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Students' Attitudes and Achievement During Biology Practical Lessons from Two Districts of Oti Region, Ghana

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Abstract
The purpose of this study was to determine the attitudes (expectations and reactions) and achievement of Second Year Home Economics students during biology practical lessons using Traditional Laboratory Approach (TLA) and Multimedia Laboratory Approach (MLA) in three topics in two Districts of Oti Region, Ghana. Quasi-experimental research design using pretest-posttest nonequivalent design was employed. The schools were selected based on performance in the three topics at the end of a preliminary investigation. In all, 50 students representing two intact classes participated in the study and were assigned randomly to each of the two practical approaches. Instruments used to collect data were Attitude Measuring Scale (AMS), Students' Knowledge in basic Biology Practical Concept Test (SKbBPCT) and Home Economics Students Achievement in Practical Biology Test (HESAPBT). Mean and standard deviation were calculated using IBM SPSS Statistics version 25. Results indicated that students who took part in TLA and MLA all exhibited satisfactory attitudes towards biology practical teaching and this resulted in improved performance. However, MLA group performed better than TLA group in two topics (biological drawing and orientation, section & body symmetry). It is therefore recommended that biology teachers in the two Districts be trained to use MLA to teach practical lessons for these two topics.
Keywords: Attitudes; Achievement; Teaching of Biology Practical; Multimedia Laboratory Approach; Traditional Laboratory Approach
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Introduction

Evidence exists that practical work contributes to the development of scientific concepts and must be encouraged (Chala, 2019). In countries like Greece and Ireland, biology teachers do not often use practical work due to insufficient resources (Chala, 2019). Moreover, in countries like Germany, it has been observed that resources are sufficient but practical work is routinely teacher-led which affects students' attitude towards practical (Chala, 2019). In Ghana, the concept profile dimensions highlighted in the teaching syllabus for elective biology emphasized the percentage weight to be achieved by teachers through instructions. These are, Knowledge and Comprehension 30%; Application of Knowledge 40%; and Practical and Experimental skills 30% (Curriculum Research Development Division, 2010). By this, it is clear that the elective biology syllabus pays critical attention to students' practical and experimental skills.

Meanwhile, many studies have been conducted comparing the effect of laboratory practical work with other means of conducting practical work. For example, Yager, Engen and Snider (1969) compared students' achievement, attitudes, critical thinking and knowledge of the process of science for three practical teaching approaches, namely, laboratory instructional approach, conventional demonstration and conventional discussion approach. The findings from the study showed no significant differences for the measured parameters.

According to Gott and Duggan (2009), the development of practical and experimental skills allows students to understand natural phenomena. In Ghana, studies have shown that some biology teachers have failed to engage students in frequent practical work as instructed by the syllabus. To this, challenges such as unavailability of time, negative attitudes of students and teachers, teacher characteristics, inadequate practical materials and equipment were identified (Ackon, 2014; Tordzro & Ofori, 2018; Klu & Ameyaw, 2020). In another study conducted by Imanda, Omwenga, Andima and Obuba (2020), it was admitted that practical activities are necessary ingredients for active learning but biology teachers have the challenge of using hands-on instructional approaches due to the fact that they are inexperience and lack innovation. With this, Ameka and Nyakwara (2020) suggested that biology teachers should be given the needed support to develop the needed experience and build innovative hands-on instructions relevant to students' needs.

There is a strong relationship between students' achievement in science and their attitudes towards science (Webster & Fisher, 2000). This implies that in any teaching and learning interaction, students' achievement as well as their attitudes are important and must be considered. This is one of the reasons for the Ghana Teacher

Network Educational Portal and Capacity building project with World Bank Partnership in 2013, aimed to collaborate with various teacher associations to support and maintain an educational portal where teachers, students, parents and researchers can have access to good instructional practices that would impact their attitudes positively (World Bank, 2013). In addition, this portal aimed to bridge the gap between what teachers in developed countries do with ICT in their classrooms to make their lessons interesting and what teachers in developing countries like Ghana fail to do with ICT as a major tool for educational development and transformation.

