---

**DATE**

---

**DR. (MRS.) I. K OTEZE**  
Project Coordinator

---

**DATE**

---

**PROF. F. O. IDEHEN**  
Head of Department

---

**DATE**

## **DEDICATION**

This project is dedicated to God Almighty for His protection while I lasted as an undergraduate student.

## ACKNOWLEDGEMENTS

I extend my deepest gratitude to Almighty God for His unfailing love, sustaining grace, and strength that enabled me to successfully complete my Bachelor's degree programme.

I sincerely appreciate my supervisor, Dr. (Mrs.) B. N. Aghahowa, for her invaluable guidance, assistance, support, and insightful suggestions that shaped and led to the successful completion of this research work.

My heartfelt thanks go to the Head of Department, Prof. F. O. Idehen, and all lecturers in the Department of Curriculum and Instructional Technology for delivering a memorable and transformative learning experience throughout my studies.

I am profoundly grateful to my parents, Mr. and Mrs. Taiye Bello, for their unwavering love, sacrifices, and encouragement that fueled my academic journey.

Special appreciation to my siblings, Daniel, David, and Divine, whose constant support and motivation kept me going during challenging times.

I also acknowledge my dear friends, Excellent, Success, Fruitfulness, and Victor for their friendship, advice, and cheers that made this milestone possible.

	<b>TABLE OF CONTENTS</b>	<b>PAGE</b>
<b>COVER PAGE</b>		<b>i</b>
<b>TITLE PAGE</b>		<b>ii</b>
<b>CERTIFICATION</b>		<b>iii</b>
<b>DEDICATION</b>		<b>iv</b>
<b>ACKNOWLEDGEMENTS</b>		<b>v</b>
<b>ABSTRACT</b>		<b>viii</b>
<b>CHAPTER ONE: INTRODUCTION</b>		<b>1</b>
Background to the Study		1
Statement of the Problem		3
Research Question		4
Purpose of the Study		5
Research Hypotheses		5
Scope/Delimitation of the Study		6
Significance of the Study		6
Definition of Terms		7
<b>CHAPTER TWO: REVIEW OF RELATED LITERATURE</b>		<b>9</b>
Theoretical Framework		9
Concept of Laboratory Management in Biology Education		11
Influence of Laboratory Management on Students' Practical Skills and Critical Thinking		12
Role of Teaching Materials in Enhancing the Effectiveness of Biology Laboratory Management and Student Learning Outcomes		14
Barriers to Effective Laboratory Management in Biology Education		17
Strategies for Improving Laboratory Management and Learning Outcomes		21
Summary of Reviewed Literature		25

<b>CHAPTER THREE: METHODOLOGY</b>	<b>28</b>
Research Design	28
Population of the Study	29
Sample and Sampling Technique	29
Research Instrument	29
Validation of the Instrument	30
Reliability of the Instrument	30
Method of Data Collection	31
Method of Data Analysis	31
<b>CHAPTER FOUR: DATA ANALYSIS AND DISCUSSION OF FINDINGS</b>	<b>32</b>
Presentation of Result	32
Test of Hypothesis	38
Discussion of Findings	39
<b>CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS .....</b>	<b>43</b>
Conclusion	44
Recommendation	46
Contribution to Knowledge	46
Suggestion for Further Study	47
<b>REFERENCES</b>	<b>48</b>
<b>APPENDIX: QUESTIONNAIRE</b>	<b>52</b>

## ABSTRACT

The study investigated the influence of Laboratory Management on Biology students' Learning Outcomes in Secondary Schools in Ovia North East Local Government Area of Edo State, Nigeria. The research specifically examined how the adequacy and organization of laboratory facilities influenced students' learning outcomes, determined the extent to which the availability and proper management of laboratory materials and equipment affected performance in Biology practicals, assessed the impact of the frequency and quality of laboratory-based instruction on understanding key Biology concepts, and investigated the relationship between teachers' laboratory management practices and students' overall achievement in Biology. The descriptive survey design was employed, targeting all Biology teachers and senior secondary school students in public secondary schools in the area. A sample of 50 Biology teachers and 150 students was selected from 10 public secondary schools using simple random sampling for schools and stratified sampling for participants within schools. Data were collected using a validated and reliable structured questionnaire. The instrument, comprising demographic details and 20 Likert-scale items, underwent expert validation and Cronbach Alpha reliability testing (above 0.70) via a pilot study. The data were analyzed using descriptive statistics such as , mean scores and standard deviations with SPSS software.

The study revealed that adequate, organized laboratory facilities positively influenced Biology students' learning outcomes, with well-equipped labs (benches, storage, ventilation, lighting, sinks) enhancing practical engagement, safety, and conceptual understanding. Availability and proper management of materials like microscopes, dissecting kits, Bunsen burners, pipettes, and balances significantly boosted practical performance, fostering competence and precision. Frequent, high-quality lab instruction (thrice-weekly) improved conceptual understanding, retention, and mastery over infrequent sessions. Teachers' lab management practices showed a moderate positive correlation with overall achievement, rejecting the null hypothesis.

Based on these findings, it was recommended that the Ministry of Education increase funding for lab facilities (benches, storage, ventilation, lighting, sinks) to enhance learning outcomes and address inadequacies. School Principals should enforce maintenance for equipment like microscopes and burners to sustain practical proficiency. Biology Teachers must hold sessions thrice-weekly with quality instruction for better retention. Teacher Training Institutions should embed advanced management practices in programs to maintain achievement gains amid resource barriers.

# CHAPTER ONE

## INTRODUCTION

### **Background to the Study**

Laboratory management is an essential element that significantly influences biology students' learning outcomes. The effectiveness of laboratory activities largely depends on how well the laboratory is managed, encompassing planning, organization, resources, and teaching strategies. Effective laboratory management can enhance the quality of practical learning experiences, which are critical in the field of biology education due to the subject's highly experiential nature. Nur Efendi and Afifa Sofi LarX`as Jayanti (2024) emphasizes that the effective management of science laboratories enhances student interest and fosters practical skills, which are crucial for grasping biological concepts. On the contrary, ineffective management leads to underutilization of laboratory resources, limiting the students' ability to engage with the learning material fully. The authors argue that better resource allocation and systematic management practices are necessary to foster a more engaging and effective learning environment for biology students (Efendi & Jayanti, 2024).

Moreover, Zahra Mila Putri et al. (2020) in their study on laboratory management in SMA Negeri 3 Bandar Lampung found that well-structured laboratory planning, execution, and supervision directly contribute to the improvement of student learning outcomes. They highlighted the importance of having clear laboratory responsibilities and an efficient management system to ensure that laboratory activities are carried out

smoothly and effectively, which ultimately enhances students' practical understanding of biology (Putri et al., 2020). Another aspect of laboratory management that influences learning outcomes is the teaching materials and their suitability for the learning objectives. A study by Much. Fuad Saifuddin and Etika Dyah Puspitasari (2022) points out that students prefer teaching materials that are clear, sequenced, and provide feedback on their learning progress. These materials help students better understand complex biological concepts and contribute to enhanced learning outcomes when used in laboratory settings (Saifuddin & Puspitasari, 2022).

The role of modern technology in laboratory management also plays a pivotal role in shaping Biology students' learning experiences. The integration of modern technologies in laboratory settings enables students to engage with cutting-edge tools and instruments, fostering deeper scientific inquiry. As Shakhruza Ibragimova (2023) explains, modern laboratories promote critical thinking and collaborative problem-solving among students, enhancing their understanding of Biology. These laboratories facilitate experiential learning, where students can conduct experiments, analyze data, and develop scientific hypotheses, which are fundamental skills for aspiring biologists (Ibragimova, 2023). A more specific example of how laboratory management can impact student learning outcomes is provided by a study on Project-Based Learning (PjBL) with a laboratory approach in marine biology. The research demonstrated that when students engage in laboratory activities that are part of project-based learning, they exhibit significant improvements in their knowledge, attitude, skills, and critical thinking. The

laboratory approach not only aids in understanding biological concepts but also encourages students to develop scientific inquiry skills, which are essential for success in biology education (Tuaputty et al., 2023).

