UNIVERSITY OF EDUCATION, WINNEBA

EFFECTIVENESS OF LEARNING ACTIVITY PACKAGE IN INFLUENCING STUDENTS' PERFORMANCE IN SELECTED BIOLOGY TOPICS

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MARCH, 2023

DECLARATION

STUDENT'S DECLARATION

I, **Ruby Yayra Ahiaba**, declare that this dissertation, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my original work, and that it has not been submitted, either in part or whole, for another degree elsewhere.

SIGNATURE: _____

DATE: _____

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of dissertation as laid down by the University of Education, Winneba.

NAME: Charles Kwesi Koomson [PhD.]

SIGNATURE: _____

DATE: _____

DEDICATIONS

I dedicate this work to my parents Mr. and Mrs. Ahiaba, Mr. Thomas Yevu and all my siblings; Godwin, Godsway and Vida for their financial and spiritual support during my stay in UEW.

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ABSTRACT

This study aimed to investigate the effectiveness of a Learning Activity Package (LAP) in improving students' performance in selected biology topics. The quasi-experimental design involved a pre-test and post-test Non-equivalent group design, with 92 students in total divided into an experimental and a control group. The experimental group consists of 44 Year 2 biology students in Asare Bediako SHS and the control group was made up of 48 Year 2 biology students from Obuasi SHTS. These two schools were sampled using purposive sampling. The experimental group was taught using the LAP while the control group received lectures. The Biology Achievement Test (BAT) was used to collect data, which was analysed using inferential and descriptive statistics. Results showed that the experimental group outperformed the control group on the post-test, with significant differences ($p < 0.05$) across all ability levels; mean scores for the experimental group = 28.7, 25.3 and 21.1 for high, average and low achievers respectively and a significant value of 0.0007 while the control group recorded mean scores of 16, 15 and 17 for high, average and low achievers respectively. The LAP was particularly effective for low-achieving students, as they showed notable gains. There was also a statistically significant difference in mean scores between males and females ($p = 0.03$), with males performing better on average, but the effect size was low in magnitude. Furthermore, the experimental group had significantly higher mean scores compared to the control group, with a practically significant difference in scores. Overall, the findings suggest that the LAP is an effective teaching method for improving students' performance in biology. Based on these findings, it is recommended that instructors should consider integrating the learning activity package (LAP) in their teaching approach. Further, additional resources and support should be provided to low-ability students to ensure their success.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter presents the background to the study, the statement of the problem, the purpose of the study, the objectives of the study, and the research questions. The delimitations of the study and limitations encountered in this study are also stated. The chapter also presents the significance of the study, the operational definition of terms and the organisation of the remainder of the study report in the chapters that follow.

1.1 Background to the Study

Biology is a hands-on subject that needs to be taught in a manner that the students will be actively engaged in the teaching and learning processes (Enohuean, 2018). Biology involves the study of life, structures, functions, growth, origin, evolutions, distributions, inter-relationships, diseases and adaptations of living things. Despite the importance placed on biology, students' performance in the subject at both terminal school examinations and external (WASSCE & NOV-DEC) examinations has been repeatedly poor (Nyarko, 2014). The poor performance of students in biology is an indication of low retention of what is taught and subsequently poor achievement. It may also be an indication that meaningful learning had not taken place.

Students vary in their academic abilities and this tends to be reflected in the extent to which they are affected by a particular teaching method. For instance, Diamond and Onwuegbuzie (2016) expressed concern over the influence of different teaching methods on the learning benefits of students of different ability groups, stating that differences in intellectual functioning among learners necessitate variations in instructional strategies. Research has indicated that teaching methods have differential

effects on students of different academic ability levels (low, average, and high levels) with one group benefiting more from a particular teaching method than the other (Nyarko, 2014; Ezeh, 2019; Udeji, 2017). For instance, both Ezeh (2019) and Udeji (2017) found that with the various methods used, the achievement is significant with the high-ability groups, while the findings of Nyarko (2014) indicated that in as much as some students are highly gifted, they do not achieve well in science. This may be due to the teaching method employed which may not suit all the groups. Given the foregoing, it might be necessary to find out the student's academic ability group (low, average or high) for which a particular teaching method will be more effective. It has been observed that effective teaching may facilitate learning and make it more meaningful. In line with this, Sander (2019) stated that effective teaching helps the learner to learn better, while poor teaching would naturally lead to poor learning and consequently poor achievement. Effective teaching involves a blend of different teaching methods to cater for students with different intellectual abilities.

Biology teachers use different approaches in the teaching of biology in order to achieve meaningful learning. These include lecture method, demonstration method, discovery, project, and inquiry among many others. The evidence available from literature on science education in Ghana consistently shows that biology teachers in senior high schools choose one type of teaching method and use it constantly (Nyarko, 2014). According to Nyarko (2014), this one-way-fix-all approach to teaching biology had failed in the recognition of the uniqueness of the inquiry-based nature of science and the learner's individuality. Furthermore, it does not facilitate the development of reasoning skills and processes in students of different intellectual abilities. It appears that the conventional methods used by biology teachers do not give attention to the individual differences of students (Anderson, 2018). This study,

therefore, is a response to this challenge, and it is aimed at investigating the effectiveness of the Learning Activity Package (LAP) on students' performance and knowledge retention in biology.

Learning activity package (LAP) is a student-centred activity-oriented teaching strategy where the teacher acts as a facilitator of learning, guiding the students through a series of activities and problems which may help learners to improve their performance (Njoku & Akamobi, 2015). Learning Activity Package may involve several instructional strategies, depending upon the instructional objectives of the unit or module. A web page or site may be effectively utilized by teachers developing learning activity packages as a wide variety of instructional strategies may be incorporated. The web page or site may contain instructional content (text, audio and video) links to other sites, interactive activities (tutorials, simulations and experiments etc), assignments, evaluation guides and any other required content (Njoku & Akamobi 2015).

LAP is a learner-centred activity that leads to individualisation of instruction which leads to higher academic achievement. From the aforesaid, it can be seen that the use of the LAP method is likely to enhance performance. That is why the researcher investigated the effectiveness of LAP in teaching some biology topics and its effects on students' performance and retention.

1.2 Statement of the Problem

The persistent poor achievement of students in biology has been revealed by many researchers such as (Anderson, 2018 and Enohuean, 2018). Their reports call for concern, especially for teachers of biology that enrol a larger number of students. The problem has to a large extent been attributed to ineffective teaching methods

employed by the teachers. Consequently, there is a felt need to improve the teaching and learning of biology by exploring the use of some innovative learner-centred teaching–learning methods, since it is believed that meaningful learning may be a result of active participation by students. Although many studies had been carried out on some innovative methods, like Programmed Instruction (PI) and Computer Assisted Instruction (CAI) methods, findings have shown that they are student centred and can also enhance learning and achievement, but the problem of large classes and non-availability of computer systems in most Ghanaian classes has made their practicability nearly impossible. Therefore, there is still the need to investigate other innovative child-centred methods that are affordable, readily available as well as flexible, combing both package learning and practical activities (i.e., minds–on and hands–on). Such a method should enable the teacher to easily diagnose the problems of the individual learner and allow the learners to evaluate themselves, receiving immediate knowledge of the result. This calls for the trial of another individualised method such as the Learning Activity Package (LAP). Hence, the study was set to investigate the effectiveness of LAP in influencing students' performance in biology lessons.

1.3 Purpose of the Study

The purpose of this study was to examine the effectiveness of the Learning Activity Package (LAP) on students' performance in selected biology topics.

1.4 Objectives of the Study

This study specifically sought to:

1. Assess the effect of the LAP on the performances of students of different ability groups in selected biology topics.
2. Asses the differential effect of the LAP on the performances of male and female students in biology.
3. Examine the difference between the performances of students taught biology using the LAP and those taught using a conventional method.

1.5 Research Questions

1. What is the effect of the LAP on the performances of students of different ability groups in selected biology topics?
2. What differences are observed between the performances of male and female students when the LAP was used to teach biology?
3. What is the difference between the performances of students taught biology using the LAP and those taught using a conventional method?

1.6 Null Hypotheses

H_{o1}: There is no statistically significant difference between the mean scores of students belonging to different ability groups, taught using the LAP.

H_{o2}: There is no statistically significant difference between the mean scores of male and female students exposed to the LAP instructional approach.

H_{o3}: There is no statistically significant difference between the mean scores of students taught biology using the LAP and those exposed to a conventional method.

1.7 Significance of the Study

The significance of the study "Effectiveness of Learning Activity Package in Influencing Students' Performance in Selected Biology Topics" lies in its potential to provide insights into the effectiveness of learning activity packages in improving students' performance in biology. This study can help educators and curriculum designers to create more effective teaching and learning strategies that can enhance students' knowledge and understanding of biology.

Moreover, the study will contribute to the development of evidence-based practices in biology education. It can help to identify the specific factors that can make learning activity packages effective, such as the types of activities, the level of interaction, and the degree of scaffolding. The findings of this study can be used to improve the design of future learning activity packages, which can ultimately benefit students' learning outcomes.

In addition, the study can also inform policymakers and educational institutions about the effectiveness of learning activity packages in improving students' performance in biology. This can lead to the integration of such teaching and learning strategies in the curriculum, which can potentially enhance the quality of education and promote students' academic success.

1.8 Scope of the Study

The study was delimited to investigate the effect of the Learning Activity Package (LAP) on senior high school students' academic performance and retention of biology concepts. The investigation was restricted only to the topics of – the Urinary System and Circulatory System as found in the senior high school biology syllabus. The

choice of topics was informed by pieces of research which identified the topics as some of those that students find difficult to learn (Anderson, 2018).

The study was carried out with only form two (2) biology students in two co-educational senior high schools in Ghana. This decision was taken to ensure that gender, which is a major variable of interest in the study, received adequate attention. Form two (2) biology students were used for the study because the topics were in their syllabus. The subunits developed were:

Parts of the urinary system

Urine formation

Urine storage and elimination

The heart

The blood

Blood vessels and circulation

1.9 Limitations of the Study

A major challenge this study faced was absenteeism on the part of some of the day students, which resulted in rescheduling some meeting and testing times.

1.10 Operational Definition of Terms

The meanings of some terms used in this study are presented next.

Learning Activity Package: A set of instructional materials and activities that are designed to promote students' active engagement in the learning process, including exercises, worksheets, diagrams, and multimedia resources.

Ability level: Ability level refers to what a student can currently do independently with a high percentage of accuracy. Ability level is sometimes referred to as independent level.

High Ability Learners [HAL]: High-ability learners are students whose ability is more advanced than that of similar-aged peers across one or more domains. These domains include intellectual ability, speed of learning and complex thinking patterns.

Low Ability Learners [LAL]: Low-ability learners are those who have slower learning paces and higher learning needs. This group of pupils may be less academically capable than their peers.

Pre-test: A preliminary test administered before the experiment to assess students' strengths.

Post-test: A test given to the students after the experiment, used in conjunction with the pre-test to measure the achievement and the effectiveness of the treatment.

Students' Performance: Refers to the level of achievement demonstrated by students in their understanding and application of selected biology topics. This can be measured through various means, such as scores on assessments, quizzes, and exams.

Selected Biology Topics: Refers to the specific areas of biology that are covered in the learning activity package, which may include topics such as cell biology, genetics, ecology, and evolution.

Effectiveness: Refers to the degree to which the learning activity package has achieved its intended outcome of improving students' performance in the selected biology topics. This can be evaluated by comparing the pre-and post-intervention scores of students' performance and assessing the extent of improvement.

1.11 Organisation of the Rest of the Study

This study was organised into five chapters. Chapter one has already been discussed. Chapter two comprises a review of related literature. It begins with an overview of the chapter and then a review of related literature under various strands. Chapter three consists of the research methodology. It is structured into the overview, the study's design, population and sampling procedure, instrumentation, the instruments' validity, the instruments' reliability, data collection, and data analysis. Chapter four contains a presentation and analysis of the results. Chapter five covers the summary of findings, conclusion, recommendations and suggestions for further study. References and appendices were then added.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter reviewed literature relevant to this study under various strands. A conceptual framework for the study, the theoretical underpinning of the study and empirical literature were also reviewed in this chapter.

2.1 Theoretical Foundations of LAP

The learning activity package innovative pedagogy is underpinned theoretically by the constructivist learning theory, specifically Dewey's (1977) theory of progressive learning and Kolb's experiential learning theory. John Dewey propounded the theory of progressive learning in 1977. In his theory, Dewey suggested the problem-solving approach to learning. He believed that for a child to learn, he should be subjected to a problem–situation, provided with necessary materials and left alone to find the solution. In this type of learning, all the sense organs of the learner are involved in active interaction with the concept under study. The involvement of several sense organs in learning ensures meaningful and more permanent learning. Teaching science and biology, in particular using LAP, allows learners to interact with objects and phenomena for a better understanding, using the sense organs during the teaching-learning processes. Thus, the use of LAP in teaching biology in senior high schools draws inspiration from Dewey's theory of progressive learning.

According to Dario et al. (2016), the experiential learning theory was propounded by psychologist David Kolb. The theory emphasizes that students can create knowledge through the processes of an experience transformation. The learning theory describes the effects of experience, cognitive abilities, and learning environment on students' emotions in the learning process. Accordingly, Kolb's model of experiential learning

highlights that learners gain experience by forming concrete and conceptual ideas from reflective observations and active experimentation (Dario et al., 2016). The experiential learning model fits into the learning activity package pedagogical approach to biology instructions. The LAP pedagogy helps students to build the capacity to acquire concrete experiences through active interaction with materials. Besides, these concrete experiences gained by the students are transformable through observation and active experimentation. Therefore, the learning activity package is modelled according to the experiential learning theory. In the process, the teachers are to facilitate the students' learning by steering them through actions that will enhance their abilities to gain concrete learning experiences.

