

Journal of

Education and Practice

(JEP)

Effect of Multimodal Instructional Approach on Students' Academic Performance in The Concept of Biological Classification

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Abstract

Purpose: This study investigated the effect of Multimodal Instructional Approach on students' academic performance in the concept of Biological Classification at Navrongo Senior High School, generally, and on gender basis.

Methodology: The study adopted quasi-experimental research design. The sample comprised of 100 Navrongo Senior High School Form Two Gold Track and Green Track science students. Students from the Gold Track and Green Track were designated experimental group and control group respectively. Each group was made up of 25 males and 25 females. Pretest was administered to all the participants. The experimental group was taught using Multimodal Instructional Approach. The control group was taught using Discussion as the teaching method. A posttest was administered to both groups to determine the effectiveness of the treatment. The reliability of the test items was determined using test-retest reliability coefficient. The test-retest reliability coefficients of the instruments were found to be 0.73 and 0.78 for the pretest and posttest respectively. The data obtained were analysed using independent sample t-test.

Results: The pretest test scores revealed that the students were homogeneous in terms of performance. Posttest results of students in the experimental group were significantly higher than the control group. There was no significant difference in the performance of males and females. The results of the posttest revealed that the use of MIA in teaching biological classification was more effective than discussion method.

Unique contribution to theory, practice and policy: This study recommended that Biology teachers in NSHS should be encouraged to teach Biological Classification using MIA in order to improve the academic performance of both male and female students. School authority should invite educational technologists, instructional materials technicians and computer experts to help science teachers of NSHS on how to incorporate ICT in teaching science subjects.

Keywords: *Biological Classification, Living Organisms, Multimodal Instructional Approach (MIA)*

1.0 INTRODUCTION

The method of instruction is very essential when teachers want the academic performance of their students to be improved. For several years, the lectured method of teaching has been the most widely used instructional approach in senior high schools in Ghana. This method of instruction does not help to develop critical thinking and creativity in students (Azure, 2018).

Development of instructional strategies to improve the teaching and learning of Biology at the Senior High School should be a major concern for Biology tutors in order to improve upon the academic performance of students. The classroom consists of students with different learning styles and they feel comfortable, learn and perform better when learning in environments that cater for their predominant learning styles (Mayer, 2010). Teachers need to take this into consideration during teaching in order to meet the needs of all students in the class.

All students have different learning styles and the function of the teacher is to identify these learning styles and find instructional strategies that will match their preferred learning style in order to enhance effective teaching and learning (Olufunmiyi, 2015).

With the introduction of Information Communication Technologies (ICTs) in the teaching and learning process, teachers can now design instructional approaches that have the capability of motivating students to learn better and improve on their academic achievement.

Proper planning of teaching methods is very necessary in order to achieve the learning goals and come up with the desired learning outcomes. The increasing use of multimedia in teaching has provided many opportunities to present multiple presentations of content (text, video, audio, images and interactive elements) to cater more effectively to the different learning styles and modal preferences of an increasing diverse student body (Sankey, Birch, & Gardiner, 2010). Multimodal learning environment allows instructional elements to be presented in a variety of presentation modes that lead learners to perceive that it is easier to learn to improve upon performance (Mayer, 2010). It has also been observed that presenting information in a variety of modes may also encourage students to develop more versatile approach to learning (Sankey *et al*, 2010).

An American Educator, Edgar Dale (27th April, 1900-8th March, 1985) found out that people remember 10% of what they read, 20% of what they hear, 30% of what they see, 50% of what they hear and see, 70% of what they say and write and 90% of what they see as they do a thing (Shabiralyani, Hasan, Hamad, & Iqbal, 2015). This is an indication that instructional strategies that give room for students to use more than one of their senses in learning will lead to better understanding of the concept presented to them and will finally result in significant improvement in their academic achievement.

Multimodal Instructional Approach (MIA) arouses students' interest, increases students' motivation, improves students' attention and improves students' understanding of concepts (Gilakjani, Ismail, & Ahmadi, 2011). Thus, MIA allows students to experience learning in ways in which they are most comfortable, while challenging them to experience and learn in other

ways as well (Picciano, 2009). Learners are not the same in abilities, skills, interests and styles in terms of learning (Ganapathy & Seetharam, 2016). Therefore, there is the need for Biology tutors to vary their instructional approaches in order to cater for the diverse learning needs of learners in the class.