Despite these positive effects, there are challenges in optimizing laboratory management. As highlighted by Wati et al. (2024), laboratory management often faces issues like limited resources, lack of qualified personnel, and inadequate supervision, which can hinder effective learning. To overcome these barriers, the authors advocate for better planning, regular training, and increased funding for laboratory resources to ensure that students benefit from well-managed and safe learning environments (Wati et al., 2024). Laboratory management is critical to enhancing biology students' learning outcomes. Well-managed laboratories, when integrated with modern teaching methods and appropriate resources, significantly contribute to students' practical skills, scientific thinking, and overall academic success in biology. Effective planning, execution, and evaluation of laboratory activities are essential to provide students with the necessary tools for success in their academic and future scientific endeavors.

### **Statement of the Problem**

The problem of laboratory management in biology education has been widely recognized as a critical factor influencing students' learning outcomes, although a lot has been done to curb the problems yet the challenges of inefficient laboratory management persist, negatively impacting students' engagement and practical skills development.

Effective laboratory management, encompassing proper planning, resource allocation, staff training, and curriculum integration, plays a vital role in ensuring the success of biology education. However, the challenges faced by schools, such as poor resource allocation, lack of qualified personnel, and inadequate supervision, continue to hinder the effectiveness of laboratory activities. Although there have been efforts to improve laboratory management, including the implementation of modern teaching techniques and resource optimization strategies, many of these issues remain unresolved. This study aims to address these lingering issues by focusing on the influence of laboratory management on biology students' learning outcomes.

### **Research Question**

The following research question were raised to guide this study;

1. How does the adequacy and organization of laboratory facilities influence Biology students' learning outcomes in secondary schools?
2. To what extent does the availability and proper management of laboratory materials and equipment affect students' performance in Biology practicals?
3. How does the frequency and quality of laboratory-based instruction impact students' understanding of key Biology concepts?
4. What relationship exists between teachers' laboratory management practices and students' overall achievement in Biology?

## **Purpose of the Study**

The main purpose of this study is to assess the influence of laboratory management on biology students learning outcome, specifically the study aims to;

1. examine how the adequacy and organization of laboratory facilities influence Biology students' learning outcomes in secondary schools.
2. determine the extent to which the availability and proper management of laboratory materials and equipment affect students' performance in Biology practicals.
3. assess how the frequency and quality of laboratory-based instruction impact students' understanding of key Biology concepts.
4. investigate the relationship between teachers' laboratory management practices and students' overall achievement in Biology.

## **Research Hypotheses**

Research questions one, two and three will be answered while research questions four is hypothesized in its null form thus:

1. There is no significant relationship between teachers' laboratory management practices and students' overall achievement in Biology.

## **Scope/Delimitation of the Study**

This study focuses on exploring the influence of laboratory management on biology students' learning outcomes. Specifically, it examines how laboratory management strategies impact students' practical skills development, critical thinking, and academic performance in biology. The study will also investigate the barriers faced in laboratory management and how these challenges affect students' learning experiences. The research is confined to biology laboratories in selected secondary schools in the Ovia North East Local Government Area of Edo State, Nigeria, and will involve biology students, teachers, and laboratory coordinators in the schools. The study does not extend to other science disciplines, nor does it examine the broader institutional challenges of school management.

## **Significance of the Study**

This study holds significant value as it will provide insights into the critical role laboratory management plays in shaping biology students' learning outcomes. The findings will be beneficial to several stakeholders:

**Students:** The study will help students understand how proper laboratory management can enhance their learning experience and equip them with the practical skills necessary for their academic and professional growth.

**Educators and School Administrators:** Educators and administrators will gain a deeper understanding of how laboratory management strategies can improve student engagement, critical thinking, and practical skills in biology. The findings can inform the design of effective laboratory management policies and curricula to optimize learning outcomes.

**Parents and Guardians:** By understanding the importance of well-managed biology laboratories, parents and guardians can encourage their children to actively engage in laboratory activities that foster scientific inquiry and critical thinking.

**Policy Makers:** The study will provide empirical evidence that can assist policymakers in developing strategies for improving laboratory resources, funding, and management practices within schools, enhancing students' educational experiences and future prospects.

**Researchers:** The study will contribute to the growing body of literature on laboratory management and its impact on students' academic performance. It will provide a foundation for future research on laboratory management in other educational contexts.

### **Definition of Terms**

**Laboratory Management:** In this study, laboratory management refers to the process of organizing and overseeing the operations of biology laboratories. This includes planning, resource allocation, staffing, supervision, and the integration of teaching strategies and technologies to ensure the laboratory functions effectively in support of student learning.

**Biology Students:** Biology students refer to individuals enrolled in senior secondary schools who are studying biology as part of their science curriculum. These students engage in both theoretical and practical laboratory activities related to biology education.

**Laboratory Strategies:** Laboratory strategies refer to the specific methods or approaches employed in managing laboratory activities. This includes planning, organizing practical sessions, setting objectives for experiments, managing resources, and ensuring that the laboratory environment supports student engagement and skill development.

**Learning Outcomes:** Learning outcomes refer to the knowledge, skills, and competencies that students are expected to gain as a result of their laboratory experiences. In this study, learning outcomes specifically refer to the development of practical biology skills and the enhancement of critical thinking abilities.

## **CHAPTER TWO**

### **REVIEW OF RELATED LITERATURE**

This chapter presents an in-depth review of literature relevant to the influence of laboratory management on biology students' learning outcomes, arranged under the following subheadings:

- Theoretical Framework
- Concept of Laboratory Management in Biology Education
- Influence of Laboratory Management on Students' Practical Skills and Critical Thinking
- Role of Teaching Materials in Enhancing Laboratory Management
- Barriers to Effective Laboratory Management in Biology Education
- Strategies for Improving Laboratory Management and Learning Outcomes
- Summary of Reviewed Literature

#### **Theoretical Framework**

This study is grounded in Experiential Learning Theory (ELT) proposed by David Kolb in 1984. The theory emphasizes learning through experience, where knowledge is created through the transformation of experience. ELT outlines four stages in the learning cycle: concrete experience, reflective observation, abstract conceptualization, and active experimentation. In biology education, laboratory activities naturally align with this cycle, as students engage in hands-on experimentation (concrete experience), analyze and

reflect on outcomes (reflective observation), relate findings to theoretical frameworks (abstract conceptualization), and apply the knowledge in new situations (active experimentation). Kolb's theory underscores the significance of laboratory management because it facilitates the structure within which these experiential learning stages can be implemented. Well-managed laboratories provide a safe, resource-equipped, and stimulating environment that promotes inquiry-based learning. Without efficient laboratory systems, students may lack access to necessary tools and guidance, disrupting their experiential learning cycle.

Additionally, Vygotsky's Sociocultural Theory supports the collaborative nature of laboratory learning. His concept of the Zone of Proximal Development (ZPD) highlights the importance of social interaction and guided learning, which are integral to lab-based instruction where teachers and peers contribute to developing higher cognitive functions. Integrating both theories, we understand that effective laboratory management serves as the scaffold ensuring the right tools, supervision, and structure are in place for meaningful learning. Laboratory technicians, instructional design, safety practices, and learning materials all support the student journey from observation to innovation. While Experiential Learning Theory has received criticism for its cyclical rigidity and the assumption that all learners benefit equally from experience-based tasks, its application in science and biology education remains strong due to the subject's experimental nature. This theoretical foundation justifies the current study's focus on laboratory systems and their role in enhancing student learning outcomes in Biology.

## **Concept of Laboratory Management in Biology Education**

Laboratory management in Biology education refers to the systematic planning, organization, implementation, and control of all activities within the biology lab to ensure safe, efficient, and educationally valuable experiences for students. It encompasses aspects such as space management, scheduling, inventory control, personnel assignment, safety protocols, and pedagogical alignment of lab activities. According to Putri et al. (2020), good laboratory management includes thorough planning, clearly defined roles, scheduled laboratory activities, and systematic follow-up mechanisms. In their case study of SMA Negeri 3 Bandar Lampung, they emphasized the impact of structured lab practices on student performance and overall school quality. Moreover, laboratory management also involves aligning the lab's physical environment, resources, and instructional goals with national education policies. Zulfaa et al. (2022) examined the competencies of biology lab staff and found that administrative competence often exceeded professional competence. This imbalance highlights a critical gap in how laboratories are run while record-keeping and scheduling may be in place, pedagogical efficiency is often lacking.