2.1.1 Learning Activity Package and Theories of Learning

According to Farrant (2012), Piaget's theory of intellectual development holds that cognitive development takes place from the active interaction of the child with their environment. This means that the basis of learning is the child's ability as the child interacts with the physical and social environment. Piaget thinks that a child must act on the objects in the environment for the child to learn. This means that the child should be actively involved and should not be passive. The active involvement of the child may be in form of direct manipulations, visual observations or through mental or internal transportation or change. According to Piaget, the mental activity of the child is organised into structures. Various mental activities are related to each other and grouped in clusters, which are known as "schemas" or patterns of behaviour. According to Woolfolk and Nicolich (2018), in the Piagetian system, the schema is the primary unit of cognitive organisation. This means that it is the basic building block of thinking. Piaget believed that mental activity which is involved in cognitive organization is a process of adaptation which is divided into two opposing but

inseparable processes: assimilation and accommodation. In assimilation, a child fits new experience into pre-existing mental structures. Accommodation is the process of the change of mental structure due to the influence of the environment. Accommodation also means to modify self to fit the new materials, while assimilation means to modify the materials to fit the self. The Piagetian theory thus places the child as the principal agent in the teaching/learning situation. This being the case, the teacher's job is to provide the individual with situations that encourage experimentation and manipulation of objects and symbols. According to Awotua–Efebo (2016), the learner must be allowed to "do" and to progress at their pace. The individual has a real comprehension of something only if he/she invents it himself or herself. Whenever we teach or present materials in quick succession, we prevent the individual from reinventing it himself or herself because of lack of understanding of the structure. The theory has direct implications for the use of the Learning Activity Package in science teaching, especially in Biology. In the first place, the Piagetian theory of intellectual development holds that cognitive development takes place from the active interaction of the child with his environment. This is why the researcher advocates the use of Learning Activity Package as it is a student-centred and an activity-oriented teaching strategy in which the teacher acts as a facilitator of learning, guiding the students through a series of activities and problems, which will enhance the achievement of the learners. Secondly, Piaget's theory emphasized active participation of the child which Learning Activity Package Strategy encourages.(Brunner,1961) This is because, in Learning Activity Package, learning materials are broken into small steps which are sequentially arranged from known to unknown and in increasing order of difficulty. A child must master a step before proceeding to the next one and in doing so the learner is actively involved in the

learning process. Moreover, there are a lot of activities which the learner is expected to carry out by himself, making the learner very active in the learning process. Other learning theories that bear direct or indirect relevance to Learning Activity Package include Ausubel's theory which observed that learning occurs meaningfully when new information or knowledge is linked or associated with already existing but relevant knowledge or concept in the learner's cognitive structure. Ausubel's theory has implications for Learning Activity Package when the learner's interests and capabilities are identified. They form the basis for designing new learning packages which are tailored to fit the individual learner's peculiar needs. What the learner already knows may determine his rate of movement with the Learning Activity Package. Based on this, the Learning Activity Package is designed in such a way that the learner progresses at his pace and in his way.(Abu,2018)

2.2 Empirical Studies of LAP

Previous research studies have found the learning activity package effective in improving students' knowledge retention in science subjects. Specifically, Neboh (2012) conducted a study on the effect of learning activity package (LAP) on male and female students' achievement in secondary school biology and found, among other things that students exposed to the learning activity package pedagogy recorded higher retention of knowledge in biology than their counterparts taught with the lecture method. Similarly, Abu (2018) conducted a study on the effectiveness of individualised and lecture instructional methods of teaching biology at the senior secondary level of education and concluded that the student's knowledge retention in biology was enhanced more with the learning activity package pedagogy than with the conventional (lecture) method. Furthermore, a study conducted by Udu (2018) on the efficacies of cooperative learning instructional approach, learning activity package,

and lecture method in enhancing students' academic retention in chemistry, found that students who were taught chemistry concepts with the learning activity package pedagogy had better retention of knowledge of the concepts learned more than their counterparts who were taught the same concepts in chemistry with the conventional (lecture) method. Besides, the LAP pedagogy gives students freedom of choice and motivates them to operate within an organized framework (Arseneau et al., 2014). Arseneau et al. added that the learning activity package furnishes structures for the student's learning while providing for the differences in their learning rates. This case study research assessed the potency of the innovative learning activity package pedagogy in fostering students' knowledge retention in science subjects in some developing nations: Nigeria, Kenya and Tanzania.

2.2.1 Concept of knowledge retention

Ajit (2019) describes students' knowledge retention as assimilating available information during the learning process and the ability to recall and apply the knowledge obtained from the learning process over time. Emphasizing further, it is noted the ease at which individuals tend to forget what they had learned and narrated that after an hour, people hold only half of the information presented to them; after one day, people forget more than 70% of everything they have learned; and after a week, people forget 90% of the information on their learning session. Therefore, teachers are to utilize innovative instructional strategies to stimulate multiple senses in the students, which may help them improve their knowledge retention abilities. Besides, Kundu and Tutoo (2012) defined knowledge retention as a preservative factor of the mind that acquires materials of knowledge through sensation and perception. However, it has been emphasized that the acquired materials in mind must be preserved in images to develop and retain knowledge. Paden and Dereskiwsky

(2017) revealed that the low retention abilities of students could be a result of instructional strategies adopted by teachers. They maintained that the use of less effective instructional approaches in teaching science subjects could invariably translate to students' inability to retain the knowledge acquired, which they could not put into practical reality. The inability to retain the concepts learned could prevent the students from solving real-life problems. Therefore, to curb the low retention abilities of the students, there is a need to explore innovative approaches to instruction for effective teaching and easy assimilation of facts by students in science subjects. These innovative pedagogies have been found to encourage the students to be fully involved in the teaching-learning processes through active participation in the learning activities and enhance the students' linking of the three levels of chemical representation for easy assimilation of chemical concepts. Moreover, active engagement in teaching/learning activities triggers students' abilities to remember learned concepts. It may enhance their capacity for knowledge retention and improve their academic performance in external examinations in the long run. Besides, the learning activity package pedagogy is an innovative instructional strategy that stimulates multiple senses in the students by helping them to link the triplet relationship of chemical representations.

2.2.2 Gender influence and students' academic retention in science subjects

Gender influence on students' knowledge retention has been a topical issue in education. However, there are conflicting research findings on this issue. For example, Bosede (2010) and Ezeudu (2013) found that gender significantly influences students' knowledge retention in science subjects. Specifically, Ezeudu (2013) found that female students performed better than their male counterparts when taught some concepts in physics and chemistry, respectively. Also, Agomuoh (2010) reported male

students' higher knowledge retention in science subjects than their female counterparts. In contrast, Nzewi (2010) reported a non-significant influence of gender on students' knowledge retention in science subjects. These contradictory findings on gender influence on students' knowledge retention in science subjects also necessitated this study. This study, therefore, evaluated the potency of LAP pedagogy in fostering students' retention of knowledge in science subjects using the lecture method as control and gender as a moderating variable.

Quite a good number of studies have been conducted on either science achievement or science achievement and retention of students. For instance, Ajit (2019) carried out a study in Egypt on the relationship between abstract concept achievement and prior knowledge formal reasoning ability and gender in Biology using a sample of 160 secondary school students (85 males and 75 females). After analysing the data using mean and standard deviation to test research questions and analysis of co-variance to test hypotheses, he found that prior knowledge and formal reasoning ability play a major role in students' achievement of abstract concepts, and secondly that the effect of students' prior knowledge on achievement seems to exceed that of formal reasoning ability. Gender had little effect on the achievement of abstract phenomena. The above study, however, has no clear view of the relationship between gender and science achievement and retention. A study on the major influences on science achievement in a developing country Kenya, carried out by Tawari (2016) in physics; using a sample of 424 respondents found after data analysis that the school and teacher characteristics play a more significant role in shaping science attitude and achievement in developing countries like Kenya than in developed countries. There were significant differences between boys and girls in student motivational orientation and achievement with boys performing better, but the relationship between gender

and achievement was indirect and mediated through variations in the different types of secondary schools and the teachers assigned to them. Conversely, the prior idea of the students before formal instructions took place was not considered by the researcher.

2.2.3 Students' ability-level and performance in science

Another related factor to achievement in science is the ability level of the students. According to Anderson (2018), the academic achievement of students in a normal classroom is not always the same. Some students perform very well and are regarded as high achievers, some averagely and are regarded as middle achievers while others perform very poorly and are known as low achievers. It has been correctly observed that no two individuals are exactly alike in their overall characteristics. Normally, it will be expected that high-ability learners will always achieve more than the average and low-ability learners in most subjects, but investigations that were carried out indicated that this is not always the case. This is shown by the study carried out by Abu (2018) which showed that there is an indication that some students are highly gifted but they do not achieve well in science. Freeman (2020) studied the effect of fieldwork as a teaching strategy on achievement in Biology. The result was significant for the above-average ability group, but not significant for the below-average group.

Also, Bosede (2010), studied the factors that influence concept development in the Nigerian Integrated Science Project. The result showed that mental ability level, among others, is one of the factors. Nzewi (2010) studied the effect of prior knowledge of behavioural objectives and study questions on achievement in Biology. The result showed that despite the ability level of the students; the achievement of the students was significant. Ezeh (2019) worked on the effects of advance organizers on student achievement, interest and retention in Integrated Science. The students were

grouped into low and high ability levels. The result after analysing with 2 x 2 analysis of co-variance indicated that there was no statistically significant difference between the low and high ability groupings with regards to their interest level but there was a significant difference between the high and low ability levels with regards to their levels of performance, with the high ability groups performing better. Georgousi, Kampourakis and Tsaparlis (2011) carried out a study on the physical – science knowledge and patterns of achievement at the primary–secondary interface from nine urban and semi-urban Greek middle secondary schools, who were tested on part of their basic physics and chemistry knowledge. The sample size was 976 seventh and eighth-grade students. The data were analysed using mean percentage scores and standard deviation. The result showed that only 128 students (13.1%) scored relatively well ("able" students) and only 58 students (5.9%) scored well ("top" students). Boy "able" and "top" students outnumbered and outscored "able" and "top" girls. The gender gap especially in numbers increased with ability in favour of boys. The above study used mean percentages for comparing gender and ability levels. The researcher used only two levels "able" and "top". There was no evidence of a reliability test. These are some of the gaps that this present study intends to cover. The above literature reveals that the ability levels of the students are an important factor in students' achievement in other words, it is related to intelligence and there is no consistency in the group's achievement using the various teaching methods and strategies. This inconsistency in the achievement of students of various ability levels calls for the need for this study, which investigated the effect of the Learning Activity Package (LAP) on the achievement and retention of students of different ability levels.

2.2.4 Related empirical studies on individualised instruction and learning activity packages (LAP)

The following empirical studies have been carried out by some researchers to investigate the effect of individualised instruction and Learning Activity Package methods of instruction on students' performance with particular reference to science subjects. Tawari (2016) worked on the relative effectiveness of two methods of teaching science (Biology) at the junior secondary school level of education in Nigeria. The methods investigated were the individualised and the conventional (lecture method) approaches to students' achievement. The subjects for the study were a total of one hundred and forty forms II students selected from four arms of two mixed school types in Benin City. The design used was the pre-test-post-test control group experimental design. The instrument consisted of a performance rating scale in biology which is a questionnaire and multiple–choice objective type of achievement test. The questions for the pre-test and post-test were drawn from the concept taught which is the mammalian skeleton. The raw scores from the subjects using the two methods on both the experimental and control groups were analysed using a factorial analysis of covariance. The result showed that the individualised instruction strategy was significant over the conventional approach concerning the students' achievement. Tawari in the study failed to indicate the particular type of individualized instruction employed. Moreover, the researcher used each of the two schools as both experimental and control, giving ways for contamination since both the control and the experimental groups could mix. There was no measure taken by the researcher to ensure the homogeneity of the two classes. Burnside (2011) carried out a study that investigated the development, implementation and evaluation of a Learning Activity Package on the use of computers. The Learning Activity Package consisted of a self-

paced word processing tool in the subject of language arts, which was developed by the teachers in conjunction with computer teaching specialists. The LAP development was not done by the teachers alone but in conjunction with the subject specialists. The result showed that the LAP was effective for presenting the writing tools using computers. The result also showed that the students enjoyed independent learning. However, there was no specification of whether the subjects were homogenous or equivalent.

Igbanugo (2016) studied the effectiveness of individualizing instruction through the diversification of learning opportunities. The subjects were 20 undergraduate students of Baruch College of Medicine in New York. The researcher developed a Learning Activity Package on blood pressure which was developed and validated and was used as a treatment for the students. The result after the pre-test and post-test showed that all the students mastered the concept and the objectives achieved with 80% achievement as the criterion. In the above study, the entire populations of 20 undergraduate students were the experimental group and there was no control group. The researcher did not use any other method of instruction, to compare with the LAP. Moreover, the study did not take care of the homogeneity of the subjects, as they were selected from different classes; even though they were more mature and were not of the same year. The study did not specify the sexes involved in the investigation. Smith (2019) worked on a comparative evaluation of three teaching methods: the Socratic dialogue method, the lecture method, and the personalized system of instruction (PSI). The class structures for the three methods were 22 students, 24 students and 21 students in that order. The instrument used for the study was a pre and post-test assessment and a questionnaire that elicited responses on the students' reactions and attitudes towards the three methods, administered at the end of the post-test. The

result showed that PSI was viewed more positively by the students. The subjects treated with the PSI produced a higher performance rating than the other two methods. The result of the research just showed a higher rating of the PSI over the other two methods together and no details of the other two methods were given.

Hwong (2013) investigated the effects of cooperative and individualized learning on prospective elementary music teachers' achievement and attitudes. A total of 43 prospective music teachers were used. The result revealed that cooperative method of instruction enhances achievement more than individualized instruction. The effectiveness of cooperative learning may be due to the nature of the subject matter which is music which involves unified effort for efficient production. Abu (2018) worked on the effectiveness of individualized and lecture instructional methods of teaching biology at the senior high level of education in two schools in Accra township of the Greater Accra Region of Ghana. A total of 80 subjects were used in the study, which was randomly selected. The instrument used for the study were the multiple-choice assessment tests and the pre/post-treatment tests. The t-test statistic was used to analyse the data collected. The result showed that the individualized instructional method (LAP) enhances the students' achievement in biology irrespective of their previous academic standings. The study was only confined to two schools in Accra township and no attempt was made by the researcher to control some extraneous variables that might have constituted a threat to the validity of the study such as irregular participation of the subjects and inter-group contamination. Mukaila (2010) worked on LAP and conventional methods of instruction and students' cognitive preference styles as determinants of secondary school achievement in heat-related concepts in physics. The subjects for the study were 284 senior secondary two physics students selected from 6-distantly located co-educational schools in

Abeokuta, Nigeria. Three instruments were used for data collection: an achievement test in physics, a physics cognitive preference style inventory and a locus of control scale. The data collected were analysed using analysis of covariance (ANCOVA) and Schaeffer multiple range test as a post-hoc measure. The result revealed that the LAP instruction group achieved significantly higher than the conventional groups. However, there was no significant main effect of gender on physics achievement [F (1) 283 = 1.979, P > 0.005]. There were also significant interaction effects of treatment and locus of control [F (2), 283 = 5.031, p < 0.05], cognitive preference style and gender [F (3), 283 – 2.993, p < 0.05] on physics achievement. The fairly large sample used in the study would have enhanced the generalisation of the stated findings. However, the fact that the study was limited only to heat–related concept in physics poses threat to its generalisability.