The use of educational technology has given birth to innovative approaches such as the multimedia instruction (Mayer, 2014). According to Mayer (2008), multimedia instruction refers to presenting words and pictures that are intended to promote teaching and learning. It is evident in literature that multimedia instruction promotes a large variety of teaching styles (such as laboratory science) as well as learning preferences (Cockerill, Comeau, Lee & Vinayata, 2015; Altherr, Wagner, Eckert & Jodl, 2004; de Sousa, Richter & Nel, 2017). In Ghana, as part of the Innovative Teaching for Effective Learning (ITEL) programme of work, Organisation for Economic Co-operation and Development [OECD] (2013), Centre for Educational Research and Innovation (CERI) investigated the pedagogical knowledge base of teachers and their knowledge dynamics in the teaching profession. Findings from such studies and others point to the fact that teachers are dealing with increasingly heterogeneous group of students, and therefore need to use blended method that involves multimedia to appeal to variety of learners (Klu, Ameyaw & Hordzi, 2021; Poon, 2013; Morris & Laurillard, 2015; Graham, 2013).

In view of this, and the fact that students attitudes (before and after) towards the use of multimedia laboratory approach and traditional laboratory approach of teaching biology practical in Oti Region of Ghana is not accounted for in literature, this study focused on closing that gap. To Gardner (1995), studies on attitudes towards science instructions are very important because it indicates the relationship that exists between students' attitudes and methods employed to teach them science. Also, according to Redish, Saul and Steinberg (1998), it is important to determine students' attitudes towards teaching methods because students can have attitudes that are very different and this can negatively affect how they understand and process scientific concepts.

Since there are evidences that students' attitudes play a very significant role in science conceptual understanding, this study examined the attitudes and achievements of students during biology practical lessons using multimedia laboratory approach group and traditional laboratory approach group. Specifically, the objectives were to determine the:

- attitudes of students before the use of multimedia laboratory and traditional laboratory approaches;
- performance of students before the use of multimedia laboratory and traditional laboratory approaches;
- attitudes of students after the use of multimedia laboratory and traditional laboratory approaches; and
- change in performance of students after they were taught using multimedia laboratory and traditional laboratory approaches.

Research question

The following research questions were answered by the study:

1) What were the expectations of students towards biology practical before they were taught using multimedia laboratory approach and traditional laboratory approach?
2) What were the performance of students before they were taught using multimedia laboratory approach and traditional laboratory approach?
3) What were the attitudes of students after they were taught biology practical using multimedia laboratory approach and traditional laboratory approach?
4) To what extent will students' performance in practical work improve after using multimedia laboratory approach and traditional laboratory approach in teaching?

Conceptual Framework

The study aimed to determine students' attitudes and achievement before and after using two biology practical teaching approaches (MLA and TLA). As a result, a conceptual framework was developed based on how social cognitivists view learning. According to Bandura (1989), learning is the interrelationship between behaviour, environment and personal factors. This implies that the behaviour and personal factors of learners are functions of their attitudes which affect learning. Whilst many factors influence the behaviour of students at any point in time during learning, none is more common than the methods teachers employ in teaching students. Based on this, methods teachers employ in teaching biology practical elicit certain attitudes (behaviours) among students which have the tendency to promote or hinder their conceptual understanding. As a result, it is important to determine how students felt about the teaching of biology practical using multimedia laboratory approach and traditional laboratory approach and consequently its impact on their performance in three biology practical topics. Here, the conceptual framework considered the two biology practical approaches (MLA & TLA) as independent variables that elicit certain attitudes among students. Again, it took cognizance of the change in performance of students as the dependent variable.