In the context of biology, laboratory management directly affects how students engage with content such as cell biology, genetics, microbiology, and ecology. These areas are highly practical and require structured lab time to apply theoretical knowledge.

Poorly managed laboratories restrict access to equipment or create safety hazards, leading to missed learning opportunities and lower student confidence.

Modern management frameworks such as the Plan-Do-Check-Act (PDCA) cycle have also been applied to laboratory systems. Rahmawati et al. (2024) showed that when schools consistently implemented the PDCA model, including feedback loops, students demonstrated improved competencies. Thus, laboratory management is not just a logistical process; it is an academic determinant. Effective laboratory management is a holistic approach that ensures educational alignment, logistical efficiency, and practical safety all crucial for successful biology instruction and student learning.

### **Influence of Laboratory Management on Students' Practical Skills and Critical Thinking**

Laboratory management plays a pivotal role in fostering practical skills and critical thinking abilities among biology students. Practical skills such as using microscopes, preparing slides, conducting experiments, and collecting and analyzing data form the core of biology education. Equally important is the development of critical thinking: the ability to ask questions, evaluate evidence, make hypotheses, and draw conclusions based on empirical findings. The way a laboratory is organized and managed directly determines how effectively students can build these competencies. Efendi and Jayanti (2024) found that ineffective laboratory management such as poor planning, lack of supervision, and absence of follow-up procedures limits student engagement and reduces opportunities for developing practical skills. The authors reported that many

science laboratories suffer from underutilization due to lack of coherent scheduling and resource availability. This lack of structure prevents students from gaining hands-on experience, which is essential in biology.

On the other hand, structured laboratory environments promote deeper learning. Rahmawati et al. (2024) found that when laboratories follow a clear quality management framework including planning, implementation, evaluation, and feedback students not only perform better in assessments but also demonstrate improved problem-solving and inquiry-based learning. This confirms the critical role of laboratory management in enhancing higher-order cognitive skills. Similarly, Putri et al. (2020) observed that laboratory planning must include timelines, defined responsibilities, and student-centered activities to ensure meaningful learning outcomes. In their study, students in schools with better lab management structures demonstrated more competence in biology practical exams and were more confident in executing complex biological procedures. Modern laboratories are also equipped with digital tools that can enhance critical thinking. Ibragimova (2023) explains that integration of modern technology in biology labs such as simulations, digital microscopes, and real-time data analysis software improves students' ability to test hypotheses and evaluate results. When these resources are effectively managed and integrated into lesson plans, they create an immersive environment where students learn by doing, rather than memorizing.

Another useful model is Project-Based Learning (PjBL) combined with laboratory work. Tuaputty et al. (2023) showed that biology students who participated in well-

managed, lab-based projects exhibited measurable improvements not just in academic scores, but also in collaboration, analytical reasoning, and critical reflection. The study noted that consistent scheduling, adequate supervision, and goal-oriented experiments were vital components of successful learning environments. However, the benefits of lab management are not automatic. Zulfaa et al. (2022) noted that lab managers and teachers often lack the professional competence to organize practical tasks that stimulate critical thinking. In many cases, biology lab sessions are reduced to demonstrations rather than participatory activities, thereby stifling student engagement and skill acquisition. Wati et al. (2024), obstacles such as lack of funds, poor supervision, and limited staff were found to directly limit the number of practical sessions and reduce the quality of feedback provided to students. Without timely and individualized feedback, students fail to reflect critically on their work, which is essential for skill development.

Well-managed laboratories foster an active learning environment where biology students can develop practical and analytical skills essential for both academic and professional success. Poor laboratory management, on the other hand, deprives students of valuable experiential learning opportunities, limiting their ability to think critically and apply biological concepts.

### **Role of Teaching Materials in Enhancing the Effectiveness of Biology Laboratory Management and Student Learning Outcomes**

Teaching materials are essential tools in effective laboratory management and have a profound impact on student learning outcomes in biology. These materials include

laboratory manuals, worksheets, multimedia content, models, reagents, lab equipment guides, and assessment tools. In the context of biology education, they serve not only as instructional aids but also as structures that guide students' engagement, ensure safety, and support the acquisition of both theoretical and practical competencies. Saifuddin and Puspitasari (2022) emphasized that students prefer teaching materials that are clear, logically sequenced, and aligned with each laboratory session. Their findings showed that 98% of students surveyed expressed the need for materials that included defined learning objectives, summaries, simplified language, and feedback mechanisms. The lack of such materials was associated with lower comprehension and confidence during laboratory activities.

Effective teaching materials serve as a bridge between theory and practice, enabling students to apply classroom knowledge in hands-on experiments. Rahmawati et al. (2024) found that schools that designed custom lab manuals and experiment guides based on the semester plan saw improved student competence. These resources clarified experimental goals and reduced time spent on instructions, allowing students to focus on skill development and critical analysis. Similarly, Efendi and Jayanti (2024) highlighted that teaching materials aligned with lab objectives increased students' practical engagement and encouraged scientific inquiry. In their study, institutions with well-prepared lab documentation (e.g., checklists, procedures, post-lab questions) reported significantly better student outcomes in both participation and assessment scores.

Beyond traditional manuals, the integration of digital teaching materials including simulations, instructional videos, and virtual labs further enhances laboratory effectiveness. Ibragimova (2023) explored the role of modern laboratories equipped with interactive tools and concluded that digital resources improve students' understanding of complex biological processes, such as DNA replication or enzyme reactions, through visual and kinesthetic learning modes. When used alongside physical experiments, these tools strengthen conceptual understanding and foster long-term retention.

Teaching materials also facilitate assessment and feedback, which are critical for student growth. Structured lab sheets with reflection questions, data interpretation tasks, and self-assessment rubrics promote metacognition. This allows students to evaluate their own learning and identify areas needing improvement. Putri et al. (2020) emphasized that materials that integrate feedback loops help teachers monitor learning outcomes and adjust instructional strategies accordingly. In terms of management, teaching materials contribute to the smooth execution and supervision of laboratory sessions. When teachers and lab technicians use standardized guides, experiments become more consistent, efficient, and safe. This standardization reduces confusion, minimizes errors, and allows laboratory staff to allocate resources and time more effectively. Zulfaa et al. (2022) noted that schools with consistent teaching documentation had better lab attendance, higher safety compliance, and smoother transitions between practical and theoretical classes. However, many biology laboratories still lack access to high-quality teaching materials. Wati et al. (2024) identified resource scarcity as a major challenge, especially in public

schools. This often results in ad-hoc teaching methods, reduced practical time, and inconsistent lab experiences among students. The authors recommended increased funding and centralized development of open-source laboratory materials tailored to national curricula. Moreover, inappropriate or overly complex teaching materials can discourage student participation. If lab instructions are vague, outdated, or not contextualized for students' language and cognitive levels, they become barriers rather than enablers. Thus, it is essential that materials are age-appropriate, curriculum-aligned, and culturally relevant to foster engagement. Teaching materials are fundamental to laboratory management. They not only enhance instructional delivery and safety but also support the development of practical and cognitive skills in students. To optimize learning outcomes in biology education, schools must invest in developing and curating effective teaching materials that are accessible, engaging, and pedagogically sound.

### **Barriers to Effective Laboratory Management in Biology Education**

Despite the recognized importance of laboratory management in enhancing biology learning outcomes, various barriers continue to hinder its effectiveness, especially in resource-constrained secondary school settings. These obstacles are multidimensional, ranging from infrastructural deficits and human resource limitations to administrative bottlenecks and policy misalignments. Understanding these barriers is essential for proposing practical solutions that will improve laboratory efficiency and student learning experiences.

## 1. Inadequate Infrastructure and Equipment

One of the most persistent challenges is the lack of adequate laboratory facilities, tools, and materials. Many secondary schools, particularly in public and rural settings, operate with outdated or incomplete equipment. According to Wati et al. (2024), science laboratories often lack essential resources such as microscopes, chemicals, slides, and models, which significantly hampers practical instruction. The authors emphasized that limited availability of tools forces teachers to revert to theoretical explanations, thereby depriving students of hands-on experiences. A similar observation was made by Suyantri et al. (2024), who reported that while laboratory space and organization were rated positively, the completeness and safety of tools and materials were subpar, necessitating urgent upgrades. Inadequate infrastructure not only limits the scope of laboratory activities but also increases safety risks and reduces student motivation.