Ajiboye and Ajitoni (2018) conducted a study on the Effects of Full and Quasi – Participatory Learning Strategies on Nigerian Senior Secondary Students' Environmental Knowledge: Implications for Classroom Practice. The study was experimental with two modes of participatory strategies, the full and quasi-participatory modes in teaching secondary school students in Nigeria some environmental education concepts. Three hundred and sixty students were randomly selected from a secondary school in Kwara State of Nigeria and assigned to the three treatment groups. Five hypotheses were tested at p < .05 level of significance. The study adopted a pre-test, post-test, control, and quasi-experimental design, using a 3 x 3 x 2 factorial matrix. Data collected were analysed using analysis of covariance (ANCOVA) to test the hypotheses and differences among groups, using pre-test scores as covariates. The t-test and Schaeffer Multiple Range test were used where significant differences were observed to determine the source of the significance. The

Multiple Classification Analysis was done to find out how each of the groups performed. The result revealed that generally, students taught using participatory modes performed better than their counterparts in the conventional lecture group. The fair large sample used for the study would have enhanced the generalization of the above findings. However, the fact that the study was limited only to environmental education concepts poses a threat to its generalisability. The above literature reveals that the various individualized methods of instruction had varied effects on achievement. This calls for the need for this study, which investigated the effect of the Learning Activity Package (LAP) on achievement and retention. (Ajiboye & Ajitoni, 2018)

2.3 Students' Achievement in Biology in Ghana

The current state of senior high school achievement in sciences especially Biology has been characterized according to some scholars as poor (Anderson, 2018; Nyarko, 2014; Freedman, 2020). The West African Examination Council's report on candidates' performance in the West African Senior Secondary Certificate Examination (2021) equally expressed concern at the deteriorating trend in the performance of candidates over the years in biology. This shows the level of low performance in biology among Ghanaian pupils and students. If this trend of low achievement is allowed to continue unabated, it will be difficult to achieve the goals of science education programmes in the National Policy on Education.

Based on this development, a lot of research work has been carried out to determine the causes of poor performance of students in science, especially in Biology. Oladipo (2012) and Jarvis and Parker (2015) reported that five factors are responsible for students' underachievement and low interest in biology. One major factor that is emphasized was the inadequacy of the learning facilities in schools against the

consistent increase in the number of students. This falls in line with the factors enumerated by Bajah (2016) as being responsible for students' under-achievement in sciences, which include:

- Poor status of science teachers;
- Lack of seriousness on the part of the student;
- Nonchalant behaviour of teachers of science;
- Uncooperative behaviour of parents;
- Non-availability of standard science laboratories;
- Poor state of science equipment in science laboratories;
- Use of a single method in teaching biology;
- Lack of an adequate number of science teachers;
- Lack of familiarity of the science teachers with the demand of the syllabus, including the delivery methods;
- Insufficient time spent on science teaching; and
- Lack of suitable textbooks.

Biology as a science course is activity oriented and should be taught by the discovery method – a resource-based method. This shows that mastery of biology concepts cannot be fully achieved without adopting a teaching method that utilizes learning materials. This is why Maduabum (2018) stressed that a professionally qualified science teacher, no matter how well trained, would be unable to put his ideas into practice if the school setting lacks the equipment and materials necessary for him or her to translate his/her competency into reality. Evidence from studies carried out by researchers (Fosu, 2018; Ampiah, 2010) point to the fact that science teachers in Gana senior high schools use predominantly lecture methods which are considered

ineffective when used especially solely for science teaching with particular reference to biology.

Farrant (2012) believed that an increase in knowledge lies solely in the ability to remember. He further explained that if an individual could not grasp and keep hold of what was taught and learnt, it would seem like trying to fill a bucket without a bottom with water. This means that if one cannot retain what one learnt then there is no need to expect one to perform in that activity in the future. That is in line with what Bruner (1961) said, that a student's participation in a lesson was a basis for understanding, achievement and retention. For instance, if a student memorizes some principles, concepts or processes in the class and quotes them when the teacher asks and forgets them immediately, the student cannot be expected to remember them in the future. Day (2019) asserted that individuals with a high need for achievements often are those who are optimistic about the future for its own sake rather than for immediate reward. This means that high achievers are those with very good retention of concepts learnt and can produce them whenever necessary. Mbajiogu (2015) in a study on the effect of the Direct-Discovery method and demonstration method on the Acquisition and retention of science process skills found that retention by students is facilitated by motivation, and by allowing the students to find out things by themselves and to draw a conclusion. In the words of Ndukwe (2017), in his study on immediate achievement and retention in expository versus project centred method of instruction in Biology, using form 1 students, the result from the retention test, given 7 weeks after the treatment had ended, showed that there is no significant difference in the two mean scores. This also falls in line with the findings of Sungur and Tekkaya (2013) who found that there is no significant difference in the acquisition of science process skills when two methods are employed.

This is contrary to the findings of Creamer (2014) who found that there is a significant difference in the acquisition and retention of science process skills when different methods are employed. Iloputaife (2011) and Eze (2012) in their independent studies on the achievement and retention of physics students found that male and female students who offer physics have no significant difference in their mean achievement and retention in physics. Furthermore, Eze (2012) found that the difference between the students' mean post-treatment retention test in physics was not significant. However, Eriba and Sesugh (2006), and Onekutu and Onekutu (2012) in their studies found that male students achieve and even retain what they have learnt better than their female counterparts at the secondary school level. On the contrary, Nworgu (2018) found that sex had a significant effect in favour of females on retention in physics. This is supported by Weaver–Hightower (2013) and Omoniyi (2016). The above-reviewed literature showed that achievement and retention can be variously affected by gender, various types of methods and other variables like motivation. The present study found out the effect of the method, Learning Activity Package, on retention and achievement.

2.4 The Learning Activity Package as an Innovative Approach

Learning Activity Package is an innovative approach that acts as a vehicle that makes for individualisation in learning. It is an adaptation of the programming of instruction. According to Smith (2019), a Learning Activity Package is a form of communication between the student and the teacher that contains instructions for student activities leading toward specified performance outcomes. It is a teacher–developed strategy of instruction, which had its conception at Nova High School in Florida (Cardarelli, 2012). According to him, LAP is a booklet on a given topic containing objectives related to this topic, diverse activities to reach these objectives, and evaluations to

determine if the objectives have been met. Likewise, LAP is a booklet containing sets of learning assignments organised sequentially to achieve the specified objectives. The package contains diverse activities to reach the objectives. In addition, it contains evaluation techniques to determine whether the objectives have been achieved or not. Romisowski (2014) described the LAP as a mode, which is a booklet on a given topic, containing objectives related to the topic, diverse activities to reach these objectives and evaluations to determine if the objectives have been met. This means that LAP improves classroom learning, presenting even the most difficult subject in small steps so that all the students can succeed at their pace. The whole process of learning is students centred. The teacher is only brought in when there is a need for him. According to Smith (2019) and Cardarelli (2012), the components of LAP are – the topic or title and objectives, pre-test, activities, quizzes and post-test.

- **Topic and Subtopics:** The student's initial introduction to LAP is the statement of the topic and subtopics. The topic should reflect the central theme or primary idea of the unit of work. Depending upon the amount or magnitude of the body of content, this primary idea may be broken down into secondary ideas, which are the sub-topics. The extent of coverage of this topic depends on the individual teacher, the type of student utilizing the LAP and how long the child has been using the LAP.
- **Rationale:** Once the decision about the topic and sub-topics are taken, the rationale follows ordinarily. This is a narrative statement that is aimed at providing the student with the reason for studying this topic. It should communicate to the learner the overall intent of the package and its relevance to the student's course of study. It should be clear and concise. It should lend continuity to previous and subsequent learning experiences. The rationale can take

a variety of forms: a film to stimulate interest, a large–group representation, a challenging experiment, an explorative study, or a written rationale which explains the relevance of the topic within the framework of the total curriculum of the student's everyday life or his future life.

- **Behavioural Objectives:** The most fundamental component for guiding or structuring the behaviours of the learner is a set of objectives which are behaviourally stated i.e., expressed in terms of what the student will be able to do upon completion of the LAP. The domain (whether it is cognitive, affective or psychomotor), the number of objectives and the levels of performance are all considerations which are dictated by the content and how the content is organized. The completeness of these objectives depends on the level of development of the student(s) involved. Within the LAP, the function of the objectives is to communicate goals to the students and it should thus be written in a simple language.
- **Pre-test:** Once the intent and the specific performance criteria (objectives) of the Activity Package have been communicated to the learners, a self-evaluation should be provided. This form of evaluation may be student – or teacher directed but it should serve the following purposes.
    i. allows the student to bypass the Activity Package if he can already meet the performance criteria.
    ii. guides the students to those portions of the Activity Package that he needs to study; and
    iii. allows the students to check on his/her progress level before the teacher's evaluation. In other words, if the pre-test is successfully carried out, it will help to diagnose weaknesses ahead of time and directly route the student to

necessary activities; providing the student, not with failure, but success; ensuring a more positive, rewarding learning experience.

- **Learning Activity:** The activities of the LAP attempt to provide the student with a multi-media, multi-modal, multi-level road to reach the objectives of the LAP. The multimedia activities, in directing the student to readings, transparencies, tapes, filmstrips, demonstration models, etc, provide for the learning style of the individual learner. The multi-modal activities, which are the learning strategies include the flexible program, large group, small group and independent activities. The multi-level activities provide the learner with the opportunity to start at the base of his particular weakness. The learning activity which the researcher employed was in a booklet, requiring students to work on the activities by themselves.
- **Quizzes:** Built into the LAP is the philosophy that if anything is worth teaching, it is also worth knowing that it has been learned. Frequent quizzes give the students feedback on their progress and correct their errors by re-routing them to remedial activities. In this way, his/her learning is a progressive development. All quiz items are designed to test specific objectives and so are consistent with the objectives.
- **Post-test:** The post-test evaluates the student's fulfilment of all objectives of the LAP. The post-test evaluation is not an end, but a beginning – a beginning of diagnosis of individual student weaknesses; a beginning of searching for more appropriate activities; a beginning of analysing and evaluating our methods of teaching. Through LAP, the post-test assumes the full role of evaluation, not only evaluating the student but evaluating the teacher and programme effectiveness as well. The post-test carried out in this research was used as an instrument to

measure the effectiveness of the LAP as compared with the expository method (lecture method). Some of the advantages of LAP according to Smith (2019) is:

i. breaking down materials into small units;
ii. instruction becomes student centred (this is because they carry out Learning Activities themselves);
iii. students develop more interest in the lessons because they are actively involved. Psychological findings of Bruner, Gagne, Piaget and others as reported by Blair and Stone (2015) have shown that students become more enthusiastic when they carry out the learning activities themselves.
iv. LAP permits time for students to assimilate and accommodate the information. According to Chauhan (2015), Piaget believed that there will be no true learning unless the child mentally acts upon information and the process, assimilates and accommodates what he encounters in his environment;
v. the instructional materials so programmed can be presented using a teaching package or booklet;
vi. the teacher is relieved of his/her routine tasks and drills;
vii. it builds self-confidence in students. It enables the students to tackle and solve problems in their learning experiences.
viii. it builds scientific attitudes in students. Such attitudes are open-mindedness, curiosity, determination, etc.
ix. it makes for meaningful learning (Wandesee, 2010).

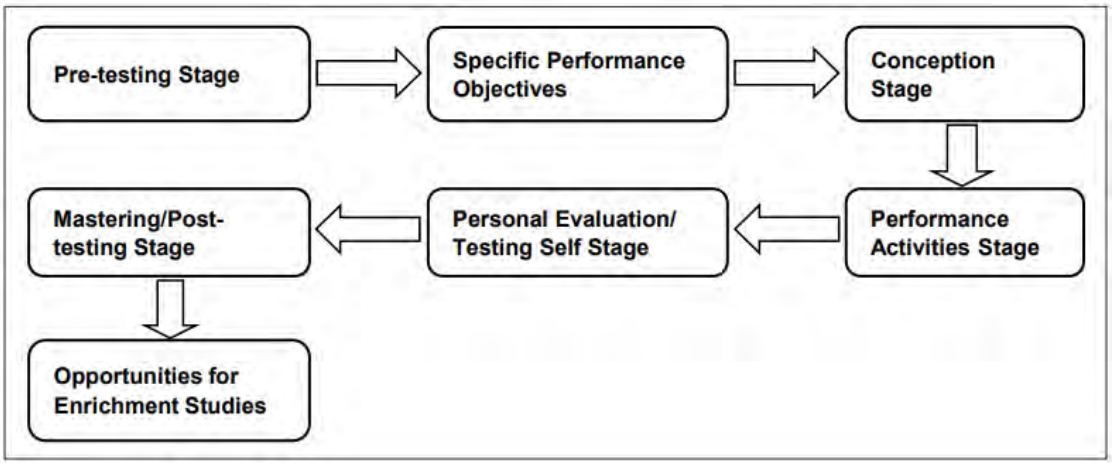

Figure 1: The Learning Activity Package Components Pathway (Source: Udu, 2018)

From the above advantages, it can be seen that the use of the LAP method is likely to enhance performance. That is why the researcher investigated the effectiveness of LAP in teaching some biology topics and its effects on achievement and retention.

2.5 Biology as a Subject

Biology is the science that studies the nature of living creatures. It is a field through which humans can understand all of the living things around them, including plants, animals, microscopic organisms, and so on. Biology is not only about describing living creatures; it is also about how to apply that knowledge in a wide variety of contexts. The knowledge of biology helps develop communities through the preparation of its citizens into fields such as agriculture, medicine, biotechnology and genetic engineering; the benefits of this type of knowledge, and competent people in these fields of study, are an immense benefit for society (Brewe, Kramer, & Sawtelle, 2010). Researchers have proposed that there are other benefits for students, as well, in terms of their intellectual development. For example, Dancy et al., (2016) believed that biology has an impact on the development of the physical, emotional and

intellectual person from childhood to adulthood, and knowledge of biology helps students to learn about responsible behaviour and to maintain healthy behaviours.

Academically, many areas in a biology class curriculum overlap with other fields of scientific knowledge, particularly physics and chemistry. This overlapping knowledge provides an important opportunity to teach not only biology but to contribute to the mastery of all scientific subjects in a wider variety of applications and contexts. Despite the aforementioned advantages, many schools and their teachers have found that teaching young people about biology can be challenging, for several reasons. In the field of education, researchers have found that teaching sciences can be problematic in terms of the lack of practical instructional tools, or perhaps, even more importantly, a lack of understanding as to how to correctly implement teaching best practices in the biology classroom (Brewe et al., 2010). Ghana has been making changes in the curriculum to help teachers better teach their students, but simply introducing curriculum changes may not be enough when it comes to knowing how to teach or use technology in the classroom. To appreciate this, we must explore the teaching methodologies mostly used by Ghanaian biology teachers.