One of the major problems facing science education in Ghana is the inability of science teachers to design pedagogical strategies that will help students understand concepts in science and also improve upon their performance (Bawa, 2018). MIA can be effective for all students with different learning abilities as individual differences can be overcome in learning through different media (Aggarwal, 2018).

According to Ogunkula and Samuel (2011), one of the key factors in facilitating meaningful learning of biological concepts is the use of effective and efficient teaching methods by teachers. Therefore, there is the need for biology teachers to design instructional methods that would promote better understanding of biology concepts for the improvement of students' academic performance. MIA which is the integration of different stimulus modes of instructions such as realia, visual, analogy, symbols and interaction within the same text to represent scientific ideas, reasoning and findings could be effective in improving students learning (Bawa, 2018).

Multimodal presentation is used to support the verbal instructional materials (examples, printed words) and the corresponding visual instruction materials (examples, illustrations, photos, videos and animations) in the interactive instructional activity (Kuo, Yu, & Hsiao, 2013). MIA involves the use of multimedia and ICT to develop dynamic resources that help to cater for diverse learning styles of students. Multimedia elements which include text, graphics, sound, video and animation help in the creation of an interactive learning environment that can help teachers' teaching and students' learning (Akinoso, 2018). MIA can be used to develop a curriculum that appeals to visual, aural, audio-visual and kinesthetic learners and overcome differences in students' performance that may result from different learning styles (Gilakjani, Ismail, & Ahmadi, 2011).

1.1 Statement of the Problem

In this study the effectiveness of MIA approach on Senior High School (SHS) science students' academic performance in the concept of Biological Classification was investigated. Classification of living organisms is also considered to be a difficult topic to understand. The difficulties faced by students in classifying living organisms came up during the researcher's discussion with Biology teachers from Zamse SHS, Bolgatanga SHS, Bolgatanga Girls SHS and Zuarungo SHS in the Upper East Region of Ghana. Biology tutors from these schools complained that their students often performed poorly in classifying living organisms. Classification of living organisms is an examinable topic in the West African Senior High School Certificate Examination in Biology paper one, two and three (practical paper) yet less attention has been given to developing strategies to eliminate these difficulties, to correct misconceptions and to improve students' academic performance in classification of living organisms.

The performance of students in Biology and particularly classification of living organisms has been generally poor (Wafula & Odhiambo, 2016). The West African Examination Council Chief Examiners' Report (WAEC, 2018) stated that a good number of candidates lost marks in biology

in the West African Senior School Certificate Examination (WASSCE) in the concept of biological classification. The Chief Examiner stated that one of the general weaknesses of students was their inability to classify specimens.

The instructional strategies used in teaching classification of living organisms in Biology at the SHS seem not to have a positive effect on the academic performance of students. The mode of teaching biological concepts in SHS whereby Biology teachers adopt only the lecture or teacher-centered method without multimodal incorporation does not help to improve the academic performance of students (Aggarwal & Dutt, 2014). Multimodal Instructional Approach (MIA) has been used by Bawa (2018) in teaching chemistry concepts in some selected Colleges of Education in Ghana. The author confirmed that students who were taught using MIA had a positive attitude towards the subject than those who were taught using Traditional Instructional Approach. Bicomong, Rosa, Abedes, and Dellosa (2015) also conducted a study on the use of Multimodal Instructional Approach in teaching Algebra (Measurement) of Grade 7 in Camp Vicente Lim National High School S.Y. 2014-2015. One of the findings of the authors was that students who were taught using Multimodal Instructional Approach performed far better than those who were taught using lecture method. Despite the effectiveness of this instructional approach, the effect of MIA on students' academic performance in the concept of biological classification and Biology in general has not been documented in Ghana. It is against this background that the researcher deemed it necessary to investigate effect of MIA on SHS Form Two science students' academic performance in the concept of biological classification at Navrongo Senior High School (NSHS) in the Upper East Region of Ghana.

1.2 PURPOSE OF THE STUDY

This study was conducted to determine the effect of multimodal instructional approach on Form Two science students' academic performance in the concept of Biological Classification at NSHS.

1.3 Objectives of the Study

The objectives of the study were to:

1. Determine the difference between the pretest mean scores of students in the control group and the experimental group.
2. Examine the difference between the posttest mean scores of the experimental and control groups.
3. Examine the difference between the pretest and posttest mean scores of male and female students in the experimental and control groups.