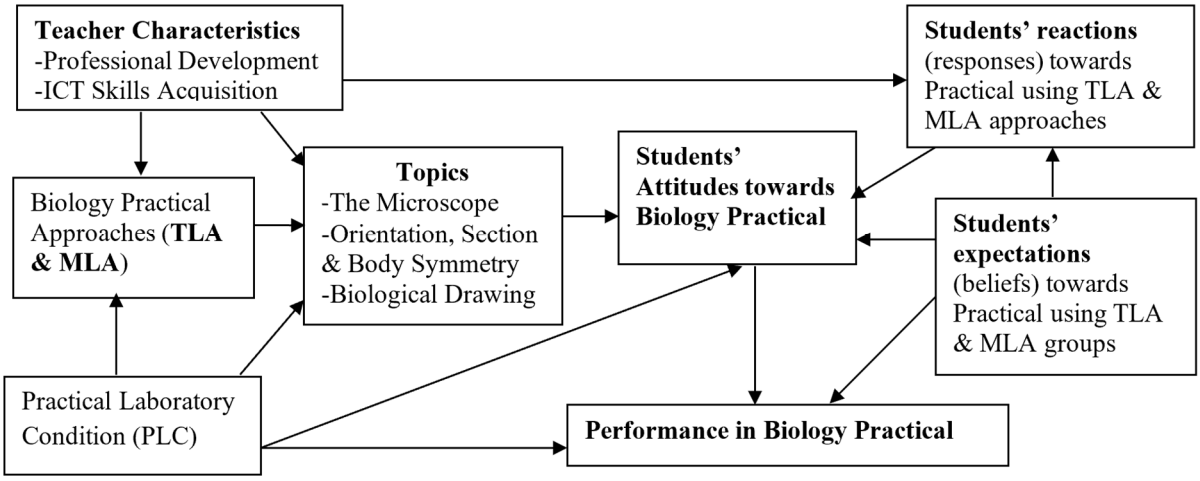

Fig 1: Conceptual Framework

Research Methodology

Scope

The study focused on Second Year Home Economics students from two schools in two Districts of Oti Region, Ghana. These schools were considered for the study because their Second Year Home Economics students could not perform creditably in some biology practical topics as established by preliminary investigations and were engaged in biology practical teaching using Multimedia Laboratory Approach (MLA) and Traditional Laboratory Approach (TLA).

Research Design: The study employed quasi-experimental research design using pretest-posttest nonequivalent design. This was because intact classes were used for the teaching process. However, the assignment of a particular school to each of the instructional pedagogies was done randomly.

Sample size and sampling

Table 1: Sample frame for the study

School	No of intact classes	Intact Class 1(IC1)		Intact Class 2 (IC2)	
		Class size	Selected	Class size	Selected
B	2	18	18	24	-
D	2	30	-	32	32
Total	**4**	**48**	**18**	**56**	**32**

Note: IC = intact class

The selection of schools as presented in Table 1 was done purposively using the following criteria: i) Poor achievement in Biology Practical Diagnostic Test (BPDT); ii) Have two or more intact classes for Home Economics Second Year students and iii) Accessibility/availability for the research. However, the selection of intact classes from each of the schools (B & D) was done randomly. Thus, in School B the class with 18 students was randomly selected while in School D, the class with class size 32 was also randomly selected. Therefore, the total number of students used for the study was 50.

Furthermore, the two classes were randomly assigned to each treatment where the 18 students from School B were assigned to Multimedia Laboratory Approach (MLA) whereas the 32 students from School D were assigned to Traditional Laboratory Approach (TLA).

Teaching exercise

The 18 students from School B (C1) were taught by the researcher using Multimedia Laboratory Approach (MLA) for a period of 120 minutes. By this approach, biology practical lessons were presented to students using audio-videos with on-screen text, still images, narrations, animations and graphics. Here, students were made to watch videos of the practical lessons and thereafter allowed to ask questions for further clarifications. Also, students had the opportunity to have a replay of sessions of the lessons as they so wished.