2.5.1 Current research into the teaching of biology in Ghana

In recent years, Ghana has spent much time, money, and effort to improve the materials and curriculum for its students. These changes have come across all subject areas, and include the study of biology. Eddy and Hogan (2014) described the goal of teaching biology in Ghana as a move from simply memorizing and recalling information, to applying it in different situations and contexts. The new method of teaching biology is different because it considers the students' role as active participants in their learning. The role of the teacher has also changed. The teacher acts as a guide for the students, by helping them take parts of the lesson, such as

individual facts and observations, and apply them to broader contexts. This process helps the teacher to connect the concepts that are difficult to understand for students and contributes to the student's acquisition of abstract concepts that are difficult to learn through traditional teaching methods. This process promotes the learning of science through research and encourages the student to think critically. Through this process, the students can investigate, survey, explore, compare and research topics, all with the goal of both promoting area content knowledge and critical thinking skills. These higher-order thinking skills lay the groundwork for students to arrive at their understandings, through observation and reasoning skills. (Awotua-Efebo, 2016)

In the traditional lecture style of teaching, the answers and ways to understand a concept are through the teacher as the provider of knowledge in the class. The expectations of the students in the curriculum have also changed in terms of how student knowledge is assessed. The focus for assessments and exams used to be on recalling small details and facts. Now, students are expected to be able to explain and understand the way things work, as this creates a more complete, longer-lasting knowledge of the topic. (Enohean, 2018)

Experts in the development of a new biology curriculum in Ghana have suggested that educators teaching this subject apply a learning quintet cycle (Pollock et al., 2013). This cycle consists of five elements, namely: engagement, exploration, explanation, expansion, and evaluation. When a teacher teaches this process, he/she must organize the lesson into five steps. First, engagement is created through the presentation of the problem, which makes the students want to try to solve it. Second, exploration is where the teacher gives students the materials and guidance to collect data. This step is centred on the learner, and the teacher in charge gives students sufficient guidance and suitable materials related to the concept to be explored. In the third element,

explanation, the teacher directs students' thinking, so that students are asked to provide her/him with the information they have gathered and processed. This helps them organize their understanding and develop the appropriate language to describe the concept. The expansion is the fourth approach in which the teacher promotes discussion and development of the topic among the students to broaden their understanding and apply what they have learned. The teacher also answers questions from the students. The fifth and final stage is the evaluation stage where the teacher asks questions to students and waits for answers. Also, a student and her colleagues discuss the solutions reached and compare and evaluate their findings with the findings of their classmates. This process of lesson creation can be applied to all subjects, but is especially relevant to the sciences, including biology, as experimentation has the benefit of allowing students to apply what they have learned to hands-on, collaborative tasks. Pollock et al., (2013)

2.6 Methods of Teaching Biology

Research on concept acquisition (Williams, 2017) has revealed that children learn by active interaction initially with concrete objects and later with abstract entities. Additionally, Joyner and Farmer (2013) suggested that cognitive development occurs through active involvement; interaction of the child with objects and phenomena that leads to cognitive conflicts and subsequently to equilibration or self-regulation. Biology as a way of acquiring knowledge includes a set of unique procedures or processes which are regarded as 'standard' or acceptable in generating new knowledge. Biology is characterized and differentiated from other ways of knowing by the nature of its knowledge and the procedures by which new knowledge is generated. The importance of using a variety of learning models in teaching biology probably cannot be over-emphasized from a psychological point of view. One of the

principal causes of students' losing interest in biology, according to Williams (2017) is the approach adopted by the teacher in teaching the subject. The biology teacher should be well acquainted with the use of a variety of instructional approaches in teaching biology content.

According to Horton (2012), approaches or strategies that one uses to communicate to learners in the teaching and learning process are referred to as the teaching method. Appropriate styles through which one can present a lesson are also referred to as teaching methods or styles. Teaching methods can otherwise be described as instructional methodology, which includes all the special ways through which an instructor imparts or inculcates knowledge into the learner. Such instructional methods may vary from teacher to teacher and from subject to subject. Every instructional method aims at involving the learner in meaningful activities which will result in the successful attainment of learning objectives (Dancy et al., 2016).

Brewe et al., (2010) defined teaching method or style as how a teacher effectively and efficiently interacts within the classroom environment to bring about quality subject matter among students. According to Brewe et al., there are three teaching methods identified in the teaching and learning of biology. These are discipline-centred, teacher-centred, and student-centred methods of teaching.

Discipline-centred method of teaching aims at the subject matter rather than what the teacher does. Contents of the syllabus or textbook must be covered regardless of what the student absorbs. This method is mostly used in senior high schools as the content must be given to students before they write their final external examinations. (Eze, 2012).

The teacher-centred method of teaching is also known as the 'chalk and talk' method of teaching. The teacher acts as an authoritative expert, the main source of knowledge and the central point of every activity in the teaching and learning process. In this teaching arena, students are passive and they merely regurgitate content. Teaching in this context is to transmit information and help the student to master facts for examination purposes only. Teacher-centred methods of teaching include lectures, explanations and illustrations. This allows minimal teacher-student interactions though much information is given to students. The lecture method is most effective at the tertiary level of education and during the introduction, demonstrations and summary of a lesson at the primary and secondary levels of education. (Ezeh,2019)

The learner–centred method is the most effective teaching method for creating a dynamic classroom environment. The prior concern of the teacher is how to engage students in activities to develop their ideas, and share them with others through collaborative work. Students can develop skills and have a cognitive understanding of concepts. Classroom activities, instructional contents and teaching methods are selected to facilitate active learning, and critical thinking, stimulate interest and promote a positive attitude towards science. The teacher in this situation is a facilitator; hence he or she uses approaches that encourage flexibility and more student engagement. Learner–centred methods of teaching include, questioning, collaborative learning, cooperative learning, discussions and activity-based methods.

The teacher-centred process raises a series of related questions for teachers: How well do we know what our students already know? What are their interests? What do they want to learn? And what lessons they walk away with from our teaching (Agus et al., 2019). The best way to learn the answers to these questions is to ask them often. Instructors should often ask their students to list what they know, what they want to

know, and what they learned in each class (Agus et al., 2019). These data are exceptionally helpful in adjusting the content of lessons to ensure that you meet the needs of the greatest number of students. Other classroom assessment techniques that are easy to use include asking students how the material relates to them or their interests, inquiring about what remains confusing, or allowing students to provide feedback to the instructor via clickers (Joyner & Farmer, 2013). These methods complement the helpfulness of frequent quizzes and written assignments that regularly monitor students' performance. Teachers who use differentiated instruction (Rakes & Casey, 2015) give students different options during class time (e.g., students form flexible groups that have complementary tasks centring on the topic of the lesson). Similarly, students have the opportunity to select from a range of options for evaluation (e.g., research paper, oral presentation, applied project, traditional exam). This approach builds on students' strengths and interests in learning biology.

According to Danso (2013), teachers need to know how students learn; this will enable teachers to put what they want to teach in suitable ways for learning to occur easily and also to expose learners to the techniques that make learning easier. According to Zhang and Chen (2019), all teaching styles can stimulate learning if used appropriately, although the student-centred style leads to better retention, better problem-solving, better application of knowledge and better motivation for learning. Examples of teaching methods used in Ghanaian schools are discussion, discovery activity, lecture, brainstorming, project, demonstration, etc. The fact that learning to "explain ideas in biology" as well as to "evaluate arguments based on scientific evidence" is given little emphasis at all levels suggests that students may be learning biology without understanding what they learn (Williams, 2017). It could also mean that biology teachers are relying on teaching methods or strategies that are ineffective

in promoting understanding of the subject. The teaching of biology in senior high schools can be made easy and interesting or difficult and boring depending upon the teacher's approach to teaching. Some teaching methods that can be used to teach biology contents are discussed next.

2.6.1 The lecture teaching method

This is a teacher-centred, student-peripheral teaching approach in which the teacher delivers a pre-planned lesson to the students with or without the use of instructional materials (Nwagbo, 2019). McCann and Johannessen (2015) observed that in using the method, the teacher talks about science while the students read about science. According to Awotua-Efobo (2016), the teacher comes to the class fully armed with a mass of facts, probably gathered from books and would start to pour out the fact. The teacher presents ideas or concepts, develops and evaluates them and summarizes the main points at the end, while the students listen and take down notes. Usually, during the course of lecturing, students' questions are not normally encouraged and in cases where questions arise, they are usually for clarification of important facts. The lecture method of instruction can be useful in teaching some biological topics or in conjunction with other methods, can be used successfully in teaching some biological concepts. However, some of its disadvantages are identified by Eya and Igbokwe (2000) as follows:

- It does not develop students' manipulative skills in science, as they are passive listeners.
- It does not cater for individual differences among the students, with the result that the slow learners and the academically weak students are dragged at a pace they cannot cope with. This may lead to low achievement and loss of interest.

- The method appeals only to the sense of hearing. This makes the method not suitable for teaching science in secondary schools. Tawari (2016) stated that complete learning takes place when the child uses all his senses in the learning process.
- The major drawback of the lecture method is that it is essentially a unidirectional mode of communication. The listening student in most cases has little or no information to influence the nature and rate of flow of information. One way communication offers little in the way of interaction and feedback, which is very essential for learning to occur. When used excessively, the lecture method encourages intellectual passivity, which is the opposite of learning and may not develop in the students the processes of inquiry and problem-solving. In other to minimize some of these drawbacks, there may be a need for an individualized method of instruction like the Learning Activity Package (LAP).

2.6.2 Question and answer (citation)

Question and answer are defined as a method both for teaching and oral testing based on the type and use of questions. Questioning techniques are one of the basic and successful ways of stimulating students thinking and learning (Dancy et al., 2016). It applies to all teaching approaches and methods.

2.6.3 Discussion

A discussion approach to instruction is an important component of any teaching or learning situation which allows students to share their ideas (Dancy et al., 2016). It can be used at the beginning of a topic to ascertain students' preconceived notions of the subject matter. Or toward the end of a subtopic by presenting the student with a new situation and asking them to explain it in terms of what they have just learned. The discussion method is a teaching and learning strategy that entails sharing and

exchange of ideas, experiences and opinions (Dancy et al., 2016). The strengths of the discussion method are; increases the depth of learners' understanding, enhances motivation and generates greater involvement of the learners, promotes leadership role skills, develops skills of organizing and presenting ideas to others in a logical form and develops a spirit of cooperation among learners. Despite the strengths, there are also limitations of the discussion method which include; being time-consuming, can be used effectively with a limited number of learners, and not being well handled some extrovert learners may dominate the discussion.

2.6.4 Brainstorming

Brainstorming is a teaching technique in which every pupil's response that applies to a given topic is acceptable (MIE, 2014). The strengths of brainstorming are; promotes exploration, analysis and problem-solving skills, develops a sense of cooperation and group cohesiveness in problem-solving, encourages the generation of creative ideas, and promotes the generation of initiatives in searching for solutions to problems. The limitations of brainstorming are; it is time-consuming if not planned, more useful to a limited number of learners and needs thorough preparation.

2.6.5 Peer instruction

Peer Instruction (PI) is a research-based pedagogy for teaching large introductory science courses (Fagen & Mazur, 2013). It is a method created to help make lectures more interactive and to get students intellectually engaged with what is going on. PI provides a structured environment for students to voice their idea and resolve individual misunderstandings by talking with their peers (Gok, 2012). Peer instruction is a cooperative learning technique that promotes critical thinking, problem-solving, and decision-making skills (Rao & Di Carlo, 2019). This method has the advantage of engaging the student and making the lesson more interesting to the student. It also has

the tremendous importance of giving the teacher significant feedback about where the class is and what it knows.

Despite these arrays of teaching methods being advocated in the literature, there is no one universally accepted method. Both learners-centred and teacher-centred methods of teaching are important in teaching and learning (Haas, 2012; Gulobia, Wakadala & Bategeka, 2018), and each is appropriate depending on the environment within which they are used. For teaching to be more effectively done, a combination of these methods should be employed since education has many different types of approaches and contexts.

2.6.6 Presentation

The presentation method of teaching involves motivating listeners to accept a new idea, alter an existing opinion or act on a given premise. The strengths of the method include mastery of the topic by the students, increases confidence among students, a good way to learn, and student searching a lot of books to collect material. Nonetheless, the presentation method has the following disadvantages; learners may collect erroneous data, students with low confidence levels may find it difficult to engage themselves in the activity, and it is time-consuming as the presenter spends a lot of time gathering relevant information. (Gok, 2012)

2.6.7 Seminar

The seminar method is a structured group discussion that may follow after a formal lecture or some sort of experience (Kimweri, 2014). The strengths of the seminar method are to stimulate and test learners' ability of comprehension, promote learners' ability of understanding and question, develop learner's sense of self–reliance, cooperation and responsibility, and ability in report writing and presentation to fellow

learners for the exchange of view and decision making. The limitations of the seminar method are; needs enough time for the learner or presenter to plan, some learners especially those who are shy and reserved may not be able to participate effectively during discussion time and some learners, particularly the vocal ones might dominate the discussion.

2.6.8 Demonstration

The demonstration method is a practical display or exhibition of a process to show or point out the fundamental principles or actions involved (Kimweri, 2014). Teaching by demonstration is a useful tool available to the teacher and plays an important part in the teaching of skills; however, for a demonstration to be effective, it should immediately be followed by a practical session to reinforce procedures (Kimweri, 2014). The strengths of demonstration include; learners getting the experience of what they are learning, interesting to learners and thus promoting their attention and retention. The limitations of the demonstration method are; time-consuming and expensive, needs thorough preparation, practice and rehearsal before the session, enough teaching and learning materials are required to successfully conduct a demonstration, and it is more appealing when used with a group that has a limited number of learners. Other methods of teaching are the role-play method, case study, and field trips.

2.6.9 The individualised instruction

The ideas underlying the concept of individualized instruction are that learners differ in their learning characteristics and that these differences need to form the basis for planning instruction for every individual learner. Different people learn best in different ways. An instructional approach that is aimed at individualizing the process of learning should be adopted. The individualized methods of instruction help the

students to become self-renewing. They reduce the number of drop-outs from schools, as each child moves at his or her rate. They make teaching and learning more precise. This is because it adjusts both the objectives and methods of learning to the needs and characteristics of the learners. (Hwong, 2013)

According to Offorma and Offoefuna (2018), individualized instruction is an instructional procedure designed to take into account the individual's aptitude and ability. According to Chauhan (2015), individualizing instruction means tailoring instruction to the particular needs, aptitudes and abilities of the learner, in which case the learner works at his or her own pace. The method takes cognizance of variation in the individual, especially in their starting competence and abilities. The learner proceeds with the learning of material content at his own pace. The teacher acts more as a facilitator of the students learning and not as the provider of information or knowledge. The basic principle guiding the individualization of instruction is that of reinforcement and recognition of individual differences. Once the learner is appropriately and correctly linked to the learning of the material content, he/she proceeds on his/her own. He/she is made aware of his/her performance through the in-built technique that comes in form of the Immediate Knowledge of Result (IKR).