1.4 Research Questions

The following research questions were addressed in the study:

1. What is the difference between the pretest mean scores of students in the experimental group and the control group?
2. What is the difference between the posttest mean score of the experimental group and the control group?

3. What are the differences between the pretest and posttest mean scores of male and female students in the experimental and control groups?

1.5 Research Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

HO₁. There is no significant difference between the pretest mean scores of students in the experimental group and the control group.

HO₂. There is no significant difference between the posttest mean score of students in the experimental group and those in the control group.

HO₃. There is no significant difference between the pretest and posttest mean scores of male and female students in the experimental and control groups.

1.6 Significance of the Study

1. The findings of the research will serve as a reference material to science teachers in NSHS.
2. Other Biology teachers in NSHS may adopt similar approach in teaching Biology concepts.
3. The study will contribute to existing body of knowledge in the concept of classification of living organisms.

2.0 LITERATURE REVIEW

2.1 Theoretical review

2.1.1 Cognitive Theory of Multimedia Learning (CTML)

The theory that underpinned this study is the cognitive theory of multimedia learning proposed by Richard E. Mayer in 2007 and other cognitive researchers such as Sorden, Sweller, Clark, and Moreno. The cognitive researchers assert that multimedia learning supports the way the human brain retains information. Mayer (2009) posits that the cognitive theory of multimedia learning is centered on the idea that learners attempt to build meaningful connections between words and pictures and that students learn more deeply than they could have with words or pictures alone. Mayer (2010) asserts that words include spoken and written text and pictures include images, charts, diagrams, animations, videos, photos and illustrations. Simhachalam (2016) discovered that the cognitive theory of multimedia learning is based on three assumptions about the nature of human learning thus the channel assumption, the limited capacity assumption and the active learning assumption. The cognitive theory of multimedia learning accepts a model that includes three components; sensory memory, working memory and long term memory.

This theory is relevant to the study because it supports the idea that the use of words and pictures during instruction process allows the brain to process more information in the working memory. The classroom consists of students with different learning needs and hence presenting information to learners through different modes (verbal, visual, audio-visual and tactile) help to cater for the diverse learning needs of learners. Chen and Fu (2003) posit that multimodal

presentation makes students feel that it is easy to learn and improve attention, thus leading to improve learning performance of even lower achieving students.

This theory provides backing to the study because it enables teachers to present content knowledge to students in more than one mode which helps the instructor to get adequate attention of the learners and achieve their teaching objectives. Gilakjani (2011) asserts that each mode contribute to meaning construction; an image on the board to get a visual backdrop, manipulation of the object to locate the discussion in the physical setting, action to make clear the dynamic nature of the concept and the image on the textbook to do a stable summary. Li and Kang (2014) indicated that the application of multimedia to classroom teaching helps to enlarge the amount of classroom information, enrich teaching content, enhance interactivity between teacher and student, increase teacher competence and as a result help teachers achieve their teaching objectives. This theory offers an alternative form of pedagogy and innovation that speed up the teaching efficacy and promotes the effectiveness of teaching.

2.2 Empirical review

Thomas and Israel (2014) investigated the effectiveness of animation and multimedia teaching on students' performance in science subjects. 100 students were randomly selected for the study. The findings of the study revealed no significant difference between male and female students taught using animation and multimedia.

Similarly, Satyaprasha and Sudhanshu (2014) studied effect of multimedia teaching on students' achievement in Biology. A total of 77 participants were sampled for the study. The findings of the study revealed that multimedia teaching enhanced students academic achievement with respect to knowledge, understanding, application and total achievement in Biology in comparison to traditional method. The findings further proved that effective use of multimedia improved that academic performance of both male and female students equally in Biology. Aggarwal and Dutt (2014) studied effectiveness of multimedia presentation in acquisition of biological concepts with 120 students (60 boy and 60 girls) at two secondary schools in Chandigarh. The findings revealed that students who were taught through multimedia presentation achieved significantly higher than those who were taught through conventional method. Contrary to the findings of Thomas and Israel, (2014), Satyaprasha and Sudhanshu, (2014), the results of Aggarwal and Dutt (2014) revealed that the academic performance of boys is significantly higher than girls taught using animation and multimedia.