On the other hand the 32 students from School D (C2) were taught by the researcher using Traditional Laboratory Approach (TLA) for a period of 120 minutes. By this approach, biology practical lessons were presented to students through hands-on activities with real or improvised bio-specimens and equipment for manipulation and observation of processes in the laboratory. Here, students were made to either engage in

individual or group practical activities after they had been provided with instructions and relevant demonstrations on the practical activities.

Instruments and data collection

a) Pretest: This test was captioned as "Students' Knowledge in basic Biology Practical Concept Test (SKbBPCT)". It comprised 30 items classified into 4 sections (A = 10: Multiple-choice questions, B = 9: Short-answer questions, C = 10: True or false questions and D = 1 Essay type question) with a total score of 50 marks and was administered by the researcher together with the class teachers at the beginning of treatment for a period of 1 hour.

b) Posttest: This test was captioned as "Home Economics Students' Achievement in Practical Biology Test (HESAPBT)". It was the same as the pretest but the test items were retrieved from the students immediately after the pre-test and the questions re-shuffled to help address the issue of familiarity.

c) Attitude Measuring Scale (AMS): This scale measured students' attitudes using 2 indicators (expectations and reactions) towards biology practical. It was adapted from Neidt (1964), and comprised 24 items which were arranged in the Likert scale format with four (4) levels (Strongly Disagree [DA] = 1, Disagree [D] = 2, Agree [A] = 3 and Strongly Agree [SA] = 4). The items were distributed such that 12 measured students' attitudes before practical teaching and the other 12 measured students' attitudes after practical teaching.

Validity and Reliability of Instruments

All instruments were validated using standard measures to check for clarity, appropriateness, correctness and commensuration of questions with the topic of the research as proposed by Robson (2011). Also, to ensure that the instruments produced scores that are stable and consistent, they were pilot-tested in a third school of equal standard and reliability coefficient determined. Here, Attitude Measuring Scale (AMS) and HESAPBT yielded 0.82 and 0.84 Cronbach's Alpha coefficient estimated values respectively.

Control of Extraneous Variable

To avoid errors due to differences in teacher characteristics, the researcher himself did the teaching in the two schools. However, the regular class teachers were trained to use the various approaches in teaching students at the end of the study.

To deal with errors introduced by Student-Student interactions, only one intact class was selected from each of the schools for the practical teaching. This was to avoid the students mixing up and exchanging ideas which would eventually affect the results of the study.

Data collection

The Students' Knowledge in basic Biology Practical Concept Test (SKbBPCT) was administered by the researcher together with the class teachers at the beginning of the teaching process for a period of 1 hour. Thereafter, the question papers were retrieved from the students. This was to prevent the students from going through the questions after the test to become familiar with the test items. The post-test (HESAPBT) was administered by the researcher together with the class teachers at the end of treatment for a period of 1 hour.

In order to measure the attitudes of the students using Attitude Measuring Scale (AMS**), t**he students were informed of the various approaches (MLA or TLA) in their groups and allowed 30 minutes to respond to the items that measured their attitudes before biology practical teaching. Also, students were allowed 30 minutes after practical teaching to respond to AMS items that measured their attitudes after teaching. The instruments were retrieved by the researcher together with the class teachers. In all, there was 100% retrieval of all instruments.

Data analysis

Quantitative data from the study were analyzed using IBM SPSS Statistics version 25. Specifically, arithmetic mean and standard deviation were used. The numeric values assigned to different scaling items used were SA=4, A=3, D=2, SD=1. Therefore, the mean for these values was determined and the cut-off point is 2.5. Any item that has a mean score of 2.5-3.4 is accepted while a mean score below 2.5 is rejected and a mean score above 3.5 is strongly accepted. The pre-and post-teaching mean changes in performance were determined by subtracting the mean scores of the TLA from that of the MLA. After that the mean differences for the changes in performance were calculated.

Results and discussion

Research Question 1

This research question which stated "**What were the attitudes of students towards biology practical before they were taught using multimedia laboratory approach and traditional laboratory approach?**" was answered by findings as presented in Table 2.

