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# Assessment of Standards and Availability of Laboratory Equipment and Utilization of Basic Science Laboratories in Federal College of Education, Zaria

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**Abstract**
Adequate provision of apparatus, equipment and standardized laboratory facilities is necessary for effective teaching and learning, also the utilization and handling of this equipment for practical in our various Colleges of education prompt the need for this study. The study accesses the standard and availability of Laboratory Equipment and the utilization of some basic science laboratory of Biology, Chemistry and Physics in Federal College of Education Zaria. The sample size for the research constitutes of 21 laboratory technicians that is seven (7) each from Biology, Chemistry and Physics department respectively. The study seeks answers to 3 research questions, 30-item questionnaire split into 3 parts were used to collect data related to the research questions. The findings indicated among others that about 50% of the respondents claimed the laboratory equipment and apparatus are available and also points to the fact that the available equipment are not sufficient enough for all the students. Factors constraining the assessment and availability of Laboratory Equipment and utilization such as lack of Government and management supervision systems were also highlighted and based on which some recommendations were proffered.

**Keywords:** Laboratory Standards Assessment, Equipment Availability, Laboratory Utilization, Basic Science Education, Federal College of Education, Zaria

## Introduction

The earliest laboratory according to the present evidence is a home laboratory of Pythagoras of Samos, the well-known Greek philosopher and scientist. This laboratory was created when Pythagoras conducted an experiment about tones of sound and vibration of string (Gouk, 2012).Researching in teams started in the 19th century, and many new kinds of equipment were developed in the 20th century (Isaev et al., 2022; Kragh, 2020; Wingfield, 2020). A 16th century underground alchemical laboratory was accidentally discovered in the year 2002. Rudolf (II), Holy Roman Emperor was believed to be the owner. The laboratory is called Speculum Alchemiae and is preserved as a museum in Prague (Campos-Pons & Lewis-Cappellari, 2020). Practical work has been defined as an experiment performed by the teacher and students for demonstrations, or series of experiments and observational exercises carried out by the students to relate theoretical knowledge with practical activities done in the laboratory, classroom, field or elsewhere (Reid & Shah, 2007). Practical activities are essential in all level of science education and to help students in internalizing and understanding the theoretical knowledge of science fields such as Chemistry, Biology and Physics, However, degree of implementation of practical activities and availability of laboratory equipment are differed from school to school (Arons, 1993; Eshiet, 1996; Onyara, 2013). According to Aliyah and Puspitasari (2022) learning with practicum activities students are able to master concepts, facts and scientific processes so as to improve students' skills. Laboratory facilities and infrastructure are also needed in order to support practicum activities, so that practicum activities can run smoothly (Aliyah & Puspitasari, 2022; Ntawuhiganayo & Nsanganwimana, 2022).

A laboratory that is often abbreviated as a "lab" is a place where scientific research, experiments, measurements, or scientific training are carried out. Scientific laboratories are usually distinguished according to their disciplines such as physics laboratories, chemical laboratories, biochemical laboratories, computer laboratories, and language laboratories (Decaprio, 2013). The laboratory is a place in the form of a building bordered by walls and roofs in which there are a number of practicum tools and materials (AAAS, 1989; Aladejana & Aderibigbe, 2007). Laboratories in learning can be in the form of open spaces or open nature and or in the form of special rooms (Agustina & Ningsih, 2017). Scientific laboratories are usually distinguished according to their disciplines such


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as physics laboratories, chemical laboratories, biochemical laboratories, computer laboratories, and language laboratories (Flaherty & Reynolds, 2016). The study is designed to assess the extent of availability and standard of apparatus and equipment's in biology, chemistry and physics laboratories of Federal College of Education Zaria.

**Objectives of Study**

The following are the objectives of the study -:

1. Assess the availability of practical equipment
2. Assess the standard of the laboratory equipment
3. To determine the measures to adopt to improve the standard and availability of equipment of the college Laboratories for practical

**Research Questions**

1. Are there sufficient equipment to carry out practical work in the college laboratories?
2. To what extent are the standard of the equipment available in biology, chemistry and physics laboratories of federal college of education Zaria?
3. What are the measures to adopt to improve the standard and availability of equipment of the college Laboratories for practical?

**Methodology**

The survey design was adopted for this study. The main instruments for this survey are self-developed questionnaire, personal interview and direct examination or observation of the basic Biology, Chemistry and Physic laboratory equipment in the school. The validity of the instruments was determined through experts rating in the Science Education (Biology, Chemistry and Physics). These experts were requested to validate the items in terms of clarity of instruction to the respondents, Functionality of the items in the laboratory and appropriation and adequacy of the items in addressing the purpose of the study (Abdullahi, 1995; Abrahams et al., 2013; Akpan, 2006). Frequency, and percentages were used for data analysis.

