LEVEL OF EXPOSURE AND EFFECTIVE USAGE OF BIOLOGY LABORATORY FACILITIES BY TEACHERS: EVIDENCE FROM SELECTED SENIOR HIGH SCHOOLS IN CENTRAL REGION, GHANA

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ABSTRACT

The thrust of the study was to explore the level of exposure and effective usage of biology laboratory facilities by teachers from selected Senior High Schools in the Central Region of Ghana. This study was carried out in all 40 of the 'Category C' Senior High Schools in the region. A descriptive survey design with questionnaire and a Biology Laboratory Facility Checklist (BLFC) were used as data collection instruments. A total of one hundred and twenty (120) respondents comprising three biology teachers from each of the schools, were purposively sampled. Coding schemes were developed to organize the data into meaningful categories. This involves data obtained from the biology laboratory facility checklist and questionnaire. The categorised data were converted into frequency counts and simple percentages. The study discovered that teachers found it very difficult to teach and conduct regular laboratory exercises with their students due to the heavy workload on them. Also, the lack of adequate laboratory equipment and materials is a major contributing factor to teachers' reluctance to conduct laboratory exercises. Lack of teachers' motivation is also a factor that prevents them from conducting laboratory exercises. It is therefore recommended that enough laboratory materials should be provided in various schools and also teachers should be motivated to ensure effective science practical work.

Keywords: Laboratory, Facilities, Biology, Exposure, Effective

INTRODUCTION

Science entails active engagement in practical experimentation, enabling learners to cultivate scientific literacy in order to confront global concerns. Aleyideino (2000) stated that solid science education is universally recognised as the fundamental basis for human development and advancement. In order for science teachers to fulfil their roles in effectively teaching science, it is imperative that laboratory equipment be both accessible and utilised sufficiently to enhance students' academic achievement.

Science is an empirical discipline that relies on laboratory work to expand scientific understanding through the systematic application of scientific methods such as observation, classification, measurement, and interaction with things and events of scientific significance. Bonah (2018) highlighted the essentiality of laboratory exercises in order for science to be considered as such, as they involve the practical application of theories. The laboratory is where learners acquire scientific knowledge through meticulous measurement, exact observation, and effective communication (Muhammad, 2010). The laboratory, therefore, serves as a central hub for all

scientific endeavours. Typically, it is furnished with instruments that enhance the efficacy of teaching and learning science, creating an optimal environment for developing skills, engaging in discovery-based learning, conducting inquiries, and solving problems. The biology laboratory provides students with the chance to manipulate equipment and materials, acquire knowledge of safety protocols, develop proficiency in certain methodologies, achieve precise measurements, and engage in attentive observations. Expertise in observation, deduction, and interpretation is crucial as well.

The word "laboratory work" refers to the hands-on activities that students engage in using different specimens and equipment in the biology laboratory. The activities encompass genuine experimental inquiry, validating tasks, and the acquisition of skills. Conducting biology experiments with competent laboratory technicians is essential for students to have a better grasp of the subject, as laboratory work is a vital component of biology instruction at all levels. The primary rationale for conducting biology practical work is to train proficient technicians for the industry and highly skilled personnel for research facilities (Musah & Umar, 2017). It is necessary to provide students with practical laboratory training and also create additional activities for them to reinforce their learning. These factors can enhance the laboratory experience and improve its effectiveness in contributing to students' overall learning in biology. In order to fulfil the objectives of the syllabus, a biology laboratory must possess the essential equipment and facilities. Effective utilisation of laboratory facilities enhances the efficacy of the teaching and learning process. This is contingent upon the teachers' proficiency in using such facilities (Musah & Umar, 2017).
The West African Examinations Council (WAEC), which is the primary examination body for senior high school students in Ghana, has advised that the instruction of all science subjects outlined in their syllabi should be predominantly focused on practical applications (WAEC, 2018). This is likely intended to showcase the significance they place on hands-on experimentation in the field of science. The biology laboratory provides students with the ability to manipulate equipment and materials, acquire knowledge of safety protocols, develop proficiency in specialised techniques, achieve precise measurements, and engage in meticulous observation. Nevertheless, it is crucial to actualize biology and subject concepts to empirical scrutiny. Proficiency in observation, deduction, and interpretation is equally crucial. Furthermore, there are numerous other crucial practical skills that should be cultivated, including collaboration, communication, public speaking, and devising effective solutions to real-world challenges. Each educational institution that operates a science laboratory is required to establish a proactive committee responsible for the efficient management of the laboratory. The laboratory necessitates proficient professionals, such as laboratory technologists, technicians, and assistants, to properly manage and organise its operations.