2.3 Research Gaps

Few studies have been reported cross the globe such as: "Develop and evaluate the effect of multimodal presentation system on students in Taiwan" by Kuo et al. (2013), "The use of multimodal approach in teaching algebra (measurement) of grade 7 in Camp Vicente Lim National High Schools" by Bicomong et al. (2015), "Effect of the use of multimedia on students performance in Secondary Schools in mathematics in Lagos State" by Akinoso (2018), "Effect of multimodal approach on achievement in Biology in IX grade students in relation to their learning styles in Amritsar City" by Aggarwal (2018) and "Effectiveness of multimedia teaching in achievement of VIII students in Biology at Bangabore, Karnataka" by Satyaprakash and Bahera (2014). The only study reported in Ghana is "Effect of multimodal instructional approaches on

students learning of Chemistry concepts in selected Colleges of Education in Ghana” by Bawa (2018). No studies have investigated the effect of multimodal instructional approach on students’ academic performance on the concept of biological classification. In order to address this gap in the literature, this study focuses on the effect of multimodal instructional approach on students’ academic performance in the concept of Multimodal Biological classification.

3.0 METHODOLOGY

3.1 Research Design

Quasi-experimental design was adopted for the study. This design made use two groups, control group (X) and experimental group (Y). The groups were similar in academic performance before they were exposed to the treatment. The experimental group was taught using Multimodal Instructional Approach and the control group was also taught using Discussion Method of teaching. The layout for the study is as follows:

Control Group X; O₁ X O₂

Experimental Group Y; O₃ Y O₄

Where; O₁, O₃; Pretest performance of students in the control and experimental groups;

O₂, O₄; Posttest performance of students in the control and experimental groups;

X represents Discussion method of teaching; and

Y, the Multimodal Instructional Approach

3.2 Population and Sample

The study was conducted at Navrongo Senior High School in the Kassena Nankana Municipality in the Upper East Region of Ghana. The population for the study included all Form Two General Science programme students of the Gold and Green tracks. The sample for the study was 100, comprised of 25 males and 25 females of the Gold Track, designated the experimental group. Another 25 males and 25 females of the Green Track served as control group.

3.3 Data Collection Instruments

The instruments used for data collection were pretest and posttest using past WAEC questions on Biology from 1993 to 2018 which were found to be relevant to the content taught.

The data were collected by the researcher before and after treatment for four weeks. Biological Classification Performance Test (BCPT) pretest was given to both the control and experimental groups before treatment. BCPT posttest was administered to both groups immediately after four weeks of intervention. The control group was taught using DM and the experimental group was also taught using MIA. Students in the experimental group were taught using real specimens, diagrams and images of specimens, videos and illustrations. Both groups were taught by the researcher. All lessons plans were prepared by the researcher on the following: Kingdom Animalia; Kingdom Fungi; Kingdom Plantae; Kingdom Prokaryotae; and Kingdom Protocista

BCPT was given before and after intervention. The pretest and posttest were made up of forty test items each. Each test was divided into two sections, A and B. Section A was made up of

thirty multiple choice questions. Each item had one key and three distractors which reflected students' misconceptions in Biological Classification. Section B was made up of 10 short answer type questions. The pretest items offered to the students before the treatment were different from the posttest items.

The instruments for data collection were given to two Biologists, Senior lecturers at the University of Education, Winneba and two WAEC Biology examiners to help establish their validity. The test items were pilot tested and the reliability of the items were determined using test-retest reliability coefficient. The test-retest reliability coefficients were found to be 0.73 and 0.78 for pretest and posttest respectively which were high enough to make the instruments reliable.

4.0 FINDINGS AND PRESENTATION

The data collected from the students' scores were analysed using descriptive statistics (mean and standard deviation) and inferential statistics (independent student t-test) to test the null hypotheses at the significant level of 0.05, using Microsoft Excel 2010.

4.1 Research Question 1. What is the difference between the pretest mean score of student in the experimental group and the control group?