**Results**

**Table 1: Assessment of Availability of Laboratory Equipment: Biology Department**

| SN. | Variable | % Response Yes | % Response No |
|---|---|---|---|
| 1 | Do you have microscope? | 100 | 0 |
| 2 | Do you have test tubes and test tubes racks? | 100 | 0 |
| 3 | Do you have dissecting tool kit? | 100 | 0 |
| 4 | Do you have electronic balance? | 100 | 0 |
| 5 | Do you have magnifying glass? | 100 | 0 |
| 6 | Do you have pH meter and thermometer? | 100 | 0 |
| 7 | Do you have animal and plant specimens? | 100 | 0 |
| 8 | Do you have glass slides and coverslips? | 100 | 0 |
| 9 | Do you have petri dishes and inoculating loops? | 100 | 0 |
| 10 | Do you have Bunsen burner or alcohol burner? | 100 | 0 |
| 11 | Does the college have enough above practical equipment for all students? | 100 | 0 |
| 12 | Do you have incubators? | 60 | 40 |

The data in Table 1 indicates a high level of equipment availability in the Biology Department for practical work. Each essential item, including microscopes, test tubes, electronic balances, pH meters, and Bunsen burners, is present at a 100% availability rate, allowing students full access to these necessary tools. However, 40% of respondents reported that incubators were not sufficiently available, indicating a slight shortage in this item. The college appears to meet the requirements for practical work in terms of fundamental laboratory equipment, with 100% of respondents confirming that there are enough of these items to support student needs.


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**Table 2: Assessment Availability of Physical Facilities and Safety Equipment: Biology Department**

| SN | Variable | % Response Yes | % Response No |
|---|---|---|---|
| 1 | Is there enough space in the laboratory to accommodate all student? | 50 | 50 |
| 2 | Are there enough safety goggles, lab apron, latex gloves for all the help? | 30 | 70 |
| 3 | Does the laboratory have emergency exit doors? | 100 | 0 |
| 4 | Does the laboratory have fire extinguishers? | 100 | 0 |
| 5 | Does the laboratory have eye wash basin, emergency shower? | 40 | 60 |
| 6 | Is there first aid kit ? | 100 | 0 |

The results in Table 2 reveal some concerns about the standards and availability of safety equipment and physical facilities within the Biology Department. Specifically: Only 50% of respondents felt that there was enough laboratory space to accommodate all students comfortably. Safety provisions such as goggles, aprons, and gloves were reported as inadequate, with only 30% availability. The laboratory is equipped with emergency exit doors and fire extinguishers (100% availability), but other safety essentials, such as eye wash basins and emergency showers, were only reported as present by 40% of respondents, indicating potential safety risks. First aid kits were fully available (100%). Generally, while there is a strong presence of basic emergency and safety equipment, areas such as space, safety gear, and certain emergency facilities require improvement to meet full safety standards

**Table 3: Measures to Improve Biology Laboratory**

| SN | Variable | SA | A | D | SD |
|---|---|---|---|---|---|
| 1 | Provision of adequate consumables like stools, practical manual for all students | 10 | 60 | 20 | 10 |
| 2 | Provision of standard laboratory equipment | 70 | 30 | 0 | 0 |
| 3 | Provision of new apparatus and proper maintenance of equipment | 30 | 70 | 0 | 0 |
| 4 | Organization of workshop for attendant, technicians | 50 | 50 | 0 | 0 |
| 5 | Exposing students to practical so as to acquire skills in handling apparatus | 60 | 40 | 0 | 0 |
| 6 | Enhancing visitation to industries and company | 30 | 70 | 0 | 0 |
| 7 | Availability of qualified lecturers | 40 | 60 | | |

Table 3 presents faculty and student perspectives on necessary measures to enhance the Biology Laboratory standards: Provision of consumables (e.g., stools and practical manuals) was strongly supported, with 60% of respondents agreeing, though 10% strongly disagreed, showing slight variability in perception. Provision and maintenance of standard laboratory equipment received unanimous support, with 70% strongly agreeing and 30% agreeing. Organizing workshops for attendants and technicians also received a strong positive response, with 50% strongly agreeing and 50% agreeing, indicating a consensus on the need for professional development. Practical exposure was highly favored, with 60% strongly agreeing and 40% agreeing, underscoring the importance of hands-on learning. Interestingly, there was a notable agreement (60% agree, 40% strongly agree) that the availability of qualified lecturers impacts practical sessions.