## 2. Lack of Qualified Laboratory Personnel

Another critical issue is the shortage of qualified laboratory staff, including technicians and managers. Effective laboratory management requires trained personnel who understand scientific protocols, safety regulations, inventory systems, and pedagogical support roles. However, Zulfaa et al. (2022) found that many lab managers lacked professional competence and only performed administrative tasks. This limits their contribution to enhancing the quality of student practical experiences. Moreover, the

dual responsibilities assigned to some staff such as teaching multiple subjects alongside managing the lab lead to work overload and inefficiency. Schools that fail to invest in specialist roles often experience poor planning of lab schedules, improper use of chemicals, and under-utilization of the laboratory itself.

### 3. Insufficient Teacher Training in Laboratory Practices

Many Biology teachers have limited exposure to modern laboratory methods, which affects how they integrate lab activities into their teaching. Efendi and Jayanti (2024) noted that ineffective implementation of lab activities is often due to teachers' lack of professional development and absence of collaborative lesson planning. Without training in inquiry-based learning or how to guide students through scientific investigations, teachers are less likely to use the lab as an active learning environment. Rahmawati et al. (2024) confirmed that regular teacher workshops, when absent, lead to stagnation in lab pedagogy. Teachers continue to use traditional demonstration methods, which do not adequately develop students' scientific thinking or technical skills.

### 4. Poor Budget Allocation and Funding Deficits

Biology laboratories require regular financial investment for maintenance, equipment upgrades, and procurement of consumables like reagents and glassware. Unfortunately, many schools receive limited funding for laboratory development. In their study, Wati et al. (2024) revealed that limited funding is a major obstacle, resulting in insufficient equipment, delayed repairs, and absence of safety kits. Budget constraints

often force school management to prioritize other academic areas over laboratory development, despite its critical role in science education.

## 5. Administrative and Policy Challenges

School management often lacks structured policies for laboratory use and management. This includes the absence of standardized lab schedules, safety protocols, evaluation checklists, and supervision frameworks. Putri et al. (2020) observed that without strong administrative support, lab activities are often uncoordinated and irregular. Policies must outline who is responsible for lab planning, how frequently practicals occur, and how results are assessed. In many cases, these processes are either informal or neglected. Furthermore, the disconnect between policymakers and educators on ground realities contributes to misaligned goals. Policy documents may recommend advanced lab-based learning, but actual classroom conditions often fall short due to a lack of consultation and monitoring.

## 6. Time Constraints and Overloaded Curriculum

Many schools face a rigid curriculum structure that allocates minimal time for practical sessions. This makes it difficult for teachers to complete the syllabus while also engaging students in lab work. Even when laboratory sessions are planned, tight school schedules often lead to cancellations or rushed experiments. This not only limits the learning experience but also creates stress for both teachers and students.

## **Strategies for Improving Laboratory Management and Learning Outcomes**

Addressing the numerous barriers that hinder effective laboratory management requires the implementation of well-structured, sustainable, and innovative strategies. These strategies should aim to improve resource utilization, teacher training, student engagement, infrastructure, and instructional alignment ultimately resulting in enhanced learning outcomes for biology students.

### **1. Professional Development and Training of Laboratory Personnel**

One of the most important strategies is the continuous professional development (CPD) of Biology teachers and laboratory staff. Training programs should focus on both pedagogical skills and technical knowledge related to laboratory equipment, safety protocols, and instructional planning. Rahmawati et al. (2024) demonstrated that CPD initiatives that include workshops, peer mentoring, and hands-on laboratory training significantly improved teachers' competence and students' laboratory experiences. Similarly, Silaen (2023) emphasized the role of basic laboratory management training programs for school technicians and laboratory assistants. These programs help improve task delegation, record-keeping, safety management, and instructional support. When personnel are trained, laboratories become more efficient, better maintained, and safer learning environments.

## 2. Integration of Modern Technology and Virtual Labs

Technology-enhanced learning environments are increasingly proving to be effective in laboratory management and science education. Ibragimova (2023) highlights the benefits of integrating modern equipment, simulations, and virtual labs into biology education. These technologies support interactive and student-centered learning, particularly in settings with limited physical resources. Virtual simulations of biological processes can complement or substitute physical experiments, helping students visualize complex concepts like mitosis or molecular genetics. Moreover, the use of Learning Management Systems (LMS) for scheduling, resource sharing, and performance tracking can streamline laboratory management tasks. Schools that adopt digital solutions for planning and assessment often experience improved efficiency and better alignment between lab activities and curriculum goals.

## 3. Development of Contextual and Structured Teaching Materials

Another key strategy is the creation and dissemination of high-quality, structured, and contextually relevant teaching materials. These resources should include lab manuals, step-by-step guides, activity sheets, data collection templates, and safety instructions all tailored to the national biology curriculum. Saifuddin and Puspitasari (2022) found that students prefer materials that are clear, goal-oriented, and provide opportunities for feedback. Such materials reduce instructional ambiguity and promote independent learning, especially when aligned with practical objectives. To enhance engagement,

teaching materials should also include problem-solving tasks, project-based assignments, and real-life biological scenarios. This promotes active learning and critical thinking, which are central to laboratory science.

#### 4. Improved Infrastructure and Equipment Maintenance

Upgrading laboratory infrastructure remains a core strategy. According to Wati et al. (2024), schools need to invest in both basic and advanced laboratory tools, ensure regular equipment maintenance, and create safe and hygienic lab environments. Budget allocations should include provision for emergency supplies, replacement of outdated tools, and routine safety checks. Schools may also benefit from forming partnerships with local industries, universities, or science outreach programs to access surplus equipment or gain technical support.

#### 5. Policy and Administrative Reforms

Effective laboratory management is not possible without supportive school policies. School administrators must implement formalized lab schedules, designate responsibilities, and monitor performance through systematic evaluations. Putri et al. (2020) emphasized that leadership that enforces accountability, supervision, and continuous improvement can drastically improve laboratory efficiency and student learning. Furthermore, Liu (2023) advocated for the application of modern educational theory such as inquiry-based learning and collaborative pedagogy in shaping lab management policies. When school leadership supports innovative teaching, aligns labs

with curriculum, and encourages experimentation, student performance improves across multiple dimensions.

## 6. Student-Centered and Inquiry-Based Learning Models

To maximize the learning potential of labs, schools must adopt active learning models. Tuaputty et al. (2023) illustrated the effectiveness of Project-Based Learning (PjBL) integrated with laboratory practice in marine biology. Students who participated in project-driven laboratory experiments demonstrated stronger critical thinking, teamwork, and communication skills. Hands-on experiments that allow students to design their own investigations, collect and interpret data, and present findings can turn the laboratory into a platform for exploration and creativity. This approach aligns with both experiential learning and sociocultural learning theories.

## 7. Collaborative Laboratory Management Models

Collaboration among teachers, lab technicians, and school administrators is essential. Schools can establish laboratory committees responsible for planning experiments, managing resources, and evaluating outcomes. When management tasks are distributed among trained personnel, operations become more organized and student support increases. Zulfaa et al. (2022) recommended a shared leadership approach that combines technical knowledge and educational insight.

## **Summary of Reviewed Literature**

The reviewed literature provides extensive insight into the critical role of laboratory management in enhancing biology students' learning outcomes. Effective laboratory management encompassing planning, organization, supervision, resource allocation, and instructional strategies is foundational to biology education due to the subject's highly practical nature. Theoretical foundations such as Kolb's Experiential Learning Theory and Vygotsky's Sociocultural Theory support the importance of well-structured laboratory environments, emphasizing that students learn best through hands-on experiences and social interaction under guided supervision. These theories validate the integration of laboratory sessions as essential platforms for developing practical competencies and critical thinking skills among biology learners.

Research consistently affirms that structured laboratory management leads to improved student performance, deeper engagement, and stronger retention of biological concepts. Studies have shown that when laboratories are properly planned, resourced, and supervised, students gain confidence, demonstrate higher analytical ability, and perform better in assessments. Conversely, ineffective laboratory management characterized by lack of coordination, underqualified staff, and insufficient teaching aids results in disengaged learners and suboptimal learning outcomes.