There are categories of individualized instructional methods that offer students flexible choices in the objectives of learning, rate of learning, method (style of learning) and content of learning. The extent to which choices are offered determines the degree of individualization in a particular lesson (Awotua – Efebo, 2016). Offorma and Ofuefuna (2018) outlined some of the designed methods of individualizing instruction. They include;

- Individualized Learning Plans for Life – Based Inquiry (ILPS).

- Protocol Packages (PP)
- Audio-Tutorial Training Models (ATTM)
- Learner-Controlled Instruction (LCI)
- Programmed Instruction (PI)
- Personalized System of Instruction (PSI)
- Individualized Prescribed Instrument (IPI)
- Self-Directed Individualized Instruction (SDII)
- Independent Study (IS)
- Computer Assisted Instruction (CAI)
- Learning Activity Package (LAP)

According to Offorma et al. (2018), the differences between these individualised instructions lie in:

Who determines the objectives

Who determines the methodology and

Who determines the materials to be used in achieving the stated objectives,

For instance, in the personalized system of instruction (PSI), the objectives are not prescribed by the teacher. The learner chooses what he wants to learn which is directed by the teacher. The students are actively and continuously participating in the learning process. While in Self-Directed Individualized Instruction (SDII), the objectives are stated for all the students to reach. All the materials needed to attain the objectives are provided. The students are allowed to choose how they can attain the objectives. In the Independent Study (IS), the students choose the objectives and the method for attaining them. The role of the teacher is that of the supervisor. In the Learning Activity Package (LAP), which is a booklet containing learning assignments

organized sequentially, the objectives are specified for the students. (Horton,2012). The teacher determines other objectives and the methods to be used to attain them. The package usually contains diverse activities to reach the objectives. The package also contains evaluation techniques to determine whether the objectives have been achieved or not. The individualised method of instruction has the under-listed advantages even though no single method can be used alone to teach all the topics and concepts in Biology. Note that there can be problems with the management of student resources and curricula. The advantages include:

- student frustration caused by material that is either too difficult or already mastered is minimized.
- concepts are presented at meaningful times because of variations in the sequencing of activities.
- self-pacing reduces study time. This is because there is no waiting for other students. Materials already learned are not restudied.
- criterion – reference design allows learners to be evaluated on personal performance criteria and not on peer performance.
- it makes the learner to be actively involved in the learning process.
- the teacher is freed from mere routine work to more professional duties.

The initial take-off of individualized instruction in advanced countries like the United Kingdom presented some problems, most of which have been surmounted. Neville (2000), in a paper presented to the Council of Education Technology for the United Kingdom titled – The Potential of Packaged Learning for Meeting Changing Demands for Education and Training, identified some of the weaknesses of packaging learning. One of them is the possibility of providing adequate education or training, when and where it is required by an individual. In addition, it was found that many

staff in further education found themselves required to practice a technology for which they had no training. He also observed that some of the packaged materials have been tried and rejected. The reason is that the authors came from a situation different from that in which the users find themselves and therefore lack credibility. It was also identified that poor information and distributary network were already inhabiting the wide use of packages. All these and similar problems and limitations faced by the use of packaged instruction in the United Kingdom have been surmounted by the advancement in science and technology in these developed nations, which had led to the wide use of various methods of individualized methods.

In Ghana, all these methods can be studied if one or more factors are put under control. Some of them are good preparation of the teachers, provision of equipment and infra-structural facilities and proper time scheduling. The researcher could not study all the various types of individualised instructional methods. Rather the Learning Activity Package (LAP) was used in this study.

2.7 Summary of Literature Review

Evidence of poor achievement in science, perhaps as a result of a lack of appropriate strategies for enhancing achievement and retention, abounds. This is very eminent in biology as a foundational course for subsequent studies in other science-related courses. This necessitates the exploration of techniques and strategies for attaining meaningful learning of biology using the Learning Activity Package (LAP). A review was also made of the lecture and individualised methods of instruction, each of which has its merits and demerits. It is obvious that no method is considered appropriate for all teaching situations and all science concepts, but methods that encourage the active participation of the learner in the teaching–learning process are often preferred to others. LAP is one such method. Generally, the previous studies on the use of

individualised methods of instruction so far reviewed have established an inconsistency in the effectiveness of the Learning Activity Package relative to the conventional method (lecture method). Tawari (2016), Burnside (2011), Smith (2019) and Igboanugo (2016) found individualised instruction more effective. Hwong (2013) found cooperative learning more effective than the individualized method of instruction. The literature reviewed so far, investigated the effectiveness of the individualized method, and nothing specifically on the use of LAP. Most of the studies were carried out in other subject areas like physiology, psychology, computer, music and physics. Based on the literature available to the researcher, the studies did not investigate the effect of LAP on students' retention in the topic of instruction. Hence, this study examined the effect of the Learning Activity Package (LAP) on students' achievement and retention in biology.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Overview

This chapter presents the general plan for carrying out the study. Specifically, it describes the design of the study, the area of the study, the population of the study, sample and sampling techniques, classification of ability group, instrument for data collection, development of learning activity package, validation and instrument, item analysis, reliability of the instrument, control of extraneous variables, experimental procedure, method of data collection and method of data analysis.

3.1 Design of the Study

The design of the study was a quasi-experimental design of the pre-test and post-test Non-equivalent group design. The design is often used in classroom experiments when experimental and control groups are assembled as intact classes and no possibility of randomisation. Hence, intact classes were used and there was no random assignment of research subjects. The design is represented in the Table:

Table 1: Diagrammatic Representation of the Research Design

Group	Pre-test	Treatment	Post-test	Retention
EG	O_1	X_1	O_2	O_3
CG	O_1	X_2	O_2	O_3

Where:

EG = Experimental Group

CG = Control Group

O_1 = Pre-Achievement Test

O_2 = Post Achievement Test

O_3 = Retention Test Scores

X_1 = Experimental Treatment

X_2 = Control Treatment

3.2 Area of the Study

The research was carried out in two senior high schools within two educational districts: the Adansi North District and Obuasi Municipal both in the Ashanti Region in the Republic of Ghana. The schools include Asare Bediako Senior High School in the Adansi North District and Obuasi Senior High Technical School in the Obuasi Municipal. The Asare Bediako Senior High School also known as ABSEC is a coeducational second-cycle public high school institution located in Akrokerri in the Adansi North District in the Ashanti region of Ghana (Fig. 2). The school was established in 1993, close to a waterlogged valley and sits on about 75-acres of land.

Figure 2: Location of ABSEC

Obuasi Senior High Technical School is a coeducational second-cycle public high school institution in Obuasi in the Obuasi Municipal District in the Ashanti Region of Ghana. The school was established in November 1965. Obuasi Senior High Technical School and Asare Bediako Senior High School are 15.8 km apart. Both schools offer biology.

3.3 Population of the Study

The target population of the study comprised all coeducational government run senior high schools in the Ashanti Region – Ghana. The accessible population comprised students who were offering biology at Asare Bediako Senior High School and Obuasi Senior High Technical School at the time of the study. The choice of year students was because the selected biology topics treated in this study were meant for form two (2) as contained in the biology syllabus of the Ghana Education Service for senior high two (2). The choice of co-educational secondary schools was based on the fact that gender is a variable in the study.

3.4 Sample and Sampling Technique

The sample used for the study consisted of a total of 92 students (45 males and 47 females), being members of two intact classes conveniently selected from 2 senior high schools. Of the 92 students, 48 were selected from Obuasi Senior High Technical School while 44 were drawn from Asare Bediako Senior High School. The two intact classes, one from each school, were assigned either to the Learning Activity Package of instruction (LAP) or the lecture method of instruction. The selection of the classes for either of the instructional methods was done through simple random sampling (balloting). The class assigned to the LAP became the experimental group whereas the class assigned to the lecture method became the control. The experimental was the intact class from Asare Bediako SHS while the control was that from Obuasi SHTS. Among the experimental group were 24 female and 20 male students. The control group comprised 23 females and 25 males.

3.4.1 Classification into ability groups

The students who participated in the study were classified into three – the high, average and low abilities. This classification was done based on the average performance of a student in year one (1) biology (that is the average of first and second-semester examination scores: from 0 – 34% were classified as low ability group. Those who scored from 35 to 67% in the average ability group and 68% and above were classified as having high ability levels).

3.5 Instrument for Data Collection

The instrument used for data collection was the Biology Achievement Test (BAT) developed by the researcher. There were two Biology Achievement Tests with parallel items. One of the BATs was used as the pre-test. The other was used as the post-test. Each of the BATs was a forty-item instrument, made up of multiple-choice questions with five response options, A to E. The multiple-choice test was developed from the units of senior high biology which were taught during the treatment phase of the study.

3.6 Validation of the Instrument

BATs were subjected to both face and content validations.

3.6.1 Face validation

For face validation, the instruments were given to three experts, one in Measurement and Evaluation Department and two in Science Education Department. The instruments were validated in terms of clarity of the questions asked proper wording of the items and the appropriateness of the language to the student's level of understanding. Consequently, the validators made some comments which formed the

basis for either modifying or rejecting some of the items. After the validation, the instruments were reviewed to reflect the validators' contributions.

3.6.2 Content validation

To ensure content validity, a table of specification [TOS] was developed by the researcher. The TOS was used to determine the number of items to be generated from a particular subunit. To do this, the researcher took into consideration the relative scope of the subunits. Accordingly, subunits that were large in scope attracted more questions than those that were relatively small in scope. In all, 40 multiple-choice questions were generated from the subunits.

3.7 Reliability of the Instrument

The reliability of the instruments was established through test-retest. The pre-BAT and post BAT which were parallel tests were administered to 40 form-two students who were not part of the study and two weeks after, the tests were administered again for stability. The scores obtained were used to establish reliability.

The co-efficient of equivalence was established for the pre-BAT and post-BAT. This was done using the scores obtained from the first trial testing of the two instruments on the students. The rationale for establishing this form of reliability was to ensure that the two forms of BAT contained items of comparable strength. The scores that were obtained were correlated using Pearson's Product Moment Correlation Co-efficient. A Pearson's Product Moment Correlation coefficient of 0.79 was obtained for the instrument; this showed that the instrument was reliable for the study.

3.8 Design of Learning Activity Package [LAP]

The learning activity package (LAP) is a self-contained set of instructional materials that are designed to facilitate independent learning. It is typically used in a classroom setting or for distance learning and is intended to provide students with a structured and meaningful learning experience.

A LAP typically includes a set of learning objectives, a set of materials (such as readings, videos, and other resources), and a series of activities that students can complete to help them achieve the learning objectives. The activities are often structured as worksheets, quizzes, or other interactive exercises that are designed to help students engage with the material and apply what they have learnt.

LAPs are often used in subject areas that require a lot of independent work, such as science and math, but can be used in any subject area. They are particularly useful for students who are self-motivated and like to work independently, but can also be helpful for students who need additional support or who are struggling with a particular concept.

Developing a learning activity package (LAP) typically involves several steps to ensure that it is effective and meets the learning objectives. For this study, here are the key steps followed in creating the LAP:

- Identify the learning objectives: The first step in creating the LAP was to identify the learning objectives that students were to achieve. These objectives were specific, measurable, and aligned with the curriculum standards.
- Gather materials: Once the learning objectives were identified, materials that would help the students achieve them were gathered. These included textbooks, articles, videos, models and other resources.

- Develop activities: The next step was to develop activities that would help the students engage with the material and achieve the learning objectives. These included worksheets, quizzes, simulations, and other interactive exercises.
- Organize the LAP: Once the activities were developed, they were carefully organized into a logical sequence that would guide the students through the learning process.
- Pilot test the LAP: Before implementing the LAP with your students, it is a good idea to pilot test it with a small group to identify any areas that may need improvement.
- Implement the LAP: After the LAP was refined based on feedback from the pilot test, it was deemed fit for implementation with the students. Clear instructions and support were provided to help students work through the activities.
- Evaluate the LAP: Finally, the effectiveness of the LAP was evaluated by assessing student learning outcomes and gathering feedback from students. This feedback might be used to make improvements and refine the LAP for future use.

3.9 Experimental Procedure

The following procedures were adopted in the administration of the instruments.

3.9.1 Pre-test session

Before the treatment, the research participants were given a pre-test. The test was administered by the regular Biology teachers in the sampled schools who have undergone training. The scripts were marked by the researcher. The pre-test was used to:

- Determine the students' initial knowledge of the materials they would learn later;
- Determine the comparability of the two groups (experimental and control) concerning their achievement in the pre-test scores.

3.9.2 Treatment

The treatment for the study was the teaching of the various sub-units of the urinary and circulatory systems to the students, using the two teaching methods (the LAP and the Lecture Method), as they carried out the activities. The experimental group was taught using the LAP while the control group was taught using the lecturer method.

3.9.2.1 The experimental group

The experimental group was taught using the Learning Activity Package. The LAP which contained the introduction and the main objectives were spelt out for each topic. The frames and various activities were itemised for the students to carry out. The students were given the LAP, each student was required to carry out the activities on his or her own using the concept of self-pacing. The students were advised to consult their teachers when necessary to discuss any difficulties relating to the concept under study.

3.9.2.2 The control group

The lecture method was used in teaching the control group. In this method, the teachers articulated the relevant concepts and principles during the lesson. The students watched and listened attentively, taking down relevant notes. The teaching of both experimental and control groups was done during the normal school biology periods, using the lesson notes and the LAP prepared by the researcher.

3.9.2.3 Post-test session

After the treatment, the post–BAT was administered to the participants (both the control and experimental groups). The scripts were marked by the researcher and the student's scores were recorded.

3.10 Method of Data Collection

The pre-BAT was administered to the participants before the treatment which lasted for four weeks. At the end of the treatment, a parallel test (post-BAT) was administered. The scores for both the experimental and control groups were recorded accordingly. The test items in both the pre-test and post-test were scored one mark each. The maximum mark was 40 while the lowest mark was zero.