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**Table 4: Measures to Improve Biology Practical**

| SN. | Variable | % Response | % Response | % Response | % Response |
|---|---|---|---|---|---|
| 1 | How may session of practical do you have in a week? | 0 (1 session) | 0 (2 session) | 100 (3 session) | 0 (4 session) |
| 2 | How many practical sessions do you have in a semester? | 0 (1 session) | 0 (2 session) | 100 (3 session) | 0 (4 session) |
| 3 | How many students do you have in your class? | 100% (above 50) | | | |

Table 4 reveals practical session scheduling and student numbers in practical classes: Practical sessions are held three times a week and per semester, ensuring frequent hands-on learning opportunities. Class sizes remain high, with 100% of respondents indicating class sizes above 50, which may impact individual access to equipment and personalized instruction.

**Table 5: Assessment of Availability of Laboratory equipment: Chemistry Department**

| SN. | Variable | % Response Yes | % Response No |
|---|---|---|---|
| 1 | Do you have beakers, test tubes, vial with cap? | 100 | 0 |
| 2 | Do you have glass wares used for measurement like volume trick flask, graduating cylinder, pipette and burette? | 100 | 0 |
| 3 | Do you have equipment often used in titration like Retort stand, Burette clamp? | 100 | 0 |
| 4 | Do you have Bunsen burner, oven, centrifuge? | 100 | 0 |
| 5 | Do you have funnel, filter, paper and wash bottle? | 100 | 0 |
| 6 | Do you have magnetic stir bar and glass stir bar? | 100 | 0 |
| 7 | Do you have pH meter and thermometer? | 100 | 0 |
| 8 | Do you have crucible, longs, desiccator? | 100 | 0 |
| 9 | Do you have reagent, distilled water? | 100 | 0 |
| 10 | Do you have acid such HCl, $H_2S0_4$, and bases like NaOH etc.? | 100 | 0 |
| 11 | Do you have halogen such as Br, F, Cl and metals such as AI, Zn etc.? | 100 | 0 |
| 12 | Does the school have enough above practical equipment and re-agent for all student? | 20 | 80 |

As shown in Table 5, essential laboratory equipment in the Chemistry Department is readily available. All surveyed items, including beakers, test tubes, titration apparatus, magnetic stir bars, pH meters, and various chemicals (e.g., acids, bases, halogens, and metals), received a 100% positive response, confirming their presence in the lab. However, only 20% of respondents felt that there was enough practical equipment and reagents to adequately serve all students. This suggests that although equipment is present, its quantity may not be sufficient for larger classes, which could limit individual hands-on practice during experiments.


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**Table 6: Assessment of Physical Facilities and Safety Equipment: Chemistry Department**

| SN. | Variable | % Response Yes | % Response No |
|---|---|---|---|
| 1 | Is there enough space in the laboratory to accommodate all the students at a time? | 50 | 50 |
| 2 | Are there enough safety goggles, lab coats, safety gloves for all the students? | 20 | 80 |
| 3 | Does the laboratory have emergency exit doors and fire alarm? | 100 | 0 |
| 4 | Does the laboratory have fire-extinguisher and sand buckets? | 100 | 0 |
| 5 | Does the laboratory have eyewash basin and emergency shower? | 100 | 0 |
| 6 | Is there first-aid kit? | 100 | 0 |

Table 6 presents insights into the Chemistry Department's physical facilities and safety equipment: Similar to findings in the Biology Department, 50% of respondents indicated that the laboratory space was inadequate to accommodate all students comfortably. Safety equipment shortages were more pronounced in Chemistry, with only 20% of respondents reporting sufficient safety goggles, lab coats, and gloves for all students. However, emergency facilities such as exit doors, fire extinguishers, sand buckets, eyewash basins, emergency showers, and first-aid kits were available at 100%, ensuring basic compliance with safety standards. These results highlight that while foundational safety equipment is well-established, there is a critical need to improve the availability of personal protective equipment and address spatial constraints for better lab safety and functionality**.**

**Table 7: Measures to Improve Chemistry Laboratory**

| SN | Variable | SA | A | D | SD |
|---|---|---|---|---|---|
| 1 | By provision of adequate consumable materials like stools, practical manuals, plain sheets for all the student | 10 | 60 | 20 | 10 |
| 2 | By provision of standard chemistry laboratory equipment | 70 | 30 | 0 | 0 |
| 3 | By provision of new apparatus and proper maintenance of laboratory equipment | 30 | 70 | 0 | 0 |
| 4 | By exposing students to practical so as to acquire skills in handling practical apparatus | 50 | 50 | 0 | 0 |
| 5 | Organization of workshop for attendant, technicians and instructor | 60 | 40 | 0 | 0 |
| 6 | Enhancing visitation to company and industries | 30 | 70 | 0 | 0 |
| 7 | Availability of qualified Lecturers | 40 | 60 | 0 | 0 |