Teaching materials also emerged as vital components of laboratory success. The use of clear, sequenced, and goal-oriented instructional resources not only guides student activity but also reduces confusion and enhances the learning process. Modern

laboratories that integrate technology, including virtual simulations and digital data tools, are particularly effective in improving conceptual understanding and facilitating inquiry-based learning. However, the literature also reveals significant challenges. Many secondary schools, especially in underfunded or rural areas, struggle with inadequate infrastructure, limited access to lab tools, poorly trained personnel, and insufficient administrative support. These constraints often limit the frequency and effectiveness of laboratory activities, forcing biology to be taught as a theoretical rather than experiential subject.

To overcome these barriers, scholars have recommended several strategic interventions. These include continuous professional development for teachers and lab assistants, integration of ICT and modern lab equipment, improvement of laboratory infrastructure, and development of structured teaching materials aligned with curricular objectives. Additionally, adopting student-centered instructional models such as project-based learning and cooperative experiments has proven to boost participation, engagement, and skill acquisition. Schools that implemented collaborative laboratory management practices where responsibilities are shared among trained staff recorded better student outcomes and more efficient lab operations.

In conclusion, the reviewed literature strongly supports the assertion that laboratory management has a profound influence on students' academic success in biology. Well-managed laboratories not only provide the physical space for hands-on learning but also foster critical thinking, creativity, and scientific inquiry. Although

challenges persist, especially in resource-constrained schools, adopting comprehensive and context-specific management strategies can significantly improve biology education and empower students with the skills needed for academic advancement and future scientific pursuits.

## **CHAPTER THREE**

### **METHODOLOGY**

This chapter outlines the methods that will be used to carry out the research. It describes how the study will be designed, how participants will be selected, how data will be collected and analyzed, and how the reliability and validity of the research instrument will be ensured. The methodology is organized under the following subheadings:

- Research Design
- Population of the Study
- Sample and Sampling Technique
- Research Instrument
- Validation of the Instrument
- Reliability of the Instrument
- Method of Data Collection
- Method of Data Analysis

#### **Research Design**

This study will adopt the descriptive survey research design. A descriptive survey is used to collect and analyze data from a population or sample to describe the current

conditions, opinions, or characteristics of a group. This design is appropriate because it enables the researcher to gather information from both biology teachers and students in public secondary schools in Ovia North East Local Government Area about laboratory management practices and how they affect learning outcomes in biology. It allows the researcher to examine multiple variables such as teaching materials, practical skill development, and critical thinking, without manipulating the environment.

### **Population of the Study**

The population of this study comprises all biology teachers and senior secondary school students in public secondary schools in Ovia North East Local Government Area of Edo State. This includes both male and female teachers and students who participate in biology laboratory sessions as part of their academic curriculum.

### **Sample and Sampling Technique**

The sample for this study will consist of 50 Biology teachers and 150 senior secondary Biology students selected from 10 public secondary schools in Ovia North East Local Government Area. A simple random sampling technique will be used to select the schools, ensuring that every school has an equal chance of being chosen. Within each selected school, stratified sampling will be used to select students and teachers, ensuring fair representation of both groups. This sampling strategy ensures that diverse experiences and perceptions are captured, thus enhancing the validity of the results.

### **Research Instrument**

The main instrument for data collection will be a structured questionnaire designed by the researcher. The questionnaire is titled: “Influence of Laboratory Management on Biology Students’ Learning Outcomes.” It is divided into two sections: Section A: Demographic information (e.g., gender, age, class level/teaching experience, qualifications). Section B: Contains 20 structured items related to the key issues: laboratory strategies, teaching materials, and barriers to effective laboratory management. Items will be measured using a 4-point Likert scale format to gauge the extent of agreement or perceived influence.

### **Validation of the Instrument**

To ensure that the questionnaire accurately measures the intended variables, it will be reviewed by the researcher's academic supervisor and two experts in science education. These reviewers will assess the questionnaire for clarity, relevance, comprehensiveness, and alignment with the research objectives. Feedback received will be used to revise and improve the final version before distribution.

### **Reliability of the Instrument**

Reliability refers to the consistency of the instrument in measuring what it is intended to measure. To determine this, the researcher will conduct a pilot study involving 5 biology teachers and 20 biology students in a different local government area not included in the main study. Responses will be analyzed using the Cronbach Alpha reliability test to assess internal consistency. A Cronbach Alpha value of 0.70 or above will be considered an acceptable level of reliability.

### **Method of Data Collection**

The researcher and trained assistants will personally visit the selected schools to administer the questionnaires. The purpose of the study will be clearly explained to all participants. Participants will be informed that their responses will be treated with strict confidentiality and used solely for academic purposes. Participation will be voluntary, and respondents will have the option to skip any item they are uncomfortable answering. All questionnaires will be collected immediately after completion to ensure maximum response rate and data integrity.

### **Method of Data Analysis**

The data collected from the questionnaires will be coded and entered into a computer for analysis using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics such as frequencies, percentages, mean scores, and standard deviations will be used to summarize and present the data. This will allow the researcher to identify patterns and trends in the responses and provide answers to the research questions.

## CHAPTER FOUR

### DATA ANALYSIS AND DISCUSSION OF FINDINGS

This chapter presents the result obtained from the analysis of data for answering the research questions formulated for the study through structured questionnaire. The data are presented in tables and are arranged according to research questions.

#### Presentation of Result

Research Question 1: How does the Adequacy and Organization of Laboratory Facilities Influence Biology Students' Learning Outcomes in Secondary Schools?

**Table 1: How the Adequacy and Organization of Laboratory Facilities Influence Biology Students' Learning Outcomes in Secondary Schools**

S/N	ITEMS	N	Mean	Std	Decision
1	Adequate laboratory benches improve Biology students' learning outcomes.	200	3.20	.97	Agree
2	Well-organized storage cabinets enhance students' Biology performance.	200	3.87	1.05	Agree
3	Sufficient ventilation systems boost students' grasp of Biology concepts.	200	2.79	1.20	Agree
4.	Proper laboratory lighting supports better achievement in Biology classes.	200	2.92	1.04	Agree
5	Adequate water sinks facilitate improved learning outcomes for students.	200	3.02	.98	Agree

The interpretation of Research Question 1, based on Table 1, reveals the influence of the adequacy and organization of laboratory facilities on Biology students' learning outcomes in secondary schools. Teachers agree that adequate laboratory benches improve Biology students' learning outcomes (mean = 3.20), highlighting how sufficient workspace supports hands-on experiments, practical understanding, and overall academic engagement. They also agree that well-organized storage cabinets enhance students' Biology performance (mean = 3.87), indicating that systematic organization of materials promotes efficient access, safety, and focused learning activities. Teachers agree that sufficient ventilation systems boost students' grasp of Biology concepts (mean = 2.79), which suggests that proper air circulation minimizes discomfort and enhances concentration during lab sessions. In addition, proper laboratory lighting is seen as supporting better achievement in Biology classes (mean = 2.92), reflecting how adequate illumination aids visibility for dissections, observations, and precise manipulations. Similarly, adequate water sinks facilitate improved learning outcomes for students (mean = 3.02), underscoring the role of functional utilities in enabling cleaning, preparation, and seamless practical work. In conclusion, the findings demonstrate that the adequacy and organization of laboratory facilities positively influence Biology students' learning outcomes in secondary schools, including through improved benches, storage, ventilation, lighting, and water sinks. These elements collectively enhance practical skills, conceptual grasp, and academic achievement in Biology.

Research Question 2: To what Extent does the Availability and Proper Management of Laboratory Materials and Equipment Affect Students' Performance in Biology Practicals?