Table 1: T-test summary of pretest means score of students in the control and experimental groups

Group	N	Mean	SD	df	t-value	p-value	Remarks
Control	50	30	3.82	98	0.29	0.57	Not Significant
Experimental	50	30.2	3.23				

Source: Field data, 2020

Significant level = 0.05

df=degree of freedom

Table 1 is a summary of the pretest mean scores of students in the control and experimental groups. From Table 1, the pretest means score of students in the control group was similar to that of the experimental group. Thus, the mean score of the control group was 30 with a standard deviation of 3.82 whilst that of the experimental group was 30.2 with a standard deviation of 3.23. The difference between the means was 0.20. To see if there was any significant difference between the mean scores, a hypothesis was used.

4.1.1 Analysis of Research Hypothesis One

Research hypothesis 1: There is no significant difference between the pretest mean scores of students in the experimental and control groups.

From Table 1, the t-value, and p value are $t = 0.29$ and $p = 0.57$. Since the $p > 0.05$, it means that there was no statistically significant difference between the pretest means scores of students in the experimental and control groups. In the light of this, the null hypothesis was accepted. This indicated that the two groups selected for the study were similar since there was no difference in their academic performance.

4.2 Research Question 2. What is the difference between the posttest mean scores of the experimental and control groups?

Table 2: T-test summary of posttest means score students in the control and experimental groups

Group	N	Mean	SD	df	t-value	P-value	Remarks
Control	50	41.06	4.45	98	13.46	0.000	Significant
Experimental	50	51.56	3.68				

Source: Field data, 2020
 Significant level = 0.05
 df= degree of freedom

Table 2 is a summary of the posttest results of the students in the control group and those in the experimental group. From Table 2, the posttest mean score of students in the control group was 41.06 with a standard deviation of 4.45 while the posttest mean scores of students in the experimental group was 51.56 with a standard deviation of 3.68. The mean difference between students in the experimental group and the control group was 10.5 which indicated that the performance of students in the experimental group was better than their counterparts in the control group. To test for significant difference between the mean scores, a hypothesis was used.

4.2.1 Analysis of Research Hypothesis Two

Research Hypothesis 2: There is no significant difference between the posttest mean score of students in the experimental and control groups.

From Table 2, the t- value, and p-value are $t = 13.46$ and $p = 0.000$. The p-value was less than 0.05. This showed that the mean score of students in the experimental group differed significantly from those in the control group. The null hypothesis was rejected and the alternative hypothesis was accepted. Therefore, there was a significant difference between the posttest mean scores of students in the experimental group and those in the control group. By implication, the students that were taught using MIA outperformed the students that were taught using discussion method as a teaching method. This is an indication that the treatment given to the students in the experimental group was effective and responsible for the difference in the performance in favour of the experimental group.

4.3 Research Question 3. What are the differences between the pretest and posttest mean scores of male and female students in the experimental and control groups?

Table 3a: T-test summary of the pretest of male and female students in the experimental group

Gender	N	Mean	SD	df	t-value	p-value	Remarks
Male	25	30	3.25	48	0.43	0.66	Not Significant
Female	25	30.4	3.27	48			

Source: Field data, 2020
 Significant level = 0.05
 df = degree of freedom

Table 3a is a summary of the results of the pretest of male and female students in the experimental group. From Table 3a, the pretest mean score of the male students in the experimental group was 30 with a standard deviation of 3.25 while the female students in the same group had a mean of 30.4 with a standard deviation of 3.27. The difference between the means was 0.40, an insignificant figure. To see if there was any significant difference between the mean scores, a hypothesis was used.

4.3.1 Analysis of Research Hypothesis 3a

Research Hypothesis 3a: There is no significant difference between the pretest mean score of the male and female students in the experimental group.

From Table 3a, the t-value, and p-value are $t = 43$ and $p = 0.66$. The p-value was greater than 0.05. In the light of this result, the null hypothesis was retained. The result of the test suggested that there was no statistically significant difference between the pretest means score of male and female students in the experimental group. This indicated that both male and female students in the experimental group were similar in academic performance since there was no significant difference in their academic performance.

Table 3b: T-test summary of the posttest of male and female students in the experimental group

Gender	N	Mean	SD	df	t-value.	P-value	Remarks
Male	25	51.84	3.69	48	0.55	0.54	Not Significant
Female	25	51.24	3.72				

Source: Field data, 2020

Significant level = 0.05

df= degree of freedom

Table 3b is a t-test summary of the results of the posttest of male and female students in the experimental group. From Table 3b, the posttest mean score of the male students in the experimental group was 51.84 with a standard deviation of 3.69 while the female students in the experimental group had a mean of 51.24 with a deviation of 3.72. The mean difference between the two groups was 0.60. To see if there was any significant difference between the mean scores, a hypothesis was used.