3.11 Methods of Data Analysis

The researcher used mean scores and standard deviation to analyse data and provide answers to the research questions. Mean and standard deviation was used because the mean is the most reliable measure of central tendency. Also, the standard deviation is the most reliable estimate of variability. Analysis of variance (ANOVA) and the t-test were used to test the hypotheses formulated for the study at a 0.05 level of significance. ANOVA was used in other to take care of the error of initial difference in the ability levels among the research participants.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This Chapter presents the relevant data for answering the research questions and for testing the hypotheses. The analysis and results are presented in tables according to the research question and hypotheses. A discussion of the main findings was done alongside the presentation.

4.1 Research Question One

What is the effect of the LAP on the performances of students of different ability groups in selected biology topics?

The mean achievement and standard deviation scores of students on the pre-BAT based on the different ability levels in biology are presented in Table 2.

Based on the data analysis presented in Table 2, there are some interesting findings to discuss. The pre-test scores of students in the experimental group and the control group have been compared based on their ability level.

Firstly, it is observed that the mean scores for the high-ability students in both the experimental and control groups are very similar, with the experimental group scoring only slightly lower than the control group. This suggests that the pre-test scores of high-ability students in the experimental group are comparable to those in the control group.

Secondly, the mean scores for the average-ability students in the experimental group are lower than those in the control group, but the difference between the two means is not very large. This suggests that the two groups are comparable.

Lastly, the mean scores for the low-ability students in both the experimental and control groups are again very similar, with no significant difference between them. This suggests that the pre-test scores of low-ability students in the experimental group are comparable to those in the control group.

Overall, the findings indicate that the students in the experimental group were comparable to the students in the control group before the treatment.

Table 2: Students' Performance in Pre-BAT Based on Ability Level

Group	Statistic	High Achievers	Average Achievers	Low Achievers
Experimental	Mean	25.7	18.5	11.6
	SD	2.2	1.8	2.2
	N	14	15	15
Control	Mean	28.9	19.5	11.7
	SD	2.7	2.5	2.3
	N	16	15	17

**SD = Standard Deviation *N = Number of Students*

The mean achievement and standard deviation scores of students on the post-BAT showing the effect of the interaction between teaching strategies and different ability levels in biology are presented in Table 3 (Appendix B).

Based on the analysis, it can be inferred that the experimental group outperformed the control group on the post-test, with mean scores of 28.7, 25.3, and 21.1 for high, average, and low-ability groups respectively. On the other hand, the control group had mean scores of 26.7, 22.5, and 17.11 for high, average, and low-ability groups respectively.

It is important to note that, the standard deviations for the mean scores of the experimental group were higher than those of the control group. This indicates that there was more variability in the scores of the experimental group, suggesting that the intervention had a differential effect on the students. (Joyner & Farmer, 2013)

Based on the analysis of the post-BAT data, it can be inferred that the intervention had a greater impact on students in the high-ability group, with a mean score of 28.7 and a standard deviation of 7.3. Furthermore, the impact of the intervention seems less pronounced for students in the average-ability and low-ability groups, with mean scores of 25.3 and 21.1 respectively. Additionally, the standard deviations for these groups were higher, indicating more variability in the scores.

Table 3: Students' Performance in Post-BAT Based on Ability Level

Group	Statistic	High Achievers	Average Achievers	Low Achievers
Experimental	Mean	28.7	25.3	21.1
	SD	7.3	7.8	6.8
	N	14	15	15
Control	Mean	26.7	22.5	17.1
	SD	5.1	8.2	7.4
	N	16	15	17

**SD = Standard Deviation *N = Number of Students*

However, comparing the pre-test results (Table 2) to the post-test results, it appears that the intervention had a positive impact on student learning across all ability groups for both the experimental and control groups. For the experimental group, the mean scores on the pre-test were 25.7, 18.5, and 11.6 for high, average, and low-ability groups respectively. On the post-test, these scores increased to 28.7, 25.3, and 21.1, respectively. This indicates that the intervention had a positive effect on student

learning for all ability levels, with particularly notable gains for the low-ability group. This suggests that the intervention was particularly effective for low-achieving students. (Obiakor, Parrish & Forgelberg, 2006)

Similarly, for the control group, the mean scores on the pre-test were 28.9, 19.5, and 11.7 for high, average, and low-ability groups respectively. On the post-test, these scores increased to 26.7, 22.5, and 17.11, respectively (Appendix B). This also indicates that there was some improvement in student learning for all ability levels in the control group, although the gains were less significant than those observed in the experimental group.

It is also worth noting that the standard deviations for the mean scores on the pre-test were generally lower than those on the post-test, suggesting that the intervention had a greater impact on reducing variability in student learning. Overall, these findings suggest that the intervention had a positive effect on student learning across all ability levels, although the impact was more pronounced in the experimental group.

Several studies (Srisawasdi & Wuttiprom, 2015; Agus et al., 2019; Zhang & Chen, 2019) have investigated the impact of LAP on student performance and have reported positive results. For example, a study conducted by Srisawasdi and Wuttiprom (2015) found that LAP improved students' problem-solving skills and learning achievement in chemistry. Another study by Agus, Asmawi, and Hamidah (2019) reported that LAP was effective in enhancing students' critical thinking skills in mathematics. Similarly, a meta-analysis conducted by Zhang and Chen (2019) on the effects of LAP on science learning found that LAP significantly improved student achievement in science. The analysis also found that the effectiveness of LAP was moderated by several factors, such as the subject area, type of LAP, and duration of implementation.

In comparison to these existing studies, the findings from the analysis provided in the earlier discussion support the positive impact of LAP on student learning in the experimental group, particularly for low-ability students. However, the impact of LAP on average and high-ability students was less pronounced. The control group also showed some improvement in student learning, although the gains were smaller than those observed in the experimental group. It is worth noting that the existing literature suggests that LAP can be effective in improving student learning across various subject areas and skill domains, although the effectiveness may depend on several factors (Srisawasdi & Wuttiprom, 2015; Agus et al., 2019; Zhang & Chen, 2019). The findings from the current analysis provide additional support for the positive impact of LAP on student learning, and further highlight the need to consider individual differences in student abilities when designing and implementing LAP.

In summary, while the findings from the current analysis align with existing literature on the effectiveness of LAP in improving student learning, additional research is needed to further investigate the factors that influence the effectiveness of LAP and to identify ways to maximize the impact of LAP on student learning outcomes.

Testing null hypothesis one: There is no statistically significant difference between the mean scores of students belonging to different ability groups, taught using the LAP.

This null hypothesis was tested using the one-way ANOVA (analysis of variance) test. The significant level was set at 0.05. The result is presented in Table 4.

Based on the ANOVA test performed, the p-value obtained is 0.03 which is less than the significance level of 0.05, indicating that there is a statistically significant difference between the mean scores of the three ability groups. In other words, the

null hypothesis, which states that there is no significant difference between the mean scores of the three groups, can be rejected in favour of the alternative hypothesis, which states that there is a significant difference between the means.

Table 4: ANOVA-Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Low ability	15	317	21.13	45.98
Medium ability	15	380	25.33	60.52
High ability	14	402	28.71	53.91

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	419.05	2	209.53	3.92	0.03	3.23
Within Groups	2191.92	41	53.46			
Total	2610.98	43				

However, the p-value alone does not provide information about the magnitude of the difference or the direction of the effect. To further understand the results, a post-hoc tests was conducted to determine which groups are significantly different from each other. The result is presented in Table 5.

Based on the Scheffé Multiple Comparison test, the mean differences between the low-ability group and the average-ability group as well as between the average-ability group and the high-ability group are not statistically significant, with p-values of 0.30 and 0.46, respectively. However, the mean difference between the low-ability group and the high-ability group is statistically significant, with a p-value of 0.02. This suggests that there is a significant difference in performance between the low-ability and high-ability groups.

The effect size for the low-ability vs high-ability comparison is moderate, with a value of 0.47. This indicates that the difference between the means of the two groups is not only statistically significant but also practically significant, meaning that the impact of the treatment was more pronounced in the high-ability learners than the low ability learners.

These findings suggest that while there may not be a significant difference in performance between the low-ability and average-ability groups or between the average-ability and high-ability groups, there was a meaningful difference in performance between the low-ability and high-ability groups.

Table 5: Scheffé Multiple Comparison

Treatments Pair	Scheffé T-Statistic	Scheffé p-value	Scheffé Inferfence	effect-size (r)
LA vs AA	1.5731	0.3007627	Insignificant	0.2765495
LA vs HA	2.7901	0.0283336	* p<0.05	0.4726506
AA vs HA	1.2443	0.4677154	Insignificant	0.2181020

*LA = low ability; AA = average ability; HA = high ability; * = significant*

LAPs are instructional materials designed to guide student learning through a series of self-paced activities that allow for individualized and interactive instruction. They are often used in conjunction with other teaching methods, such as lectures or discussions, to enhance student engagement and comprehension. Several studies have examined the effectiveness of LAPs in various contexts, including science, mathematics, and language learning, among others (Horton, 2012; McCann & Johannessen, 2015; Rakes & Casey, 2015).

In the context of the current study, it is possible that the use of LAPs may have had a greater impact on high-ability students, leading to the significant difference in

performance between the low-ability and high-ability groups. This could be due to a variety of factors, such as the complexity of the LAPs, the level of prior knowledge required to complete the activities, or individual differences in learning styles or motivation.

Alternatively, it is possible that the LAPs were not effective in improving the abilities of low-ability students, which may account for the lack of significant differences between the low-ability and average-ability groups, and the average-ability and high-ability groups. Further research would be needed to confirm or refute these possibilities, and to determine the specific factors that may contribute to the effectiveness of LAPs for different student populations.

4.2 Research Question Two

What differences are observed between the performances of male and female students when the LAP was used to teach biology?

The mean achievement and standard deviation scores of students on the post-BAT showing the effect of the treatment based on sex are presented in Table 6.

The analysis provides information on the mean scores and standard deviations of male and female students on a post-test. The mean score of male students is 27.6, while that of female students is 22.7. This suggests that, on average, male students performed better on the post-test compared to their female counterparts.

The standard deviation of male students is 6.9, which indicates that the scores of male students were less variable than those of female students. The standard deviation of female students is 7.8, suggesting that the scores of female students were more variable than those of male students.

Table 6: Students' Performance in Post-BAT Based on Sex

Group	Mean	SD	N
Males	27.6500	6.9455	20
Females	22.7500	7.8919	24
Pooled Total	**24.9773**	**7.7923**	**44**

**SD = Standard Deviation *N = Number of Students*

LAPs are instructional materials designed to provide students with a structured approach to learning. They typically include a variety of activities, such as readings, exercises, and assessments, that are designed to help students acquire knowledge and skills in a particular subject area. LAPs have been used in a variety of educational settings, from K-12 schools to higher education institutions.

Research on LAPs has generally found them to be effective in improving student learning outcomes, including academic performance. However, there is limited research specifically examining gender differences in academic performance in relation to LAPs.

One study by Obiakor, Parrish, and Fogelberg (2006) examined the use of LAPs with students with disabilities and found that both male and female students improved their academic performance following the use of LAPs. Another study by Joyner and Farmer (2013) found that LAPs were effective in improving the academic performance of male and female students in a college-level statistics course.

Overall, while there is limited research specifically examining gender differences in academic performance in relation to LAPs, the existing research suggests that LAPs can be effective in improving student learning outcomes regardless of gender. To

better understand the potential differential effects of LAPs on male and female students' academic performance, the results were subjected to statistical testing.

Testing null hypothesis two: There is no statistically significant difference between the mean scores of male and female students exposed to the LAP instructional approach.

The p-value for the test is 0.03, which is less than the significance level (alpha) of 0.05. This suggests that one can reject the null hypothesis and conclude that there is a statistically significant difference between the mean scores of males and females on the post-test.

Additionally, the effect size of 0.31 suggests that the difference between the mean scores of males and females is low in magnitude. This effect size is calculated using Cohen's d, which is a standard measure of effect size for independent samples t-tests. An effect size of 0.2 is generally considered small, 0.5 is moderate, and 0.8 or greater is large. It is inferred from the effect size of 0.31 that even though the difference between the mean scores of males and females is statistically significant, its practical implication is low hence may not be seen.

In summary, based on the results of the t-test, it appears that there is a statistically significant difference between the mean scores of males and females on the post-test, with males performing better on average. The effect size suggests that this difference is low in magnitude with no significant practical implication (Table 7)

Table 7: t-Test: Two-Sample Assuming Unequal Variances

Statistic	Male	Female	effect-size (r)
Variance	48.23947368	62.2826087	0.31
Observations	20	24	
Df	42		
t Stat	2.18979627		
p-value	0.034145047		
t Critical	2.018081703		

LAPs have been found to have positive effects on students' learning outcomes, including increased exam scores and retention rates (Pollock et al., 2013). However, the impact of LAPs on different genders has been a topic of interest in educational research. The finding that males performed significantly better than females on average when LAPs were used to teach biology is consistent with some previous research findings. For instance, one study found that LAPs had a larger impact on male students' exam scores than on female students' exam scores (Dancy et al., 2016). Similarly, another study found that male students showed greater gains in understanding biology concepts after participating in a LAP compared to female students (Brewe et al., 2010).

However, it is important to note that the effect size in this particular study was low, which suggests that the difference in performance between males and females was not very large. This finding is in contrast to some previous studies, which have reported larger gender differences in the effectiveness of LAPs. For example, a study by Eddy and Hogan (2014) found that the LAP had a larger impact on male students' exam scores than on female students' exam scores, and the effect size was relatively large.

There are several possible explanations for the gender differences in the effectiveness of LAPs. One explanation is that male students may be more likely to participate in

LAP activities and take advantage of the opportunities provided by LAPs than female students. This could be due to differences in motivation, confidence, or cultural factors. Another explanation is that the LAP activities may be more aligned with male students' learning styles or interests than female students' learning styles or interests. (Omoniyi, 2016)

It is important to note that the gender differences observed in LAP effectiveness are not necessarily indicative of inherent differences in cognitive ability between males and females. Rather, these differences may be due to a variety of contextual and social factors that influence how male and female students engage with and benefit from educational interventions like LAPs. (Onekutu & Onekutu,2012)

In conclusion, the finding that males performed significantly better than females on average when LAPs were used to teach biology is consistent with some previous research findings, but the effect size in this particular study was low.

4.3 Research Question Three

What is the difference between the performances of students taught biology using the LAP and those taught using a conventional method?

The mean achievement and standard deviation scores of students on the post-BAT showing the effect of the treatment on control and experimental groups are presented in Table 8.