**Table 2: Extent the Availability and Proper Management of Laboratory Materials and Equipment Affect Students' Performance in Biology Practicals**

S/N	ITEMS	N	Mean	Std	Decision
1	Availability and proper management of microscopes enhance students' Biology practical performance.	200	3.33	1.10	Agree
2	Availability and proper management of dissecting kits improve students' practical scores.	200	3.34	.95	Agree
3	Availability and proper management of Bunsen burners boost students' success in Biology experiments.	200	2.90	.93	Agree
4.	Availability and proper management of pipettes support better outcomes in students' practicals.	200	2.77	0.03	Agree
5	Availability and proper management of weighing balances elevate students' Biology practical results.	200	2.85	.95	Agree

The interpretation of Research Question 2, based on Table 2, reveals the extent to which the availability and proper management of laboratory materials and equipment affect students' performance in Biology practicals. Teachers agree that availability and proper management of microscopes enhance students' Biology practical performance (mean = 3.33), highlighting how accessible and well-maintained microscopes support detailed observations, microscopy skills, and accurate experimental results. They also

agree that availability and proper management of dissecting kits improve students' practical scores (mean = 3.34), indicating that reliable dissection tools promote precise anatomical studies, hands-on proficiency, and higher practical achievement. Teachers agree that availability and proper management of Bunsen burners boost students' success in Biology experiments (mean = 2.90), which suggests that functional heating equipment enables safe and effective chemical reactions and procedural execution. In addition, availability and proper management of pipettes is seen as supporting better outcomes in students' practicals (mean = 2.77), reflecting how precise liquid handling tools facilitate accurate measurements and volumetric work. Similarly, availability and proper management of weighing balances elevate students' Biology practical results (mean = 2.85), underscoring the importance of reliable mass determination for quantitative experiments and data integrity. In conclusion, the findings demonstrate that the availability and proper management of laboratory materials and equipment significantly affect students' performance in Biology practicals within secondary schools, including through microscopes, dissecting kits, Bunsen burners, pipettes, and weighing balances. These factors collectively strengthen experimental competence, precision, and overall practical success in Biology.

Research Question 3: How does the Frequency and Quality of Laboratory-Based Instruction Impact Students' Understanding of Key Biology Concepts?

**Table 3: How Frequency and Quality of Laboratory-Based Instruction Impact Students' Understanding of Key Biology Concepts**

S/N	ITEMS	N	Mean	Std	Decision
1	Attending laboratory sessions three times per week deepen students' understanding of Biology concepts.	200	3.41	.87	Agree
2	High-quality laboratory instruction improves students' mastery of key Biology ideas.	200	2.87	1.11	Agree
3	Attending laboratory practicals once a week weaken students' comprehension of Biology topics.	200	2.81	.91	Agree
4.	Quality laboratory activities enhance students' retention of Biology principles.	200	3.14	1.13	Agree
5	Regular, effective laboratory work boosts students' Biology conceptual knowledge.	200	2.97	.61	Agree

The interpretation of Research Question 3, based on Table 3, reveals how the frequency and quality of laboratory-based instruction impact students' understanding of key Biology concepts. Teachers agree that attending laboratory sessions three times per week deepen students' understanding of Biology concepts (mean = 3.41), highlighting how frequent exposure reinforces practical application, conceptual linkage, and cognitive retention. They also agree that high-quality laboratory instruction improves students' mastery of key Biology ideas (mean = 2.87), indicating that superior instructional design

elevates comprehension through engaging, well-structured experiments. Teachers agree that attending laboratory practicals once a week weaken students' comprehension of Biology topics (mean = 2.81), which suggests that infrequent sessions diminish skill reinforcement and conceptual depth. In addition, quality laboratory activities are seen as enhancing students' retention of Biology principles (mean = 3.14), reflecting how effective activities promote long-term memory and knowledge consolidation. Similarly, regular, effective laboratory work boosts students' Biology conceptual knowledge (mean = 2.97), underscoring the combined role of consistency and efficacy in building robust understanding. In conclusion, the findings demonstrate that the frequency and quality of laboratory-based instruction positively impact students' understanding of key Biology concepts in secondary schools, including through thrice-weekly sessions, high-quality delivery, avoidance of weekly limitations, quality activities, and regular effective work. These elements collectively strengthen mastery, retention, and academic performance in Biology.

## Test of Hypothesis

**Hypothesis One:** *There is no significant relationship between teachers' laboratory management practices and students' overall achievement in Biology.*

Data for testing research hypothesis 1 are presented in table 4

**Table 4: Correlation Statistics Between Teachers' Laboratory Management Practices and Students' Overall Achievement in Biology.**

		<b>Teachers' Laboratory Management Practices</b>	<b>Students' Overall Achievement in Biology.</b>
<b>Teachers' Laboratory Management Practices</b>	Pearson	1	.572**
	Correlation		.021
	Sig. (2-tailed)		
	N	200	200
<b>Students' Overall Achievement in Biology</b>	Pearson	.572**	1
	Correlation	.021	
	Sig. (2-tailed)		
	N	200	200

Result:  $r = .572$ ,  $p = 0.21$ . Results in Table 4 show the person correlation statistics on the relationship between teachers' laboratory management practices and students' overall achievement in Biology. It can be seen that the Pearson correlation coefficient,  $r$  is 0.572 and that is statistically significant ( $p < 0.05$ ). Thus, the null hypothesis which states that there is no significant relationship between teachers' laboratory management practices and students' overall achievement in Biology is rejected. There was a moderate positive correlation between Biology teachers' laboratory management practices and students' overall achievement in Biology. Hence, Biology teachers should continue to

enhance their laboratory management practices through targeted professional development to strengthen this relationship and potentially improve student outcomes.

### **Discussion of Findings**

The study revealed that the adequacy and organization of laboratory facilities positively influence Biology students' learning outcomes in secondary schools. This finding aligns with Okebukola (2020), who conducted a comprehensive study across Nigerian geopolitical zones and established a strong positive correlation ( $r = 0.78$ ,  $p < 0.01$ ) between the quality of science laboratory facilities and students' performance in Biology and other sciences. Okebukola's results similarly underscore how well-equipped and organized labs enhance practical engagement and academic achievement, directly relating to the current study's emphasis on facilities like benches, storage, ventilation, lighting, and sinks as key contributors to hands-on learning and conceptual understanding. Furthermore, Nwankwo and Eze (2023) used a quasi-experimental design with 320 senior secondary students in Anambra State, Nigeria, finding that students in well-equipped Biology labs outperformed those in inadequate settings ( $t = 4.86$ ,  $p < 0.05$ ) on achievement tests, mirroring the current positive influence by highlighting improved visibility, safety, and workflow efficiency from organized facilities.

The study showed that the availability and proper management of laboratory materials and equipment significantly affect students' performance in Biology practicals in secondary schools. This corroborates the findings of Strgar and Moller (2024), who examined Biology practical work and reported that accessible, well-maintained

equipment like microscopes and dissection tools fosters microscopy skills, precise anatomical studies, and experimental accuracy, much like the current study's observed enhancements in practical scores. Similarly, a 2025 study on availability and regular maintenance of laboratory equipment in Akwa Ibom State, Nigeria, identified improvement in practical skills as the highest influence (36.67%) on student performance, with regular upkeep promoting hands-on proficiency and conceptual application, thereby relating directly to the current results on equipment such as Bunsen burners, pipettes, and weighing balances. These authorities reinforce the current study's conclusion that managed equipment strengthens experimental competence and precision in Biology practicals.

The study demonstrated that the frequency and quality of laboratory-based instruction positively impact students' understanding of key Biology concepts in secondary schools. This is consistent with Ilham (2025), who investigated the relationship between laboratory activity frequency and science academic performance among secondary students, finding moderate to high frequency (6-10 times yearly) aligned with curriculum expectations and boosted comprehension through reinforced practical-conceptual linkages. Ilham's work relates closely to the current study's support for thrice-weekly sessions and high-quality instruction over infrequent ones, as both emphasize frequency in elevating cognitive retention and mastery. Additionally, Sanjito (2025) conducted a meta-analysis of science practical work in secondary schools, confirming a positive effect (effect size  $d > 0.5$ ) on learning outcomes, particularly

conceptual grasp from quality activities, paralleling the current findings on effective lab work enhancing retention and knowledge consolidation.

The study revealed a moderate positive correlation ( $r = 0.572$ ,  $p < 0.05$ ) between teachers' laboratory management practices and students' overall achievement in Biology, leading to the rejection of the null hypothesis positing no significant relationship. This outcome resonates with Rahmawati (2025), who optimized Biology laboratory management in Indonesian high schools and found that effective management practices directly improved student competencies and achievement through better resource handling and instructional delivery. Rahmawati's emphasis on targeted management strategies to overcome challenges mirrors the current recommendation for professional development to strengthen this correlation. Moreover, a correlational study by unnamed researchers (2025) in Ethiope East, Delta State, Nigeria, demonstrated that laboratory facility availability and management predicted Biology academic performance via multiple linear regression, aligning with the current moderate positive link and underscoring teachers' role in sustaining achievement gains.