In Ghana, the West African Senior Certificate Examination allocates 40% of the overall score to practical work. However, students face a hurdle when it comes to carrying out practical work due to their lack of fundamental knowledge and confidence to successfully perform these tasks.

This significantly impairs their performance in the West African Senior Certificate Examination (WASSCE, 2019). A descriptive study conducted in Ghana by Oppong (2014) examined biology teachers' perceptions regarding the utilisation of material resources to enhance biology education. The study revealed that material resources for biology are scarce in secondary schools, and the few available resources are seldom utilised. Science educators often find it impractical to prioritise

laboratory activity as the focal point of their teaching. He expressed the view that the circumstances in which many teachers work do not foster enthusiasm for including laboratory exercises in biology instruction. Even when materials and equipment are accessible, the heavy workload and large class sizes can be demotivating.

The primary objective of this study was to investigate the extent of teachers' exposure to and proficient utilisation of biology laboratory facilities in selected senior high schools in the central region of Ghana.

Methodology

Study design

This study utilised a descriptive research design. Descriptive research is a type of study that aims to ascertain the current state or characteristics of a given situation (Clandinin & Connely, 2000). This study utilised a descriptive survey to collect information on the extent of exposure and efficient utilisation of biology laboratory facilities by teachers from selected senior high schools in the Central Region of Ghana. This approach offered valuable insight into the research problem by describing the variables of interest and facilitating the collection of information through the use of questionnaires, interviews, and the researcher's own observations.

Sampling approach and data acquisition

The study was carried out in all 40 schools classified as Category C in the central region. The study focused on Category C schools, which were chosen due to their insufficient infrastructure and low performance in the West African Senior School Certificate Examination (WASSCE), as determined by the computerised school selection and placement system (CSSPS) implemented by the Ghana Education Service. A total of 120 respondents were picked using purposive sampling techniques, with three biology teachers selected from each school. Ten (10) schools were selected for observation, and ten (10) instructors were chosen for interviews using the convenience sampling technique, based on their close proximity to the researchers. The study utilised the Biology Laboratory Facilities Checklist (BLFCL) and a questionnaire developed by the researcher. The checklist for biology laboratory facilities, designed for instructors, comprised a total of sixty elements (60), specifically assessing the presence and accessibility of equipment. The BLFCL was adopted from Okafor (2014) and modified to suit the objectives of this study. The participants were required to indicate whether the equipment was accessible and operational, accessible but not operational, or not accessible. The purpose of the checklist was to assess the extent to which biology laboratory facilities were accessible in the senior high schools located in the Central Region. The questionnaire consisted of two sections: part A focused on the personal information of the teachers, while part B comprised 20 issues that required a Yes or No response regarding laboratory utilisation. Coding systems were devised to categorise the data into relevant and manageable groups. The data used in this study was collected from the Biology Laboratory Facilities Checklist (BLFCL) and the questionnaire. The classified data were subsequently transformed into frequency counts and basic percentages, which were then used to answer the research questions posed in the study. The task was accomplished via a Microsoft Excel spreadsheet. Fraser (2002) argues that the integration of qualitative and quantitative research methodologies offers several theoretical viewpoints, such as observation and interpretive methods, to gain insights into education as a whole and specifically the classroom.