Table 2: Students' attitudes before the use of TLA & MLA

S/N	Item	Group	N	Mean	SD	Decision
1.	Practical lesson presentations will exceed my expectation	MLA	18	2.6	1.24	Accepted
		TLA	32	2.8	1.05	Accepted
2.	Practical lesson will improve my understanding of biology	MLA	18	2.6	1.14	Accepted
		TLA	32	3.0	1.12	Accepted
3.	I will be able to follow instructions	MLA	18	2.7	1.27	Accepted
		TLA	32	2.7	1.25	Accepted
4.	The teacher will spend enough time to demonstrate practical activities	MLA	18	2.8	1.26	Accepted
		TLA	32	3.1	.91	Accepted
5.	I will be glad to wait for the next practical lesson	MLA	18	2.6	1.29	Accepted
		TLA	32	3.3	.96	Accepted
6.	I will be encouraged to study biology	MLA	18	2.7	1.23	Accepted
		TLA	32	3.2	.91	Accepted
7.	I will be able to enjoy practical lessons as I expect	MLA	18	2.1	1.23	Rejected
		TLA	32	1.6	.71	Rejected
8.	I will ask questions during practical lessons	MLA	18	2.2	1.06	Rejected
		TLA	32	1.9	.95	Rejected
9.	Teacher will give me the needed attention	MLA	18	1.8	1.15	Rejected
		TLA	32	2.1	1.09	Rejected
10.	I will be able to follow instructions	MLA	18	2.2	1.20	Rejected
		TLA	32	2.0	1.12	Rejected
11.	Lesson will help me develop interest for biology	MLA	18	2.1	1.16	Rejected
		TLA	32	2.1	1.19	Rejected
12.	I will be satisfied with time spent on practical lessons	MLA	18	2.5	1.25	Accepted
		TLA	32	2.4	1.16	Rejected

From Table 2, students admitted that practical lesson presentations in both groups will exceed their expectation, improve their understanding of biology, enable them to follow instructions, experience enough teacher demonstration time, build the interest to wait for the next practical lesson, and be encouraged to study biology. This implies that students' have specific expectations of practical teaching that will positively impact their overall educational experience. According to Jackson, Helms and Ahmadi (2011), it is important to meet these specific expectations of students because that is one of the core educational processes that can impact students' overall educational experience. To this, Williams and Williams (2011) in their study concluded that when students' expectations are addressed, they become happy, pay attention, begin to work on task immediately, ask questions and volunteer answers, and they are eager to learn.

Again, the results revealed that students were not sure they will be able to ask questions, receive the needed attention, follow instructions and develop interest for biology. According to Driscoll (2011), these uncertainties in expectations are mostly due to how much knowledge students have acquired from their earlier interactions. By this, students expect more from the biology practical teaching methods to be able to build generally positive attitudes towards them. Tracey-Ann, Burke and Aubusson (2017) revealed that teachers are relatively influential in the determination of students' satisfaction and must be encouraged to do so. To Walsh, Owen, Mustafa and Beech (2020), teaching methods need to be autonomy-oriented and well-organized to help elicit positive attitudes among students.

Also, responses from students in both groups on their expectations towards satisfaction with time-on-task showed that, MLA group expected to be satisfied with time-on-task whilst TLA group was not sure they would be satisfied. By this and the fact that students were earlier introduced to biology practical teaching using the traditional method, they were not satisfied with the period of time allocated for its use.

Research Question 2

Here, the research question which was stated as "**What were the performance of students before they were taught using multimedia laboratory approach and traditional laboratory approach?"** has its results presented in Table 3.