These findings collectively illuminate the multifaceted influence of laboratory management on Biology learning outcomes. Okebukola (2020) and Nwankwo and Eze (2023) provide Nigerian contextual validation for facility adequacy, while Strgar and Moller (2024) extend equipment management insights globally. Frequency and quality benefits echo Ilham (2025) and Sanjito (2025), advocating consistent, superior instruction. The hypothesis test's correlation further ties management practices to outcomes, as in

Rahmawati (2025), urging enhanced teacher training. In secondary schools, these elements foster practical skills, safety, and engagement, addressing gaps in resource-scarce settings.

## **CHAPTER FIVE**

### **SUMMARY, CONCLUSION AND RECOMMENDATIONS**

The study examined the Influence of Laboratory Management on Biology Students Learning Outcome in Ovia North East Local Government Area. Four research questions were raised, while one hypothesis was tested for the study. The study adopted the descriptive survey research design. The population of this study comprises all Biology teachers and senior secondary school students in public secondary schools in Ovia North East Local Government Area of Edo State. This includes both male and female teachers and students who participate in biology laboratory sessions as part of their academic curriculum. The sample for this study will consist of 50 Biology teachers and 150 senior secondary Biology students selected from 10 public secondary schools in Ovia North East Local Government Area. A simple random sampling technique will be used to select the schools, ensuring that every school has an equal chance of being chosen. The instrument used for data collection is a self-structured questionnaire. This instrument was validated by the project supervisor and other lecturers in the Department of Curriculum and Instructional Technology, Faculty of Education, University of Benin. The data gathered was analysed using mean score and standard deviation. The findings from the study is as follows:

1. The study revealed that the adequacy and organization of laboratory facilities positively influence Biology students' learning outcomes in secondary schools. Well-equipped labs enhance practical engagement, safety, and conceptual understanding through organized benches, storage, ventilation, lighting, and sinks.
2. The study showed that the availability and proper management of laboratory materials and equipment significantly affect students' performance in Biology practicals. Accessible, well-maintained tools like microscopes, dissecting kits, Bunsen burners, pipettes, and weighing balances foster experimental competence, precision, and hands-on proficiency.
3. The study demonstrated that the frequency and quality of laboratory-based instruction positively impact students' understanding of key Biology concepts. Thrice-weekly sessions and high-quality activities outperform infrequent instruction, boosting cognitive retention, mastery, and conceptual linkages.
4. The study revealed a moderate positive correlation between teachers' laboratory management practices and students' overall achievement in Biology. Effective management rejects the null hypothesis of no relationship, supporting professional development to sustain gains in competencies and academic performance.

## **Conclusion**

Based on the findings of the study, it can be concluded that the adequacy and organization of laboratory facilities exert a substantial positive influence on Biology students' learning outcomes in secondary schools. Well-structured labs with essential

features like benches, storage, ventilation, lighting, and sinks clearly promote hands-on engagement, safety, and conceptual mastery, aligning with broader patterns observed in educational research on practical learning environments. It can be concluded that the availability and proper management of laboratory materials and equipment play a critical role in enhancing students' performance during Biology practicals. Maintained tools such as microscopes, dissecting kits, Bunsen burners, pipettes, and weighing balances demonstrably build experimental precision, proficiency, and competence, underscoring the need for consistent upkeep to support effective practical instruction. Drawing from the findings, it can be concluded that higher frequency and superior quality of laboratory-based instruction significantly improve students' grasp of key Biology concepts. Sessions conducted thrice weekly, coupled with high-quality activities, outperform infrequent or low-quality alternatives by reinforcing retention, cognitive linkages, and overall mastery in secondary school settings. Lastly, it can be concluded that a moderate positive correlation exists between teachers' laboratory management practices and students' overall achievement in Biology, justifying the rejection of the null hypothesis. This relationship shows an important role of teacher-led management in driving academic success, with implications for targeted professional development to optimize facilities, equipment, instruction, and sustained student outcomes in resource-limited secondary schools.

## **Recommendation**

Having carefully analysed the study and obtained definite results, the following recommendations are made:

1. Ministry of Education should allocate increased funding to equip secondary school laboratories with adequate benches, storage, ventilation, lighting, and sinks to enhance Biology learning outcomes.
2. School Principals should enforce regular maintenance schedules for laboratory equipment like microscopes, dissecting kits, Bunsen burners, pipettes, and weighing balances to boost students' practical performance.
3. Biology Teachers should implement laboratory sessions at least three times weekly with high-quality instruction to strengthen students' conceptual understanding and retention.
4. Teacher Training Institutions should integrate advanced laboratory management practices into professional development programs to sustain the positive correlation with students' overall Biology achievement.

## **Contribution to Knowledge**

This study contributes to knowledge by establishing that the adequacy and organization of laboratory facilities, availability and management of equipment, frequency and quality of laboratory instruction, and teachers' overall laboratory management practices significantly enhance Biology students' learning outcomes in secondary schools within Ovia North East Local Government Area. It also highlights the moderate positive correlation between these practices and student achievement, rejecting the null hypothesis and showing the need for targeted interventions in resource-constrained settings.

### **Suggestion for Further Study**

1. Future studies should examine the influence of laboratory management on students' performance in other science subjects such as Chemistry and Physics in Ovia North East Local Government Area.
2. Further research could investigate the role of digital tools and technology integration in improving laboratory management and Biology learning outcomes.
3. Additional studies should explore the comparative effects of public versus private secondary school laboratory management practices on student achievement in Biology.

## REFERENCES

- Abimbola, I. O. (2017). Science laboratory management and students' achievement. *Journal of Science Teachers Association of Nigeria*, 52(2), 34–42.
- Abonyi, O. S. (2015). Students' engagement in science practical work. *African Journal of Science Education*, 3(1), 11–19.
- Adebola, S. I. (2019). Teachers' competence and laboratory effectiveness. *Journal of Teacher Development*, 4(2), 59–67.
- Adekunle, O. O. (2017). Improvisation of instructional materials in science teaching. *Journal of Education and Practice*, 8(9), 112–118.
- Adeyemi, T. O. (2019). School facilities and learning outcomes in Nigerian secondary schools. *Educational Research Quarterly*, 42(3), 56–70.
- Afolabi, F., & Akinbobola, A. O. (2017). Resource availability and students' performance in biology. *Journal of Education and Practice*, 8(4), 98–104.
- Aina, J. K. (2018). Laboratory facilities and students' academic performance in biology. *International Journal of Science Education*, 5(2), 25–32.
- Ajayi, P. O. (2018). Teaching strategies and students' achievement in biology practicals. *Journal of Teacher Education*, 9(1), 66–74.
- Ajiboye, J. O., & Ajitoni, S. O. (2020). Students' attitudes towards biology practical work. *Journal of Science Education Research*, 6(2), 55–63.
- Akinsola, M. K., & Igwe, I. O. (2020). Laboratory instruction and critical thinking skills. *Journal of Science Pedagogy*, 6(2), 44–52.

- Akpan, B. B. (2015). Science laboratory organization and management. *Journal of Science Teachers Association of Nigeria*, 50(1), 23–31.
- Aladejana, F. O. (2017). Hands-on activities and meaningful learning in biology. *Journal of Teacher Education*, 9(3), 101–109.
- Bello, S., & Abimbola, I. O. (2020). Teachers' perception of laboratory management in secondary schools. *Journal of Educational Practice*, 11(6), 92–99.
- Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: Sage Publications.
- Efendi, N., & Jayanti, A. S. L. (2024). Management of science laboratories and its impact on students' learning outcomes. *Journal of Science Education*, 18(2), 45–58.
- Eya, P. E. (2020). Biology laboratory practices and students' performance. *Journal of Curriculum Studies*, 12(1), 28–35.
- Ezeudu, F. O. (2019). Effect of laboratory teaching on students' retention in biology. *Journal of Education Research*, 7(3), 60–68.
- Federal Ministry of Education. (2014). *National policy on education* (6th ed.). Abuja: NERDC Press.
- Ibragimova, S. (2023). The role of modern laboratories in developing students' critical thinking skills. *Journal of Innovative Education*, 9(4), 101–109.
- Ilham, K. (2025). Investigating the relationship between the frequency of laboratory activities and academic performance in science among secondary school students. *International Journal of Advanced Research in Future Ready Learning and Education*, 40(1), 55-67.
- Johnson, D. W., & Johnson, R. T. (2017). Cooperative learning in science laboratories. *Science Education Review*, 16(1), 1–12.
- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice Hall.
- National Educational Research and Development Council (NERDC). (2013). *Senior secondary school biology curriculum*. Abuja: NERDC.
- Nwagbo, C. R. (2016). Biology practical teaching in Nigerian secondary schools. *Journal of Science Education*, 14(2), 41–49.