4.3.2 Analysis of Research Hypothesis 3b

Hypothesis 3b. There is no significant difference between the posttest mean scores of the male and female students in the experimental group.

From Table 3b, the t-value and p-value are, $t = 0.55$ and $p = 0.54$. Since $p > 0.05$, it indicates that there was no significant differences between the posttest mean scores of the male and the female students in the experimental group. In the light of this, the null hypothesis was retained. Therefore, sex is not a major issue in learning and understanding concepts in biological classification when taught using MIA. This indicated that the use of MIA in teaching Biological classification is effective to both male and female students since the performance of the male and female students were similar.

Table 3c: T-test summary of the pretest of male and female students in the control group

Gender	N	Mean	SD	df	t-value	p-value	Remarks
Male	25	30.2	4.49	48	0.73	0.49	Not Significant
Female	25	29.8	3.09				

Source: Field data, 2020

Significant level = 0.05

df= degree of freedom

Table 3c is a t-test summary of the results of the pretest of male and female students in the control group. From Table 3c, the pretest mean score of male students in the control group was 30.2 with a standard deviation of 4.49 while the pretest mean score of female students in the control group was 29.8 with a standard deviation of 3.09. The mean difference between the two groups was 0.40. To see if there was any significant difference between the mean scores, a hypothesis was used.

4.3.3 Analysis of Research Hypothesis 3c

Research Hypothesis 3c: There is no significant difference between the pretest mean score of the male and female students in the control group.

Also, from Table 3c, the t-value and p-value are, $t = 0.73$ and $p = 0.49$. The p-value is greater than 0.05. In the light of this result, it was hard to reject the null hypothesis. The results of the pretest proved that there was no statistically significant difference between the pretest means score of the male and female students in the control group. This proved that male and female students sampled for the study were similar in academic performance.

Table 3d: t-test summary of the posttest of male and female students in the control group

Gender	N	Mean	SD	df	t-value	p-value	Remarks
Male	25	40.88	5.24	48	0.62	0.74	Not Significant
Female	25	41.24	3.09				

Source: Field data, 2020

Significant level = 0.05

df= degree of freedom

Table 3d is a t-test summary of the results of the posttest of male and female students in the control group. From Table 3d, the posttest mean score of the male students in the control group was 40.88 with a standard deviation 5.24 while the female students in the control group had a mean of 41.24 with a standard deviation of 3.09. The mean difference between the two groups was 0.36. To see if there was any significant difference between the mean scores, a hypothesis was used.

4.3.4 Analysis of Research Hypothesis 3d

Research Hypothesis 3d: There is no significant difference between the posttest mean score of the male and female students in the control group.

Also, from Table 3d, the t-value and the p-value are, $t = 0.62$ and $p = 0.74$. Since $p > 0.05$, the null hypothesis was accepted. The result of the posttest of the male and female students in the control group proved that there was no statistically significant difference between the posttest means score of the male and female students. Therefore, sex is not a major issue in learning and understanding concepts in biological classification when taught using discussion method. By implication, the use of discussion method of teaching biological classification is not peculiar to a particular sex since the performance of the students were similar.

5.0 DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Discussion

The purpose of the study was to find out the effect of MIA on students' academic performance in the concept of classification of living organisms.

There was no statistically significant difference between the pretest mean scores of the students in the control group and those in the experimental group. This implies that the sample was drawn from a student population that is similar in academic achievement before the treatment. Similar finding was made by Azhar, Niwaz and Khan (2017), who researched on scientific application of audio-visual aids in teaching science in Government Model High School Vehari, in Punjab and revealed that there was no significant difference in achieved scores of control and experimental groups of students in the pretest.