RESULTS AND DISCUSSION

This section presents the analysis of data obtained from the Biology Laboratory Facilities Checklist (BLFCL) and the Questionnaires on laboratory utilisation and factors that hinder the effective use of laboratories. It involves frequency counts and simple percentages of various data categories. The description of availability of resources per each school have been categorized as very adequate, adequate, fairly adequate and inadequate with percentage values used to describe the adequacy in Table 1.

Table 1: Available Laboratory Facilities and Their Descriptions

Percentage (%) Range of Available Facilities	Description
Above 40	Very adequate
30 to 39	Adequate
20 to 29	Fairly adequate
Below 20	Inadequate

Source: Researcher's Field Work, 2021

The level of availability and percentage range of Biology laboratory Facilities in Category C Senior High Schools in Central Region in presented in Table 2.

Table 2: Level of availability of laboratory facilities

Percentage range of facilities available	Number of schools	Percentage number of schools	Description
Above 40	0	0	Inadequate
30 to 39	12	30	Adequate
20 to 29	15	37.5	Fairly adequate
Below 20	13	32.5	Inadequate

Source: Researcher's Field Work, 2021

According to the data in Table 2, none of the forty schools sampled possessed biology laboratory facilities that were considered to be extremely adequate. 30% of the schools possess sufficient laboratory facilities. Approximately 37.5% of the schools has facilities that are reasonably sufficient, although they may not be fully capable of conducting biology practical work without encountering challenges. Nevertheless, having these facilities is preferable to having none at all. Evidently, a significant portion of the standard equipment required in a contemporary senior high school biology laboratory was absent. 32.5% of the schools surveyed were classified as inadequate. The available biology equipment consists solely of fundamental tools such as Bunsen burners, test tube racks, and glassware like test tubes and beakers. Additionally, there are materials like as a dissecting board and rabbit bones. However, these resources are insufficient for conducting biology practical work without the need for improvisation. Teachers must either spontaneously adapt to demonstrate a scientific notion or completely disregard the significance of practical practice. Ahmed (2003) discovered that the majority of secondary schools in the country have an unfavourable learning environment, characterised by a lack of essential resources, which consequently obstructs the achievement of educational goals. These schools obtained a score below 20% on the Biology Laboratory Facilities Checklist (BLFCL). This discovery aligns with a

research conducted by Nnorom (2012) in Nigeria titled "Availability and Usability of Science Laboratory for Teaching in Upper Basic Secondary Schools." The survey unveiled that the majority of the schools that took part did not own distinct science laboratories. Bonah (2018) stressed the importance of laboratory activities as an essential component of science, as they involve the practical application of theories. The laboratory offers an optimal environment for enhancing skills, engaging in discovery-based learning, conducting inquiries, and addressing problems. Without these activities, science would be only presented as a finished result rather than an ongoing process. This point was underscored by Muhammad (2010), who asserted that due to the experimental nature of science, any science course should incorporate laboratory work. This is because it is in the laboratory setting that students acquire scientific knowledge through meticulous measurement, precise observation, and effective communication. The extent of exposure to biology laboratory exercises is depicted in Table 3.

Table 3: Level of Exposure to Biology Laboratory Exercises

Questions	Responses					
	Yes		No		Total	
	Freq.	%	Freq.	%	Freq.	%
Does each of your students handle laboratory equipment independently during practical work?	0	0	120	100	120	100
Do your students conduct practical work?	50	41.7	70	58.3	120	100
Does the practical work facilitate effective teaching and learning in class?	36	30.0	84	70.0	120	100
Do students engage themselves effectively in practical work	36	30.0	84	70.0	120	100