Based on the descriptive analysis, it appears that the experimental group scored higher on the post-test compared to the control group. The mean score of 24.97 for the experimental group suggests that, on average, participants in this group performed better on the post-test compared to the control group who had a mean score of 19.87. Furthermore, the standard deviation for both groups indicate the degree of variability

or dispersion in the data. The higher standard deviation for the experimental group (7.79) compared to the control group (6.47) suggests that there was more variability in the experimental group's scores. In other words, while the average score for the experimental group was higher, there was also a wider range of scores in that group.

Overall, these findings suggest that the intervention or treatment provided to the experimental group may have had a positive impact on their performance on the post-test.

Table 8: Effect of Treatment on Control and Experimental Groups

Group	Mean	SD	N
Experimental	24.9773	7.7923	44
Control	19.8750	6.4795	48
Pooled Total	**22.3152**	**7.5461**	**92**

**SD = Standard Deviation *N = Number of Students*

It is important, however, to note that descriptive analysis only provides a summary of the data and cannot establish causality. Therefore, to understand the data better, inferential testing was adopted to determine whether the difference in scores between the experimental and control group is statistically significant or due to chance. The result of the inferential testing is presented next.

Testing hypothesis three: There is no statistically significant difference between the mean scores of students taught biology using the LAP and those exposed to a conventional method.

Based on the mean scores of the experimental and control groups, it appears that the experimental group had a higher mean score (24.9) compared to the control group (19.8). Further, the t-test analysis indicates that the difference in mean scores between the two groups is statistically significant. The p-value of 0.0007, (Table 9) which is

less than the pre-defined alpha level of 0.05, suggests that the observed difference in mean scores between the two groups is not likely to have occurred by chance. It also suggests that there is enough evidence to reject the null hypothesis that there is no statistically significant difference between the mean scores of students taught biology using the LAP and those exposed to a conventional method.

Additionally, the effect size of 0.34 indicates a moderate effect of the experimental intervention on the post-test scores. This means that the experimental group's scores were not only higher, but the difference in scores between the two groups is also practically significant.

Therefore, based on these results, it can be concluded that the experimental intervention had a statistically significant, moderate effect on the post-test scores of the participants compared to the control group. This suggests that the experimental intervention may have a positive impact on the performance of students in biology and may warrant further investigation or implementation in practice.

Table 9: t-Test: Two-Sample Assuming Unequal Variances

Statistic	**Experimental**	**Control**	**effect-size (r)**
Variance	60.72040169	41.76965772	0.34
Observations	44	48	
Df	84		
t Stat	3.488094512		
p-value	0.000776829		
t Critical	1.988609667		

Result of data analysis on Table 9 shows that students taught with LAP performed significantly better in the biology concepts than their counterparts who were taught using the lecture method.

This result is in agreement with the result of earlier studies carried out by Obiakor, Parrish and Fogelberg (2006) who found that Learning Activity Package (LAP) was more effective than the conventional methods in fostering students' achievement. The relative superiority of the LAP over the lecture method in enhancing students' achievement in biology could be attributed to the fact that, as a teaching method the LAP is student – centred and ensures active participation of students in the teaching learning process more than the lecture method. The lecture method often subjects the learner to the position of the passive recipient of the facts as handed down to him by the teacher. Moreover, the activities in the LAP were carried out by the students themselves, at their own pace during and after the school periods; which is in contrast to the lecture method where the teacher did most of the work for the students. The active participation of the students involving the use of several sense organs invariably should arouse greater interest. Given, these prevailing circumstances under which the LAP and the lecture method are employed in classroom instruction, it is not surprising that the treatment group (LAP) outperformed the control group in the post-BAT. The above result on the effect of LAP on achievement, does not, however, agree completely with findings of Joyner and Farmer (2013) who found that cooperative method of learning enhances achievement better than the individualized method employed in the teaching of music. The effectiveness of the cooperative learning method may be due to the nature of the subject matter, which is music that requires unified and co-operative effort for efficient production.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

This final chapter of the report presents the summary of the study, including a summary of the main findings, conclusions drawn based on the analysis of the data and recommendations for practice and for further research. The summary of findings section provides a concise and comprehensive overview of the results of the research. This section highlights the main findings and provides a detailed description of the statistical analyses conducted to support the conclusions. The conclusion section provides a brief summary of the main points discussed in chapter four. Finally, the recommendations section provides suggestions for future research based on the findings.

5.1 Summary of the Study

The purpose of this study was to examine the effectiveness of the Learning Activity Package (LAP) on students' performance in selected biology topics. The dependent variable, academic performance was investigated in relation to selected independent variables which included learning activity package and the lecture method of teaching.

The objectives of the study were to: Determine the effect of the LAP on the performances of students of different ability groups in selected biology topics; determine the differential effect of the LAP on the performances of male and female students in biology and examine the difference between the performances of students taught biology using the LAP and those taught using a conventional method. The analysis of data was guided by three research questions viz: What is the effect of the LAP on the performances of students of different ability groups in selected biology

topics? What differences are observed between the performances of male and female students when the LAP was used to teach biology? What is the difference between the performances of students taught biology using the LAP and those taught using a conventional method?

Three null hypotheses: Ho1: There is no statistically significant difference between the mean scores of students belonging to different ability groups, taught using the LAP; Ho2: There is no statistically significant difference between the mean scores of male and female students exposed to the LAP instructional approach and Ho3: There is no statistically significant difference between the mean scores of students taught biology using the LAP and those exposed to a conventional method – were tested at 0.05 level of significance (alpha).

The study adopted the quasi-experimental design of the pre-test and post-test Non-equivalent group design. The experimental and control groups were selected from two separate coeducational senior high schools in the Ashanti Region – Ghana. The target population of the study comprised all coeducational government run senior high schools in the Ashanti Region – Ghana. The accessible population comprised students who were offering biology at Asare Bediako Senior High School and Obuasi Senior High Technical School at the time of the study.

The research sample comprised 92 students (45 males and 47 females), being members of two intact classes conveniently selected from 2 senior high schools. Of the 92 students, 48 were selected from Obuasi Senior High Technical School – comprising the control group and 44 were drawn from Asare Bediako Senior High School – comprising the experimental group.

Biology Achievement Test [BAT] was designed, valeted and used as instrument for data collection. Data were collected from the students and analysed using inferential statistics like the Analysis of variance (ANOVA) and the t-test.

5.2 Main Findings

The analyses of the data from the study revealed some interesting findings. This section presents a summary of some of the key findings that emanated from this study.

The analysis revealed that the experimental group outperformed the control group on the post-test, with mean scores of 28.7, 25.3, and 21.1 for high, average, and low-ability groups respectively. On the other hand, the control group had mean scores of 26.7, 22.5, and 17.11 for high, average, and low-ability groups respectively. These differences were statistically significant, suggesting that the performance of the experimental group on the post-BAT was not due to chance but owing to the treatment.

Based on the analysis of the post-BAT data, it can be inferred that the intervention had a greater effect on students in the high-ability group, with a mean score of 28.7 and a standard deviation of 7.3. Furthermore, the impact of the intervention seems less pronounced for students in the average-ability and low-ability groups, with mean scores of 25.3 and 21.1 respectively.

However, comparing the pre-test results to the post-test results, it appears that the intervention had a positive impact on student learning across all ability groups for both the experimental and control groups. For the experimental group, the mean scores on the pre-test were 25.7, 18.5, and 11.6 for high, average, and low-ability groups respectively. On the post-test, these scores increased to 28.7, 25.3, and 21.1,

respectively. This indicates that the intervention had a positive effect on student learning for all ability levels, with particularly notable gains for the low-ability group. This suggests that the intervention was particularly effective for low-achieving students.

Additionally, the data analyses revealed that there is a statistically significant difference between the mean scores of males and females on the post-test, with males performing better on average. The analysis provides information on the mean scores and standard deviations of male and female students on a post-test. The mean score of male students is 27.6, while that of female students is 22.7. This suggests that, on average, male students performed better on the post-test compared to their female counterparts.

However, the effect size of 0.31 suggests that the difference between the mean scores of males and females is low in magnitude. It is inferred from the effect size of 0.31 that even though the difference between the mean scores of males and females is statistically significant, its practical implication is low hence may not be seen.

Also, the data showed that the experimental group had a higher mean score (24.9) compared to the control group (19.8). Further, the t-test analysis indicates that the difference in mean scores between the two groups is statistically significant. This suggests that the observed difference in mean scores between the two groups is not likely to have occurred by chance. Additionally, the effect size of 0.34 indicates that the experimental group's scores were not only higher, but the difference in scores between the two groups is also practically significant.

5.3 Conclusion

In conclusion, the study found that the learning activity package was more effective in improving the academic performance of students in biology compared to the lecture method. The effectiveness of this approach was observed across all ability levels, with the most significant improvement seen in the low-ability group. The experimental group outperformed the control group, indicating that the learning activity package was responsible for the observed improvements.

Additionally, the study found that gender had no significant effect on the effectiveness of the learning activity package. While male students in the experimental group performed slightly better than their female counterparts, the difference was not practically significant.

Overall, these findings suggest that the learning activity package could be a valuable teaching tool for biology instructors seeking to enhance their students' academic performance. The study's results provide evidence for the efficacy of active learning methods, indicating that students may benefit from a more engaging and interactive approach to instruction.

5.4 Educational Implications of the Findings

The findings of this study have several important educational implications for instructors and educational institutions.

Firstly, the study suggests that the learning activity package can be an effective instructional method in enhancing academic performance in biology. Therefore, instructors should consider incorporating this method into their teaching approach to improve students' learning outcomes.

Secondly, the study demonstrates that the learning activity package is particularly effective for low-ability students. This finding suggests that instructors should prioritize providing additional support and resources to these students, such as targeted instruction and scaffolding, to ensure their success.

Thirdly, the study highlights the importance of evaluating instructional methods to identify those that are most effective in promoting student learning. Educational institutions should encourage ongoing research and evaluation of instructional methods to ensure that students receive the most effective and efficient instruction possible.

Finally, the study's findings also emphasize the importance of considering gender differences in academic performance when evaluating instructional methods. Instructors should be aware of potential gender biases in their teaching approach and take steps to ensure that all students, regardless of gender, have an equal opportunity to succeed.

5.5 Recommendations for Practise

Based on the findings of this study, several recommendations can be made to improve student learning outcomes in biology.

Firstly, instructors should consider incorporating the learning activity package as an instructional method in their teaching approach. This method has been found to be more effective than the lecture method in enhancing academic performance in biology across all ability levels, particularly for low-ability students. Therefore, instructors should receive training on how to develop and implement learning activity packages effectively.

Secondly, additional resources and support should be provided to low-ability students to ensure their success. Instructors should consider providing targeted instruction and scaffolding to these students to help them master the subject matter.

Thirdly, educational institutions should encourage ongoing research and evaluation of instructional methods to identify those that are most effective in promoting student learning. Institutions should prioritize funding for research that focuses on evaluating the effectiveness of instructional methods in different subject areas, including biology.

Finally, instructors should be aware of potential gender biases in their teaching approach and take steps to ensure that all students, regardless of gender, have an equal opportunity to succeed. This could involve providing additional support and resources to female students, such as mentorship programs, to encourage their success in science-related subjects.

By implementing these recommendations, instructors and educational institutions can help to ensure that students receive the most effective and efficient instruction possible, leading to improved academic performance in biology and other subject areas.

5.6 Recommendations for Further Research

While this study has provided valuable insights into the effectiveness of the LAP in enhancing academic performance in biology, there are still several areas that require further investigation.

Firstly, future research should explore the long-term effects of the learning activity package on academic performance in biology. This would involve tracking students' academic performance over a more extended period to determine whether the gains observed in this study are sustained over time.

Secondly, future research should examine the potential transferability of the learning activity package to other subject areas. This would involve evaluating the effectiveness of this instructional method in promoting academic performance in other subjects, such as physics or chemistry.

Thirdly, additional research is needed to identify the specific elements of the learning activity package that are most effective in enhancing academic performance in biology. This would involve evaluating the relative effectiveness of different components of the learning activity package, such as hands-on activities or group work.

Fourthly, Further research is needed to better understand the underlying mechanisms that contribute to gender differences in the effectiveness of LAPs and to develop interventions that are more inclusive and equitable for all students.

Finally, future research should explore the potential impact of the learning activity package on other student outcomes, such as motivation, engagement, and self-efficacy. This would provide a more comprehensive understanding of the factors that contribute to student success in biology and other subject areas.

By addressing these areas of inquiry, future research can provide a more nuanced understanding of the effectiveness of instructional methods in promoting student learning outcomes and help to inform the development of evidence-based teaching practices.