Another finding of the study is that there was a significant difference between the posttest means scores of students in the experimental group and those in the control group. This is an indication that students who were taught concepts of biological classification using MIA, performed better in classifying living organisms than those who were taught using discussion as an instructional method. Students in the experimental group performed better than their counterparts in the control group because participants in the experimental group's interest, participation, motivation and concentration level were very high due to the treatment. This finding agrees with previous study by Bawa (2018), who found out that students exposed to MIA performed better than those exposed to conventional teaching method in learning chemistry concepts. This finding also agrees with Kuo *et al.* (2018) who found out that those students who were exposed to multimodal presentation performed better than those who were exposed to blackboard/ marker board presentation. This finding further agrees with Bicomong *et al.* (2015), who investigated the use of multimodal approach in teaching algebra (Measurement) and found out that students who were exposed to MIA performed better than those exposed to conventional method of teaching. This study is also in agreement with Thomas and Israel (2014), on the effectiveness of animation and multimedia teaching on students' performance in science subjects and showed that the performance of students in the multimedia teaching group was far better than the performance of the students in the conventional teaching group. Similar finding was made by Aggarwal and Dutt (2014), who researched on the effectiveness of multimedia teaching and showed that students who were taught with multimedia presentation performed significantly better than those taught with the lecture method.

Another finding of this study is that there was no significant difference between the pretest means scores of the male and the female students in the experimental group. This shows that

both male and female students in the experimental group were similar in academic achievement before the treatment.

A further finding of the study is that there was no significant difference between the posttest means scores of the male and the female students exposed to multimodal instructional approach. This means that MIA influenced both male and female students' ability to classify living organisms equally. This implies that the use of MIA in classifying living organisms is not influenced by gender. This may be due to the advantages that MIA presents to students irrespective of gender. MIA helps in boosting students' understanding of difficult topics and also raises their interest level (Simhachalam, 2016). This study further agrees with Akinoso (2018) on effect of the use of multimedia on students' performance in Secondary Mathematics revealed that there was no significant difference between the mean achievement of male and female students taught using Multimedia. This finding is also in agreement with Thomas and Israel (2018), who studied the effectiveness of animation and multimedia teaching on students' performance in science and found that there was no significant difference in the performance of male and female students taught using animation and multimedia. This finding further corroborates the finding of Satyaprakasha and Sudhanshu (2014) on effect of multimedia teaching on students' achievement in Biology where it was found out that both male and female students' academic achievement was equal when they were taught using multimedia teaching method. This finding did not agree with Olutola (2017) who conducted a study on school and gender as predictors of students' performance in WASSCE multiple choice test in Biology and found that female performed significantly better than male students. This finding also disagreed with Aggarwal and Dutt (2014) who found that male students performed better than female students in acquisition of Biological concepts using multimedia presentation.

Also, there was no significant difference between the pretest means score of the male and female students in the control. This is an indication that both male and female students in the control group were similar in academic success before they were taught using the discussion method of instruction.

Finally, there was no significant difference between the posttest means score of male and female students in the control group. This proved that the effect of discussion method of instruction on students' ability to classify living organisms was equal for male and female students in the control group.

5.2 Conclusion

The study investigated the effect of MIA on students' academic performance in the concept classification of living organisms. The following conclusions were drawn on the basis of statistical analyses and the findings of the study. The study showed that MIA was effective in teaching the concept, classification of living organisms since the students who were exposed to MIA performed significantly better than their counterparts who were taught using discussion method. It is also established that MIA was more effective in enhancing the academic performance of both male and female students in biological classification. The claim that a significant difference occurs between male and female students in acquisition of biological concepts may not be true as the performance of male and female students in the experimental

group was similar. This study portrayed that MIA being a learner-centered approach, changed students' attitude positively towards biological classification that contributed towards improved academic performance.

The findings also provide empirical evidence for concluding that multimodal instructional approach facilitates higher level of learning and understanding of the concept, Biological Classification that lead to improved academic performance. Based on the findings, there is an urgent need for Biology teachers to adopt instructional methods that place students at the centre of the lesson and enhance the critical thinking skills of the students. Science teachers should shift from the traditional mode of instruction to one that caters for the diverse learning needs of students in the classroom, such as MIA since learners have different learning styles.

5.3 Recommendations/ Contribution to Practice, Theory and Policy

Based on the findings of this study the following recommendations are put forward by the researcher:

- i. Biology teachers in NSHS should be encouraged to teach Biological Classification using MIA in order to improve the academic performance of both male and female students.
- ii. PTA and NABIA should organize workshops, seminars and conferences for science teachers on the need to adopt current instructional strategies in order to improve upon the academic performance of students.
- iii. School authority should invite educational technologists, instructional materials technicians and computer experts to help science teachers of NSHS on how to incorporate ICT in teaching science subjects.

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