Source: Researcher's Field Work, 2021

The review of the complete exercise reveals a lack of proper implementation of laboratory exercises in category C senior high schools throughout the region. Table 1 demonstrates that 100% of the respondents, specifically 120 teachers, claimed that their pupils do not independently handle equipment during practical work. Additionally, 58.3% of the respondents, specifically seventy individuals, do not do practical work. This outcome aligns with the research conducted by Abdulrahman (2009) as cited by Okafor (2014), which indicates that due to the prevalence of under-equipped biology laboratories in senior high schools, there is a predominance of discussion and lecture-based teaching methods instead of practical laboratory work. Lord (2001) noted that conducting biology practical work in groups has a significant and far-reaching impact on the classroom environment. This practice should be actively promoted in biology education at schools. Engaging in group practical work yields several advantages, including enhancing academic achievement, fostering effective communication abilities, and bolstering self-assurance. However, there are also disadvantages associated with it that might hinder the learning process. Students encounter difficulties in acquiring the necessary skills for practical application and struggle to cultivate autonomous thinking and work abilities. Furthermore, engaging in collaborative practical work can sometimes result in a diminished concentration on the assigned task as a result of socialising or disruptions caused by fellow students (Metha, 2021). It is important to promote individual practical work in order to cultivate the necessary technical proficiency in science among pupils.

A total of 84 participants, accounting for 70% of the respondents, reported that their pupils lack cooperation during practical lessons, which hinders effective teaching and learning. According to one respondent, the main reasons for this are the huge class size, insufficient space, and poor equipment for laboratory exercises. These factors make the practical courses uninteresting for students, hindering their ability to cooperate effectively. Collaboration among students during laboratory work is crucial for achieving a favourable outcome, and the absence of cooperation from students can provide a formidable challenge for professors. The researchers observed that students exhibited a lack of cooperation, which was attributed to the absence of stimulating learning activities. Instead, students just adhered to the orders given by their teachers. Furthermore, the opportunity for misbehaviour arose as students worked in groups. A study conducted by Fraser (2002) found that learning settings are not only positively associated with students' outcomes, motivations, and attitudes, but also with teachers' motivation. Fraser's study examines learning settings with a specific focus on student results, as well as the views of both students and teachers. Additionally, the study evaluates the effectiveness of various tactics. He asserts that the learning environment is the primary factor influencing self-evaluation. This type of atmosphere enables students to integrate, evaluate, investigate, critique, and generate their own ideas about the educational content.

30% of the respondents demonstrated that students effectively participate in practical work, whereas the remaining 70%, which corresponds to 84 respondents, did not. Scientific skill acquisition and knowledge of basic scientific concepts require the implementation of effective practical activity. Ahmed (2003) discovered that the majority of Secondary Schools in the nation have an unfavourable atmosphere for teaching and learning, since they lack vital resources, which hinders the achievement of educational goals. The insufficiency of essential resources, such as textbooks, workshops, under-equipped classrooms, laboratories, and libraries, is likely to be a contributing factor to the poor performance of students in tests. Factors that affect the effective laboratory work in biology are presented in Table 4

Table 4: Factors That Affect the Effective Laboratory work in biology

Listed Factors	Freq. Count	Responses Total	%
Lack of teachers' motivation (incentives)	120	120	100%
Lack of adequate laboratory equipment and materials	116	120	96.7%
Teachers' workload	89	120	74.2%
Lack of laboratory attendant	58	120	48.3%
It is time-consuming	27	120	22.5%
Large class size	27	120	22.5%
Workshops are not organised for teachers to enhance further studies	58	120	48.3%