Table 7 provides an analysis of measures respondents believe would enhance the standards in the Chemistry laboratory: Provision of consumables was agreed upon by 60% of respondents, with 10% strongly supporting and 10% opposing, suggesting that while consumables are considered necessary, opinions are slightly divided. Provision of standard laboratory equipment had strong support, with 70% strongly agreeing and 30% agreeing, reflecting a unanimous need for quality equipment. Exposure to practical work was favored by all respondents (50% strongly agreed, 50% agreed), indicating a consensus on the importance of practical experience in skill acquisition. Workshops for staff and industrial visitations were highly endorsed, with support from 60% and 70% of respondents, respectively, showing the need for ongoing professional development and industry exposure to stay updated with current practices. Remarkably, 60% of respondents agreed and 40% strongly agreed that practical sessions are impacted by the availability of qualified lecturers.


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**Table 8: Measures to Improve Chemistry Practical**

| SN | Variable | % Response | % Response | % Response | % Response |
|---|---|---|---|---|---|
| 1 | How may session of practical do you have in a week? | 0 (1 session) | 60 (2 session) | 0 (3 session) | 0 (4 session) |
| 2 | How many practical session do you have in a semester | 0 (1 session) | 0 (2 session) | 100 (3 session) | |
| 3 | How many students do you have in your class? | 100% (above 50) | | | |

According to Table 8, practical sessions in Chemistry are structured as follows: Most students experience two practical sessions per week (60% response rate for two sessions), with three sessions conducted per semester (100% response rate), demonstrating a moderate frequency for hands-on learning. Class sizes are reported as large, with 100% of respondents indicating class sizes above 50 students, which may limit personalized instruction and reduce individual access to resources during practicals.

**Table 9: Assessment of Availability of Laboratory Equipment: Physics Department**

| SN | Variable | % Response Yes | % Response No |
|---|---|---|---|
| 1 | Do you have adequate power supply | 100 | 0 |
| 2 | Do you have darkroom poor light experiment | 10 | 90 |
| 3 | Do you have Vernier caliper and micrometer screw gauge ? | 100 | 0 |
| 4 | DO you have pendulum equipment like stopwatch and meter rules? | 100 | 0 |
| 5 | Do you have electromagnet and u-shape magnet | 100 | 0 |
| 6 | Do you have turning forks? | 100 | 0 |
| 7 | Do you have so no meter? | 100 | 0 |
| 8 | Do you have resonance tubes? | 100 | 0 |
| 9 | Do you have spherometer? | 100 | 0 |
| 10 | Do you have spectrometer? | 100 | 0 |
| 11 | Do you have computers? | 100 | 0 |
| 12 | Does the college laboratory have enough practical equipment for all students? | 10 | 90 |

Table 9 highlights the availability of essential equipment in the Physics Department. Equipment such as vernier calipers, micrometers, pendulum apparatus, resonance tubes, and spectrometers is fully available (100% response rate for "Yes"). However, only 10% of respondents felt that there was enough practical equipment available to meet the needs of all students, indicating a significant shortage for large classes. Additionally, specific facilities like a darkroom for low-light experiments were only available for 10% of respondents, suggesting a gap in specialized equipment required for advanced physics experiments.


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**Table 10: Assessment of Physical Facilities and Safety Equipment : Physics Department**

| SN. | Variable | % Response Yes | % Response No |
|---|---|---|---|
| 1 | Is there enough space to accommodate all students at the same time? | 80 | 20 |
| 2 | Are there enough safety goggles, lab apron, gloves and boots for all helps? | 10 | 90 |
| 3 | Does the laboratory have emergency exit doors and fire alarm? | 100 | 0 |
| 4 | Does the laboratory have fire extinguishers? | 100 | 0 |
| 5 | Does the laboratory have fume box? | 100 | 0 |
| 6 | Is there first aid kit? | 100 | 0 |

Table 10 shows that while basic emergency and safety provisions, such as emergency exits, fire alarms, fire extinguishers, and fume boxes, are available at 100%, safety gear for students and lab personnel is lacking. Only 10% of respondents reported having sufficient safety goggles, aprons, gloves, and boots, posing a risk to lab safety. In terms of lab space, 80% of respondents felt that the laboratory space was adequate, while 20% felt it was insufficient for accommodating all students simultaneously. This suggests that, while the Physics Department meets many safety and facility standards, there is a need for more personal protective equipment (PPE) to ensure comprehensive lab safety.