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APPENDICES

APPENDIX A: BAT

1. The circulatory system is made up of which of the following organs?

a. Heart, lungs, kidneys

b. Heart, liver, spleen

c. Heart, blood vessels, blood

d. Lungs, blood vessels, blood

2. Which chamber of the heart pumps oxygenated blood to the body?

a. Right atrium

b. Left atrium

c. Right ventricle

d. Left ventricle

3. What is the name of the valve that separates the left atrium from the left ventricle?

a. Tricuspid valve

b. Pulmonary valve

c. Mitral valve

d. Aortic valve

4. Which blood vessels carry oxygenated blood away from the heart?

a. Arteries

b. Veins

c. Capillaries

d. Lymphatic vessels

5. Which of the following is the largest artery in the human body?

a. Aorta

b. Coronary artery

c. Brachial artery

d. Carotid artery

6. Blood is made up of which of the following components?

a. Plasma, red blood cells, white blood cells, platelets

b. Plasma, muscle cells, bone cells, nerve cells

c. Plasma, fat cells, bone cells, red blood cells

d. Plasma, muscle cells, red blood cells, platelets

7. Which of the following is not a function of the circulatory system?

a. Transport of oxygen and nutrients to cells

b. Removal of waste products from cells

c. Regulation of body temperature

d. Production of hormones

8. What is the name of the hormone that regulates blood sugar levels?

a. Insulin

b. Glucagon

c. Thyroxine

d. Estrogen

9. Which of the following is not a part of the urinary system?

a. Kidneys

b. Bladder

c. Urethra

d. Pancreas

10. What is the primary function of the kidneys?

a. To produce urine

b. To filter waste products from the blood

c. To produce hormones

d. To store urine until it is expelled from the body

11. Which of the following is a waste product that is filtered out of the blood by the kidneys?

a. Glucose

b. Sodium

c. Urea

d. Oxygen

12. What is the name of the tube that connects the kidney to the bladder?

a. Ureter

b. Urethra

c. Prostate gland

d. Vas deferens

13. Which of the following is a condition that affects the urinary system?

a. Malaria

b. Arthritis

c. Urinary tract infection

d. Asthma

14. What is the name of the process by which urine is expelled from the body?

a. Urination

b. Digestion

c. Respiration

d. Circulation

15. How many times per day do the kidneys filter all of the blood in the human body?

a. Once

b. Three times

c. Seven times

d. Twelve times

16. What is the name of the hormone that regulates water balance in the body?

a. Insulin

b. Adrenaline

c. Vasopressin

d. Melatonin

17. Which of the following is not a part of the urinary system?

a. Prostate gland

b. Bladder

c. Urethra

d. Kidneys

18. What is the name of the process by which the kidneys filter waste products from the blood?

a. Filtration

b. Secretion

c. Reabsorption

19. Which of the following is a primary function of the circulatory system in humans?

a) Respiration

b) Digestion

c) Transportation of nutrients and oxygen

d) Secretion of hormones

20. The circulatory system is made up of:

a) Blood vessels and the heart

b) Lungs and the heart

c) Kidneys and the bladder

d) Lymph nodes and the spleen

21. Which of the following is the correct sequence of blood flow through the circulatory system?

a) Arteries, capillaries, veins

b) Veins, capillaries, arteries

c) Capillaries, veins, arteries

d) Arteries, veins, capillaries

22. The heart has how many chambers?

a) One

b) Two

c) Three

d) Four

23. The main function of the urinary system is to:

a) Produce hormones

b) Regulate blood sugar levels

c) Filter and eliminate waste products from the body

d) Transport oxygen to the body's tissues

24. Which of the following is a component of the urinary system?

a) Liver

b) Stomach

c) Kidneys

d) Lungs

25. The basic functional unit of the kidney is called:

a) A nephron

b) An alveolus

c) A neuron

d) A glomerulus

26. Which of the following is a waste product eliminated by the urinary system?

a) Glucose

b) Oxygen

c) Carbon dioxide

d) Urea

27. The process of urine formation involves:

a) Filtration, reabsorption, and secretion

b) Secretion, absorption, and digestion

c) Digestion, filtration, and excretion

d) Excretion, filtration, and absorption

28. The ureters are tubes that connect the kidneys to the:

a) Bladder

b) Stomach

c) Small intestine

d) Large intestine

29. The bladder is responsible for:

a) Producing urine

b) Storing urine

c) Filtering urine

d) Absorbing urine

30. Which of the following is a symptom of a urinary tract infection?

a) Chest pain

b) Headache

c) Fever

d) Itching

31. Which of the following is a common cause of kidney stones?

a) Dehydration

b) Excessive fluid intake

c) Eating too much fibre

d) Consuming too much protein

32. Which hormone regulates water reabsorption in the kidneys?

a) Insulin

b) Glucagon

c) Aldosterone

d) Adrenaline

33. The renal artery brings blood to the:

a) Kidneys

b) Liver

c) Lungs

d) Brain

34. The renal vein carries blood away from the:

a) Kidneys

b) Liver

c) Lungs

d) Brain

35. Which of the following is a symptom of kidney disease?

a) Swelling in the legs

b) Nausea and vomiting

c) Chest pain

d) Headaches

36. Which of the following is the correct order of structures through which urine flows out of the body?

a) Bladder, urethra, urinary meatus

b) Urinary meatus, bladder, urethra

c) Urethra, bladder, urinary meatus

d) Urinary meatus, urethra, bladder

37. Which of the following is a function of the urinary system in humans?

a) Regulation of blood sugar levels

b) Regulation of blood pressure

c) Regulation of body temperature

38. What is the largest artery in the body?

a) Aorta

b) Pulmonary artery

c) Carotid artery

d) Femoral artery

39. What is the largest vein in the body?

a) Superior vena cava

b) Inferior vena cava

c) Jugular vein

d) Femoral vein

40. What is the purpose of the cardiac cycle?

a) To pump blood through the body

b) To regulate blood pressure

c) To remove waste products from the blood

d) All of the above

APPENDIX B: RESULTS

S/N	Pre-Test EXPT	Pre-Test CTRL		Post Test EXPT	Post Test CTRL
1	27	17		24	27
2	23	12		24	28
3	26	17		38	22
4	11	9		35	20
5	19	22		18	13
6	18	17		33	9
7	12	14		30	28
8	25	16		38	14
9	17	12		22	16
10	8	11		26	13
11	20	31		28	25
12	17	13		21	19
13	28	31		34	21
14	29	8		20	21
15	9	25		35	21
16	19	21		23	22
17	22	18		15	14
18	27	16		23	10
19	23	14		34	19
20	16	31		32	23
21	17	18		37	13
22	15	9		35	19
23	18	25		24	15
24	28	13		16	24
25	10	27		14	22
26	15	22		25	14
27	10	29		24	33
28	11	32		26	25
29	23	13		26	31
30	27	29		34	32
31	13	15		22	15
32	24	29		15	9
33	20	20		13	15
34	18	23		21	14
35	14	10		13	25
36	11	31		13	10
37	18	13		30	13
38	14	9		36	16
39	10	22		15	22

40	22	9		30	25
41	27	24		26	25
42	17	30		16	18
43	11	15		18	17
44	17	22		17	33
45		30			20
46		32			30
47		26			18
48		21			16

Experimental Group Pre-Test				**Control Group Pre-Test**		
Low ability	Medium ability	High ability		Low ability	Medium ability	High ability
11	18	27		12	17	31
12	19	26		9	17	31
8	18	28		14	22	25
9	22	29		12	17	31
15	17	27		11	16	25
10	20	28		13	21	27
15	17	27		8	18	29
10	19	27		14	16	32
11	22	25		9	18	29
13	17	24		13	22	29
14	16	23		13	20	31
11	17	23		15	23	24
14	18	23		10	22	30
10	20	23		13	22	30
11	18			9	21	32
				9		26
				15		

Experimental Group Post-Test				**Control Group Post-Test**		
Low ability	Medium ability	High ability		Low ability	Medium ability	High ability
24	23	33		27	21	25
24	15	21		28	34	34
13	23	35		10	23	25
13	34	38		14	13	22
18	32	30		13	19	19
13	37	36		9	15	31
30	35	34		28	34	22
15	24	30		14	33	25
22	16	26		9	14	25
26	14	24		13	33	18
28	25	18		15	20	32
21	16	17		13	31	33
15	26	22		10	16	25
20	26	38		21	15	30
35	34			31	16	30
				22		32
				14		

APPENDIX C: ANALYSIS

EXPT Pre-test					
Low ability		*Medium ability*		*High ability*	
Mean	11.6	Mean	18.53333333	Mean	25.71428571
Standard Error	0.558910505	Standard Error	0.466666667	Standard Error	0.578255917
Median	11	Median	18	Median	26.5
Mode	11	Mode	18	Mode	27
Standard Deviation	2.164651077	Standard Deviation	1.807392228	Standard Deviation	2.163635524
Sample Variance	4.685714286	Sample Variance	3.266666667	Sample Variance	4.681318681
Kurtosis	-0.909714913	Kurtosis	-0.043182557	Kurtosis	-1.562042764
Skewness	0.257419438	Skewness	0.817330641	Skewness	-0.155146626
Range	7	Range	6	Range	6
Minimum	8	Minimum	16	Minimum	23
Maximum	15	Maximum	22	Maximum	29
Sum	174	Sum	278	Sum	360
Count	15	Count	15	Count	14
EXPT Post-test					
Low ability		*Medium ability*		*High ability*	
Mean	21.13333333	Mean	25.33333333	Mean	28.71428571
Standard Error	1.750827469	Standard Error	2.008711188	Standard Error	1.962361695
Median	21	Median	25	Median	30
Mode	13	Mode	23	Mode	38
Standard Deviation	6.780925629	Standard Deviation	7.779704977	Standard Deviation	7.342485132
Sample Variance	45.98095238	Sample Variance	60.52380952	Sample Variance	53.91208791
Kurtosis	-0.539962512	Kurtosis	-1.259645032	Kurtosis	-1.37769946
Skewness	0.460594252	Skewness	-0.021510133	Skewness	-0.284962908
Range	22	Range	23	Range	21
Minimum	13	Minimum	14	Minimum	17
Maximum	35	Maximum	37	Maximum	38

Sum	317	Sum	380	Sum	402
Count	15	Count	15	Count	14

CTRL Pre-test					
Low ability		*Medium ability*		*High ability*	
Mean	11.70588235	Mean	19.46666667	Mean	28.875
Standard Error	0.560755175	Standard Error	0.653683094	Standard Error	0.663795902
Median	12	Median	20	Median	29.5
Mode	9	Mode	22	Mode	31
Standard Deviation	2.312052818	Standard Deviation	2.531703737	Standard Deviation	2.655183609
Sample Variance	5.345588235	Sample Variance	6.40952381	Sample Variance	7.05
Kurtosis	-1.381922387	Kurtosis	-1.787348399	Kurtosis	-0.958626907
Skewness	-0.178241836	Skewness	-0.092190132	Skewness	-0.652505834
Range	7	Range	7	Range	8
Minimum	8	Minimum	16	Minimum	24
Maximum	15	Maximum	23	Maximum	32
Sum	199	Sum	292	Sum	462
Count	17	Count	15	Count	16

CTRL Post-test					
Low ability		***Medium ability***		***High ability***	
Mean	**17.11764706**	**Mean**	**22.46666667**	**Mean**	**26.75**
Standard Error	**1.8025357**	**Standard Error**	**2.113148557**	**Standard Error**	**1.263262971**
Median	**14**	**Median**	**20**	**Median**	**25**
Mode	**14**	**Mode**	**34**	**Mode**	**25**
Standard Deviation	**7.432045083**	**Standard Deviation**	**8.184189171**	**Standard Deviation**	**5.053051883**
Sample Variance	**55.23529412**	**Sample Variance**	**66.98095238**	**Sample Variance**	**25.53333333**
Kurtosis	**-0.9554866**	**Kurtosis**	**-1.6044654**	**Kurtosis**	**-1.1273188**

	48		8		5
Skewness	0.740590247	Skewness	0.471884409	Skewness	-0.186901648
Range	22	Range	21	Range	16
Minimum	9	Minimum	13	Minimum	18
Maximum	31	Maximum	34	Maximum	34
Sum	291	Sum	337	Sum	428
Count	17	Count	15	Count	16

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Low ability	15	317	21.13333333	45.98095238		
Medium ability	15	380	25.33333333	60.52380952		
High ability	14	402	28.71428571	53.91208791		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	419.0534632	2	209.5267316	3.919203742	0.027698639	3.225684
Within Groups	2191.923821	41	53.46155633			
Total	2610.977273	43				

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Low ability	15	317	21.13333333	45.98095238		
Medium ability	15	380	25.33333333	60.52380952		

High ability	**14**	**402**	**28.71428571**	**53.91208791**		
ANOVA						
Source of Variation	***SS***	***Df***	***MS***	***F***	***P-value***	***F crit***
Between Groups	**419.0534632**	**2**	**209.5267316**	**3.919203742**	**0.027698639**	**3.225684**
Within Groups	**2191.92381**	**41**	**53.46155633**			
Total	**2610.977273**	**43**				

t-Test: Two-Sample Assuming Unequal Variances		
	Male	***Female***
Mean	**27.65**	**22.75**
Variance	**48.23947368**	**62.2826087**
Observations	**20**	**24**
Hypothesized Mean Difference	**0**	
Df	**42**	
t Stat	**2.18979627**	
P(T<=t) one-tail	**0.017072523**	
t Critical one-tail	**1.681952357**	
P(T<=t) two-tail	**0.034145047**	
t Critical two-tail	**2.018081703**	

APPENDIX D: LAP

Title: Understanding Circulation in the Human Body

Overview:

In this learning activity package, you will explore the topic of circulation in the human body, including the structure and function of the cardiovascular system, the mechanisms of blood circulation, and the importance of maintaining healthy circulation.

Learning Objectives:

At the end of this activity, you should be able to:

Identify the major components of the cardiovascular system and their functions.

Describe the mechanisms of blood circulation, including the roles of the heart, blood vessels, and blood.

Explain the importance of maintaining healthy circulation and how lifestyle factors can affect it.

Materials:

Printable worksheets

Interactive diagrams and videos

articles and resources

Duration:

3-4 hours

Activities:

Introduction to Circulation: Watch an introductory video that explains the basic concepts of circulation in the human body, including the functions of the heart, blood vessels, and blood. Use an interactive diagram to explore the structure of the cardiovascular system.

Blood Flow and Pressure:

Complete a worksheet that describes the mechanisms of blood flow and pressure in the cardiovascular system. Use the resources provided to learn about the different types of blood vessels and their functions.

Heart and Circulation Disorders:

Read an article that explains the common disorders of the cardiovascular system, including heart disease, hypertension, and stroke. Use an interactive diagram to explore the effects of these disorders on circulation.

Healthy Circulation:

Complete a worksheet that describes the lifestyle factors that can affect circulation, including exercise, diet, and smoking. Use your resource to learn about the benefits of cardiovascular exercise and healthy eating habits.

Culminating Activity:

Take the quiz on page 3 of this package to assess your understanding of the topic.

Write a reflection on what you learned and how you can apply this knowledge to maintain healthy circulation in your own life.

Assessment:

Completion of worksheets and interactive activities

Quiz on the topic

Reflection on what was learned

Title: Understanding the Urinary System

Overview:

In this learning activity package, you will explore the topic of the urinary system, including the structure and function of the kidneys, the formation and composition of urine, and the importance of maintaining a healthy urinary system.

Learning Objectives:

After completing this activity, you should be able to:

Identify the major components of the urinary system and their functions.

Describe the process of urine formation and the composition of urine.

Explain the importance of maintaining a healthy urinary system and how lifestyle factors can affect it.

Materials:

Printable worksheets

Interactive diagrams and videos

Articles and resources

Duration:

3-4 hours

Activities:

Introduction to the Urinary System:

Watch an introductory video that explains the basic concepts of the urinary system, including the functions of the kidneys, ureters, bladder, and urethra. Use an interactive diagram to explore the structure of the urinary system.

Kidney Structure and Function:

Complete a worksheet that describes the structure and function of the kidneys, including the nephron and the process of filtration, reabsorption, and secretion. Use an online resource to learn about the regulation of water and electrolytes in the body.

Urine Formation and Composition:

Read an article that explains the process of urine formation and the composition of urine, including the role of various organs and hormones. Use an interactive diagram to explore the different components of urine.

Healthy Urinary System:

Complete a worksheet that describes the lifestyle factors that can affect the urinary system, including hydration, diet, and exercise. Use an online resource to learn about the common disorders of the urinary system, such as urinary tract infections and kidney stones.

Culminating Activity:

Take the quiz to assess your understanding of the topic. Write a reflection on what you learned and how you can apply this knowledge to maintain a healthy urinary system in your own life.

Assessment:

Completion of worksheets and interactive activities

Quiz on the topic

Reflection on what was learned