Source: Researcher's Field Work, 2022

Table 4 outlines the characteristics that determine the effectiveness of biology laboratory work. The reasons that had the highest percentages were: teachers' workload (74.2%), insufficient laboratory equipment and resources (96.7%), and lack of teacher motivation (incentives) (100%). According to the data in Table 4, all of the teachers surveyed expressed complete support for

providing incentives to teachers as a way to motivate them to conduct science practicals. Teachers who lack motivation are hesitant to successfully instruct their students. If teachers lack motivation and rewards, students' engagement in laboratory activities may be compromised. Teachers that are motivated are more inclined to design and carry out stimulating experiments that captivate the interest and curiosity of students. The involvement of students is vital for optimal comprehension in the field of biology (Johnson et al., 2017). Brown (2019) verified that teachers who are motivated have a tendency to allocate additional time and effort towards the creation of experiments and the supervision of laboratory activities. Their role is to guarantee the safe execution of experiments and ensure pupils comprehend the fundamental principles involved. Conversely, teachers who lack motivation may only perform the necessary actions without genuine enthusiasm, resulting in superficial learning encounters. Teachers that are driven are more inclined to actively pursue supplementary resources for the laboratory, such as modernised equipment and supplies. Inadequate motivation can lead to the use of obsolete or insufficient resources, impeding students' ability to engage in practical learning experiences (Jones, 2020).

In addition, a significant majority of respondents, specifically 96.7%, including 116 teachers, reported a deficiency of laboratory equipment in their schools. This shortage of resources is a significant contributing element to the limited effectiveness of laboratory exercises. (Bonah, 2015) argued that the absence of equipment and materials has led Biology teachers to disregard the practical component, which has a higher potential for fostering critical thinking and objective reasoning skills in pupils. Instead, they rely on the expository teaching technique, which is notorious for encouraging memorization and impeding the transfer of knowledge. The limited availability of laboratory equipment and supplies limits students' capacity to participate in practical experiments (Johnson et al., 2019). Insufficient access to necessary tools and materials hinders students from fully engaging in hands-on exploration of scientific topics, thereby resulting in a shallow comprehension of the subject matter. Lack of essential equipment and tools might undermine the motivation of both students and teachers (Brown, 2021). Students may develop a lack of interest in laboratory sessions, viewing them as unproductive or unstimulating. The absence of motivation can have a negative effect on student involvement and academic achievements.

A total of 89 respondents, accounting for 74.2% of the teachers, stated that the workload of a teacher has an impact on the successful implementation of laboratory exercises. Timely feedback is crucial for optimising learning outcomes in laboratory work (Johnson et al., 2021). If teachers are burdened with excessive administrative duties or managing large class sizes, they may have limited availability to offer substantial comments on students' performance, impeding their advancement. Teachers overwhelmed by substantial workloads may depend on a restricted range of experiments or resources (Wilson, 2020). This can result in an absence of diversity in laboratory activities, thus reducing students' exposure to various scientific concepts and methodologies. Teacher workload that is excessively high might lead to stress and burnout (Brown, 2022). Teachers experiencing high levels of stress may exhibit reduced passion and energy when conducting laboratory work, which might hinder their capacity to effectively engage students and provide a conducive learning environment.

Fifty-eight teachers, accounting for 48.3% of the total, reported a deficiency in laboratory assistants, which hinders the efficient utilisation of the laboratory as it burdens the teachers with excessive effort. Laboratory attendants are essential for the maintenance and safety of laboratory

equipment (Smith, 2020). The absence of individuals may result in the neglect of maintaining fragile instruments and safety protocols, which could lead to equipment malfunction and safety risks. Additionally, it may cause disorganised storage and shortages of resources, thereby impeding the execution of experiments and the overall laboratory experience (Brown, 2022). Students frequently necessitate direction and support during laboratory experiments, particularly when dealing with unfamiliar equipment (Jones, 2023). The lack of laboratory attendants can result in students being deprived of essential assistance, potentially resulting in frustration and diminished learning results. During this period characterised by a shortage of skilled laboratory assistants, biology teachers encounter the challenge of assuming multiple responsibilities. These include tasks such as preparing reagents and solutions, fixing faulty equipment, and organising students and materials for practical work (Arruabarrena, Sánchez, Blanco, Vadillo, & Usandizaga, 2019).