Table 3: Performance of students before using TLA & MLA

Topic	MLA Approach			TLA Approach		
	N	Mean	SD	N	Mean	SD
M	18	4.28	1.776	32	3.06	1.605
OSS	18	4.61	2.004	32	4.56	1.703
BD	18	2.67	2.890	32	2.84	1.886

***Note*:** M: Microscope; OSS: Orientation Section and Body Symmetry; BD: Biological Drawing

Based on the findings as presented in Table 3, students in both TLA and MLA groups did not perform creditably in the three topics. However, their performance in both groups showed similar baseline characteristics in the topics Orientation, Section and Body Symmetry and Biological Drawing. Also, for the topic microscope, students in MLA group showed better performance than those in TLA group.

Research Question 3

This research question which was stated as "**What were the attitudes of students after they were taught using multimedia laboratory approach and traditional laboratory approach?**" was answered by the findings in Table 4.

Table 4: Students' attitudes after the use of TLA & MLA

S/N	Item	Group	N	Mean	SD	Decision
1.	Practical lesson presentations exceeded my expectation	MLA	18	2.8	1.26	Accepted
		TLA	32	3.5	.71	Strongly Accepted
2.	Practical lesson improved my understanding of biology	MLA	18	2.9	.99	Accepted
		TLA	32	3.1	1.05	Accepted
3.	I was not able to follow instructions	MLA	18	1.9	.99	Rejected
		TLA	32	1.8	.64	Rejected
4.	The teacher did not spend enough time to demonstrate practical activities	MLA	18	2.1	1.10	Rejected
		TLA	32	1.5	.84	Rejected
5.	I was not happy to wait for the next practical lesson	MLA	18	2.4	1.33	Rejected
		TLA	32	1.8	.84	Rejected
6.	I was encouraged to study biology	MLA	18	3.1	1.16	Accepted
		TLA	32	3.2	1.03	Accepted
7.	I was able to enjoy practical lessons as expected	MLA	18	2.5	1.20	Accepted
		TLA	32	2.8	1.11	Accepted
8.	I was able to ask questions during practical lessons	MLA	18	2.8	1.06	Accepted
		TLA	32	2.8	1.12	Accepted
9.	The teacher gave me the needed attention	MLA	18	2.7	1.19	Accepted
		TLA	32	3.3	.81	Accepted
10.	I was not able to interact with my colleagues during practical	MLA	18	2.0	1.03	Rejected
		TLA	32	1.8	1.11	Rejected
11.	Lesson did not help me to develop interest for biology	MLA	18	1.8	.92	Rejected
		TLA	32	2.0	1.02	Rejected
12.	I was satisfied with time spent on practical lessons	MLA	18	2.2	1.35	Rejected
		TLA	32	2.1	1.09	Rejected

From the findings as presented in Table 4, students' responses to items 1 and 2 indicate that their expectations

were exceeded, and their understanding of biology was improved. According to Pedro, Mendes and Lourenço (2018), there is ample anecdotal evidence that teaching processes influence students' satisfaction. To this, the results of items 1 and 2 showed that both teaching methods influenced students' satisfaction positively. However, TLA did better because of the presence of physical materials/equipment and students' familiarity with the teaching method. This agrees with Pedro, Mendes and Lourenço (2018) that students' satisfaction is clearly linked to the presence of physical facilities during teaching and learning.

Further, the findings showed that students were able to follow instructions, the teacher spent enough time to demonstrate practical activities, they were happy to wait for the next practical lesson, encouraged to study biology, able to enjoy practical lessons as expected, able to ask questions during practical lessons, and the teacher gave them the needed attention during the teaching using MLA and TLA. These findings agree with what Nyathi and Sibanda (2022) intimated that students' levels of satisfaction could be influenced by their active participation through learner-learner and learner-facilitator interactions. Again, the findings agree with Derakhshandeh, Vora, Swaminathan and Esmaeili (2023) that students' interactions help to facilitate and promote effective teaching and learning.