**Table 11: Measures to improve Physics Laboratory**

| SN. | Variable | SA | A | D | SD |
|---|---|---|---|---|---|
| 1 | Provision of adequate consumables materials like plain sheets, manual and dry cell for all students | 50 | 50 | 0 | 0 |
| 2 | Provision of standard laboratory equipment | 60 | 40 | 0 | 0 |
| 3 | Provision of new apparatus and proper maintenance of equipment | 60 | 40 | 0 | 0 |
| 4 | Exposing students to practical so as to acquire skills in handling practical apparatus | 50 | 50 | 0 | 0 |
| 5 | Provision of adequate power supply | 70 | 30 | 0 | 0 |
| 6 | Organization of workshop for attendants, technicians and instructors | 50 | 50 | 0 | 0 |
| 7 | Enhancing visitation to company and industries | 40 | 60 | 0 | 0 |

Table 11 outlines suggested measures to enhance the standards and resources in the Physics Laboratory: Provision of consumables (e.g., dry cells, manuals) was unanimously supported, with 50% of respondents strongly agreeing and 50% agreeing, indicating the importance of consumable resources in practical learning. Provision of standard equipment and regular maintenance also received strong support, with 60% strongly agreeing and 40% agreeing, reflecting a consensus on the need for equipment upkeep. Power supply improvement was a priority, with 70% strongly agreeing and 30% agreeing, as reliable power is crucial for physics experiments. Workshops for lab personnel were equally supported, with a 50-50 split between strong agreement and agreement, indicating a shared belief in the value of professional development.

**Table 12: Measures to improve physics practical**

| | | |
|---|---|---|
| 1 | How many practical sessions do you have in a week? | 100 ( 3 session) |
| 2 | How many practical sessions do you have in a semester? | 100 (24 session) |
| 3 | How many students do you have in your lab per session? | 100 (above 50) |

According to Table 12, the Physics Department holds a consistent number of practical sessions: Each week includes three practical sessions, totaling 24 sessions per semester (100% response rate), which allows for comprehensive hands-on experience. Class sizes remain high, with over 50 students per session, which can potentially limit individual attention and access to equipment during practicals.


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**Discussion**

The finding from the availability of Laboratory Equipment, from the results presented in Tables 1, 5 and 9, of all the 21 respondents from all laboratories (Biology Chemistry and Physics), 11(52%) responses that there are apparatus and equipment available in the respective Laboratories and 10 (48%) points the problem that the available equipment is not sufficient enough for all the students in respective departments. While on the availability of physical facilities and safety Equipment, from the results presented in table 2, 6 and 10 shows that there is lack of dark room for light experiment in physics laboratory, and also 80% of respondent from all the Biology Chemistry and Physics department responses to lack of safety goggles, lab apron, boots and gloves for technologist and students.

However, On the measures that could be adopted to improve the standard and utilization of Laboratory equipment of Biology Chemistry and Physics departments at FCE Zaria, Table 3-4, 7-8 and 11-12 shows that all the 7 items were accepted by the respondents as shown in the tables. Provision of sufficient equipment and apparatus ranked the most so as to enable every student participate in the practical. The remaining measures that were agreed also include organization of workshop for technicians and attendants and proper maintenance of the Laboratory equipment and facilities.

**Conclusion**

The study assesses the availability, standard and utilization of laboratory equipment, the problems associated with the inadequacy of the laboratory equipment and some safety equipment and also measures that could be adopted to improve the standard of the college Laboratory. The study also comes up with measures such as provision of adequate and standard laboratory equipment and apparatus, proper maintenance and utilization which if implement by the Departments, lab technicians, authorities of College of Education and the National Commission for College of Education (NCCE) will provide good oriented learning situation efficiently and effectively.

**Recommendations**

Based on the findings of the study, the following recommendations were made.

1. The Federal Ministry of Education and NCCE should ensure that adequate equipment and apparatus are supplied to biology, chemistry and physics laboratories.
2. Steady power supply should be made available to all laboratories in our Institutions.
3. Alternative source of energy, preferable solar energy, should be provided in all laboratories for unlimited access to practical activities by the student at any period of the day.
4. Government and other stakeholders like community, NGOS and World Bank should offer assistance by donating some necessary equipment and apparatus lacking in the college Laboratories.
5. Apparatus and equipment should be properly maintained by students and lab technicians.
6. Workshop for technologist, technicians and attendants should be encourage and lecturers to handle practical should be sent for training in order to keep them abreast in their area of specification.

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