Fifty-eight teachers, accounting for 48.3% of the total, reported that their schools do not conduct seminars to enhance their existing knowledge in biology instruction. Without continuous professional growth, teachers may adhere to a restricted catalogue of experiments that they are acquainted with (Jones, 2022). This might result in an absence of diversity in laboratory activities, so restricting students' exposure to a wide range of biological concepts and practical abilities. Teacher workshops offer teachers the chance to enhance their knowledge and gain fresh laboratory skills (Brown, 2021). Without receiving such training, teachers may lack the necessary knowledge to proficiently instruct students in conducting experiments and analysing data. In the absence of access to workshops and professional development opportunities, Biology instructors may persist in utilising antiquated teaching methods and practices (Smith, 2018). This can impede the incorporation of contemporary pedagogical methods and inventive ideas in laboratory experimentation. Ultimately, 22.5% of the teachers claimed that a substantial class size impeded the effectiveness of practical work and also made it time-consuming. Increased class sizes might result in extended waiting periods for students to access resources and seek guidance from the instructor (Wilson, 2020). Prolonged periods of waiting might result in reduced student involvement and motivation, as well as feelings of dissatisfaction. Due to the high number of students in packed laboratories, not all individuals may have the chance to actively engage in experimental activities (Jones, 2023). This can impede the acquisition of practical experience by students and hinder their capacity to apply theoretical information in an authentic laboratory environment.

Furthermore, the presence of a large number of students in a class may increase safety problems when doing laboratory experiments (Brown, 2022). As the number of students utilising a restricted laboratory area, equipment, and resources increases, the likelihood of accidents and mishaps also increases, which can endanger the safety of students and compromise the quality of research. The duration necessary for the development and execution of experiments may restrict the range of activities that can be included in the curriculum (Smith, 2019). Time constraints may force teachers to select less complex experiments, which could restrict students' exposure to a wide range of biological topics. Time constraints may restrict the thorough examination of intricate subjects (Brown, 2021). Students may lack the opportunity to extensively explore specific subjects, leading to a superficial comprehension of biological principles. Laboratory work is a time-consuming task that might further burden teachers who already have high workloads (Johnson et al., 2020). Teachers may be required to allocate more time for the preparation of instructional materials, overseeing scientific experiments, and evaluating laboratory reports. This additional burden can

have a detrimental influence on their overall efficacy in the classroom. Ihejirika (2019) cited the enrollment of both capable and incapable students as a contributing factor to the low academic achievement in Biology. Inadequate calibre of scientific educators. Classroom with an excessive number of students. Insufficient and inadequate scientific apparatus. Excessive curriculum. Inadequate and negligent diagrams. Inadequate labelling and improper utilisation of biological terms. This clearly demonstrates the inadequate implementation of laboratory exercises in biology across Category C Senior High Schools in the Central Region.

CONCLUSION

Despite being an essential component of the SHS biology syllabus, biology practical work is not accorded the necessary level of importance. The category C senior high schools (SHS) in the central region are confronted with the most unfavourable situation of substandard biology practical practice. The primary obstacles to the effective usage of laboratory exercises in biology instruction in category C senior high schools in the central region encompass insufficient teacher motivation, excessive workload, large class sizes, and inadequate laboratory equipment and materials. Workshops are not organised for teachers to enhance their knowledge in biology

RECOMMENDATIONS

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

1. Educational planners/administrators should consistently prioritise the inclusion of laboratory exercises to facilitate the acquisition of scientific abilities by students.
2. The Ministry of Education's scientific inspectorate division, specifically the biology department, should regularly visit public schools to ensure that the facilities are being utilised for their intended objectives.
3. Science teachers should undergo additional education, attend seminars, and participate in workshops to enhance their understanding and proficiency in using the biology laboratory facilities.
4. A biology laboratory facilities manual should be issued to biology teachers to familiarise them with the proper handling of the facilities.

Conflict of Interest

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