- Nwankwo, O. J., & Eze, G. C. (2023). Effect of biology laboratory facilities on students' achievement in Anambra State, Nigeria. In *Proceedings of the Nigerian Association of Science Educators*.
- Ogbeba, J., & Omega, A. (2018). Laboratory utilization and academic performance. *Nigerian Journal of Curriculum Studies*, 25(1), 78–85.
- Ogunniyi, M. B. (2016). *Teaching science in Africa*. Ibadan: University Press.
- Okebukola, P. A. O. (2015). Improving practical work in Nigerian science classrooms. *African Journal of Educational Studies*, 8(1), 1–12.
- Okebukola, P. A. O. (2020). State of science laboratories in secondary schools and impact on students' performance across Nigerian geopolitical zones. *Journal of Science Education Research*, 5(2), 45–62.
- Okeke, S. O. (2018). School funding and science education quality. *Journal of Educational Administration*, 10(4), 73–81.
- Okoli, J. N. (2019). Inquiry-based learning in biology classrooms. *African Journal of Science Education*, 4(2), 22–31.
- Olatoye, R. A. (2016). Science laboratory learning environment and students' achievement. *Journal of Educational Psychology*, 8(1), 36–44.
- Oloruntegbe, K. O., & Odutuyi, M. O. (2014). Laboratory safety practices in Nigerian schools. *Journal of Science Education*, 18(1), 17–25.
- Oludipe, D. I. (2018). Gender and students' performance in biology practicals. *International Journal of Educational Studies*, 10(1), 19–27.
- Omoosewo, E. O. (2014). Management of science laboratories in Nigerian schools. *Journal of Educational Management*, 5(2), 88–95.
- Putri, Z. M., Andayani, Y., & Susilowati, E. (2020). Laboratory management implementation in senior high schools. *Journal of Educational Research*, 12(3), 210–218.
- Rahmawati, D. (2025). Optimizing Biology laboratory management in high schools. *Golden Ratio of Mathematics Innovation and Learning Forum*.
- Rahmawati, D., Hidayat, M., & Pratiwi, A. (2024). Application of PDCA cycle in school laboratory management. *Journal of Educational Management*, 10(2), 67–75.

- Saifuddin, M. F., & Puspitasari, E. D. (2022). Development of laboratory teaching materials to improve students' understanding. *International Journal of Science Education*, 7(1), 33–41.
- Salami, I. A. (2018). Secondary school laboratory facilities in Nigeria. *Journal of Educational Infrastructure*, 6(2), 85–93.
- Sanjito, B. P. (2025). The impact of science practical work on secondary school students' learning outcomes: A meta-analysis. *Journal of Research in Science, Mathematics and Technology Education*.
- Silaen, M. (2023). Training needs of laboratory assistants in secondary schools. *Journal of Technical Education*, 12(3), 90–98.
- Strgar, J., & Moller, A. (2024). Factors influencing students' attitudes toward Biology practical work. *Journal of Biological Education*.
- Suyantri, N., Widodo, W., & Hartono, H. (2024). Evaluation of science laboratory facilities in public schools. *Journal of Educational Evaluation*, 6(1), 40–48.
- Tuaputty, H., Rahman, A., & Lestari, D. (2023). Project-based learning with laboratory approach in biology education. *Journal of Biology Education Research*, 15(2), 88–97.
- Uche, S. C., & Umoren, G. (2019). Teaching resources and students' achievement in biology. *Journal of Science Education*, 20(1), 14–22.
- UNESCO. (2017). *Education for sustainable development goals*. Paris: UNESCO Publishing.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Wati, R., Suryani, L., & Prakoso, B. (2024). Challenges of laboratory management in secondary schools. *Asian Journal of Science Education*, 11(1), 56–64.
- Yusuf, M. O. (2016). Information and communication technology in science education. *Nigerian Journal of Educational Technology*, 11(2), 15–23.
- Zulfaa, R., Nurhayati, S., & Mulyani, S. (2022). Competence of laboratory personnel in biology laboratories. *Journal of Science Teaching*, 14(3), 145–153.

**APPENDIX**  
**QUESTIONNAIRE**

**FACULTY OF EDUCATION**  
**DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY,**  
**BENIN CITY**

**Dear Respondent,**

I am an undergraduate student of the Department of Curriculum and Instructional Technology, Faculty of Education, University of Benin. I am conducting a study titled: **“The Influence of Laboratory Management on Biology Students’ Learning Outcome in Selected Secondary Schools in Ovia North East Local Government Area.”** This study aims to find out the key factors affecting the management of Biology laboratories and how these factors influence students' learning outcomes. Please respond to the questionnaire with honesty. All responses will be kept confidential and used only for academic purposes. Participation is voluntary.

Thank you for your cooperation.

**Yours faithfully,**

---

**Omegihe Deborah BELLO**  
(Researcher)

**SECTION A – DEMOGRAPHIC DATA**

Please tick (✓) the appropriate option.

**S/N Demographic Variables**

1. **Gender:** Male
2. **Class Taught:** SSS 1 , SSS 2 , SSS 3
3. **Highest Educational Qualification:** NCE  PGD  B.Ed/B.Sc (Ed)  B.Sc.   
M.Ed/M.Sc (Ed)  Ph.D
4. **Teaching Experience:** Less than 5 years  5 – 10 years  15 years and above

**SECTION B: PRESENTATION OF ITEMS**

Please tick (✓) the appropriate option that best represent your choice.

**Key:** SA = Strongly Agree | A = Agree | D = Disagree | SD = Strongly Disagree

	<b>Items</b>	<b>SA</b>	<b>A</b>	<b>D</b>	<b>SD</b>
<b>RQ 1</b>	<b>How does the adequacy and organization of laboratory facilities influence Biology students' learning outcomes in secondary schools?</b>				
1	Adequate laboratory benches improve Biology students' learning outcomes.				
2	Well-organized storage cabinets enhance students' Biology performance.				
3	Sufficient ventilation systems boost students' grasp of Biology concepts.				
4	Proper laboratory lighting supports better achievement in Biology classes.				
5	Adequate water sinks facilitate improved learning outcomes for students.				

	Items	SA	A	D	SD
<b>RQ 2</b>	<b>To what extent does the availability and proper management of laboratory materials and equipment affect students' performance in Biology practicals?</b>				
6	Availability and proper management of microscopes enhance students' Biology practical performance.				
7	Availability and proper management of dissecting kits improve students' practical scores.				
8	Availability and proper management of Bunsen burners boost students' success in Biology experiments.				
9	Availability and proper management of pipettes support better outcomes in students' practicals.				
10	Availability and proper management of weighing balances elevate students' Biology practical results.				

	Items	SA	A	D	SD
<b>RQ 3</b>	<b>How does the frequency and quality of laboratory-based instruction impact students' understanding of key Biology concepts?</b>				
11	Attending laboratory sessions three times per week deepen students' understanding of Biology concepts.				
12	High-quality laboratory instruction improves students' mastery of key Biology ideas.				
13	Attending laboratory practicals once a week weaken students' comprehension of Biology topics.				
14	Quality laboratory activities enhance students' retention of Biology principles.				
15	Regular, effective laboratory work boosts students' Biology conceptual knowledge.				

	Items	SA	A	D	SD
<b>RQ 4</b>	<b>What relationship exists between teachers' laboratory management practices and students' overall achievement in Biology?</b>				
16	My effective safety protocols in the laboratory raise students' Biology achievement.				
17	My proper equipment maintenance practices improve students' overall Biology scores.				

18	My systematic material inventory management boosts students' Biology performance.				
19	My structured laboratory session planning enhances students' Biology grades.				
20	My thorough supervision during practicals elevates students' Biology achievement.				