To Williams and Williams (2011), when students are satisfied with teaching, they pay attention, work on task immediately, ask questions, volunteer answers, appear happy and eager to learn. Practically, the results of this study revealed that students in both groups had the opportunity to interact with each other (learner-learner interaction) and also their teacher (teacher-learner interaction) and these helped them to develop interest for biology. According to Nyathi and Sibanda (2022), learner-learner interaction helps to build students' satisfaction and prevent lukewarm attitudes towards teaching and learning. Again, research revealed that when students interact effectively with each other during lessons, they learn as much, or more from each other and are able to develop positive attitudes towards subject interest and understanding (Bower, 2003; Palloff & Pratt, 2001; Martinez-Caro & Campuzano-Bolarin, 2011).

The findings also revealed that students were not satisfied with time-on-task which was 120 minutes as required by the teaching syllabus. This implies that students are of the view that the time-on-task must be reviewed upwards.

Generally, students who benefited from MLA and TLA were all satisfied to a large extent about the two methods of teaching. It can be deduced that on large scale there were not enough differences between their responses. This suggests that both methods are very useful in changing the attitude of students and thus boosting their interest in biology. This can help in promoting teaching and learning of biology practical. The findings of this agree with Sinatra and Mason (2013) when they posited that students have attitudes and these attitudes affect their conceptual development and satisfactory performance. For Morrison and Lederman (2003) in a study on how to improve students' performance, it came to the fore that students believed that teachers should be encouraged to pay attention to their attitudes and adjust teaching and learning techniques.

Research Question 4

The results for research question 4 which states "**To what extent will students' performance in practical work improve after using multimedia laboratory approach and traditional laboratory approach in teaching?"** are presented in Table 5.

Table 5: Change in performance of students after the use of TLA & MLA

Topic	MLA Approach			TLA Approach			Mean difference
	N	Mean	SD	N	Mean	SD	
M	18	11.06	2.127	32	10.41	1.998	0.65
OSS	18	11.22	2.602	32	9.94	2.747	1.28
BD	18	9.67	1.715	32	8.31	2.023	1.36

Note: M: Microscope; OSS: Orientation Section and Body Symmetry; BD: Biological Drawing

As seen from Table 5, students' performance in both TLA and MLA improved in the three topics (M, OSS & BD) taught. However, students who were taught using MLA approach performed better in all cases. This is evident from the mean differences where they are all positive. This implies that MLA approach was better in enhancing students' understanding of biology practical lessons than TLA approach.

Conclusions

The findings revealed that students exhibited both positive and negative attitudes towards biology practical teaching regardless of the approach (TLA or MLA) before the teaching was done. Also, before these approaches were used, students had specific positive attitudes that undergirds their general satisfaction towards practical biology teaching and this must be harnessed for effective teaching and learning. A further revelation of the study is that majority of the students could not perform well in the topics used for the teaching before the two methods were used. The scores also revealed that students from the two schools were of similar standard before the teaching was done. Deducing from the findings, it can be concluded that the use of MLA and TLA drastically improved the

attitudes of the students which subsequently contributed to their better performance after the teaching. However, it can be said that the use of MLA can bring about better understanding of biological practical lessons because in this study students who benefited from the MLA approach scored higher marks than those who benefited from the use of TLA. Thus, MLA is more suitable for teaching Microscope, biological drawing and orientation section & body symmetry than TLA.

Educational Implications and Recommendations

The findings of the study have implications for practice and further research. For practice, Biology teachers in the two Districts of Oti Region should be trained and encouraged to use Multimedia Laboratory Approach in the teaching of microscope (M), biological drawing (BD) and orientation section and body symmetry (OSS) because there is empirical evidence that MLA has the ability to induce positive attitudes which leads to enhanced performance in the topics. To this end, headmasters in the various schools in the two districts should assist biology teachers by providing them with the necessary ICT infrastructure support system. Furthermore, biology teachers who cannot afford the necessary ICT facilities for MLA approach in the districts should be encouraged to continue using the traditional laboratory approach in teaching biology practical particularly during the teaching of the three topics. For research, a follow-up study in other regions of Ghana which would include more biology practical topics from the senior high school syllabus is recommended.

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