UNIVERSITY OF EDUCATION, WINNEBA

EFFECT OF MASTERY LEARNING APPROACH ON SENIOR HIGH SCHOOL STUDENTS' ACADEMIC PERFORMANCE AND MOTIVATION IN BIOLOGY

JENNIFER BAIDEN-AMISSAH

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JENNIFER BAIDEN-AMISSAH

(220012391)

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JULY, 2023

DECLARATION

CANDIDATE'S DECLARATION

I, **JENNIFER BAIDEN-AMISSAH** declare that this thesis, with the exception of quotations and references contained in published works which have been identified and duly acknowledged, is entirely my original work, and that no part of it has been presented for another degree in this university or elsewhere.

SIGNATURE: ……..……..……

DATE: ……..……

SUPERVISORS' DECLARATION

I hereby declare that the preparation and presentation of this thesis was supervised by the guidelines on supervision of thesis laid down by the University of Education, Winneba.

SUPERVISOR: DR. CHARLES KWESI KOOMSON

SIGNATURE: ……..……

DATE: ……

DEDICATION

I dedicate this work to my beloved father, Mr John Kwabena Eshun for his massive prayers and encouragement and my lovely mother, Lily Ama Sackey whose immerse contributions, advice and support have made me reach this far.

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LIST OF ABBREVIATIONS

STEM: Science, Technology, Engineering, and Mathematics.

WAEC: West African Examinations Council.

MLA: Mastery Learning Approach

BAPT: Biology Academic Performance Test

PSI: Keller's Personalized System of Instruction

LMA: Lecture Method Approach

SLT: Social Learning Theory

SMQ: Self-Motivation Questionnaire

LCM: Learning Cycle Model

ABSTRACT

The study investigated the effect of mastery learning approach on the academic performance of senior high school students and their motivation in Biology. It was carried out in the Nsaba Presbyterian Senior High School in the Agona East District in the Central Region of Ghana. The research study adopted the quasi-experimental research design using the pre-test and post-test design. The sample comprised of 64 second-year science students. This was done using purposive sampling. Two validated instruments were used which included the Biology Academic Performance Test (pretest and post-test) which measured the student's academic performance in the selected topic in Biology and the student's motivation questionnaires (SMQ) which was used to measure the students' motivation in learning Biology. The sample size were split into two groups with one serving as the experimental group and the other serving as the control group. The experimental group was exposed to the mastery learning approach while the control group was exposed to the traditional lecture approach or method. After the treatment, a post-test was administered to both groups to determine the effectiveness of the treatment. The questionnaire was also administered to determine the levels of their motivation. The tests (pre-test, post-test) and questionnaire results were then analysed using SPSS version 27.0. When the results of the two methods were compared, there was a notable distinction between mastery learning and the traditional lecture method. The responses to the questionnaire proved that majority of students agreed that the mastery learning approach is an effective method of teaching Biology. Results also revealed that there was no differential effect of mastery learning approach on male and female students' performance in Biology. It is therefore recommended that Biology teachers should adopt mastery learning approach in teaching and also Biology teachers should be made to attend workshops, seminars and conferences to update their knowledge of the methods of teaching concepts in Biology.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

The study of biology encompasses various aspects of living organisms and their interactions with the environment (Begon & Townsend, 2021). In the context of education in Ghana, biology holds a prominent position as a core subject in integrated science and an elective in Senior High Schools. This recognition underscores the importance of studying biology.

As the curriculum's implementer, the biology teacher must be dynamic in using teaching methods, strategies, and pedagogic resources to achieve goals and elicit meaningful student responses (Bhattarai, 2022). To ensure quality in biology teaching and learning, the teacher must consider important factors like instructional materials, technological tools, teaching and learning approaches, etc. Absolutely, educators have a fundamental goal to ensure that all of their students learn and succeed academically, socially, and emotionally (Bhattarai, 2022).

The lecture method of teaching has been a traditional approach to education for many years, but it has recently faced criticism for being too passive and not engaging enough for students. Recent literature indicates that although the lecture method of teaching can be effective in certain situations, it is crucial to complement it with interactive activities and other active learning approaches. This combination not only engages students but also fosters deeper learning outcomes.

The mastery approach to teaching, also known as mastery learning, is a teaching approach that focuses on ensuring that all students achieve a deep understanding of a topic before moving on to new material (Jones, 2009). Mastery learning is a set of

group-based, individualized, teaching and learning strategies based on the premise that students will achieve a high level of understanding in a given domain if they are given enough time. The motivation for mastery learning comes from trying to reduce achievement gaps for students in average school classrooms. John Carroll and Benjamin Bloom (1960) pointed out that, if students are normally distributed with respect to aptitude for a subject and if they are provided uniform instruction (in terms of quality and learning time), then achievement level at completion of the subject is also expected to be normally distributed (Björck, 2002).

This approach emphasizes on the significance of developing motivation in student's learning experiences **(**Jones, 2009). In this mastery learning approach, the classroom includes personal feedback, opportunities to build on academic success (John and Musoba, 2010) and opportunities for different rates of student mastery (Jones, 2009). It is critical to note that for effective learning to occur, the necessary teaching and learning techniques, quality instructions, evaluation, feedback, and instructional materials must be properly implemented, as humans learn better by hearing, seeing, and doing rather than reading (Branch & Kopcha, 2014). As a result, it is critical to use well-defined instructional materials that aid pedagogy and the learning process when teaching. Students in a mastery learning approach classroom are allowed to work on the standards until they master them; students are not pushed forward to keep up with the class (Andrade & Du, 2013). At the same time, if students quickly master standards, they can accelerate their learning through enrichment. When students are working on reinforcing ideas, rather than turning them in and waiting for feedback, they meet with a teacher to review their work. This is especially important in classrooms teaching middle-level science, where students' prior knowledge can vary greatly (Andrade & Du, 2013).

Mastery learning approaches propose that, if each learner were to receive optimal quality of instruction and as much learning time as they require, then a majority of students could be expected to attain mastery. It provides students with a greater sense of satisfaction and accomplishment, as they are able to progress at their own pace and have an achievable goal to work towards. It also increases confidence, engagement, and self-esteem in the student as they learn through trial and error without fear of failure or punishment (Branch & Kopcha, 2014).

Motivation, according to Deci and Ryan (2022), is defined as a set of forces that influence how people behave. It is a collection of forces that influence behaviour and determines its form, direction, and intensity. Motivation is defined as the energizing force that induces, compels, and sustains behaviour (Hancock, 2004). In the learning process, there are two types of motivation; extrinsic and intrinsic. Extrinsic motivation is focused on earning external rewards for a learner, whereas intrinsic motivation is doing something because it is intrinsically interesting or enjoyable (Deci & Ryan, 2022). According to Hancock (2004), a motivated learner performs well. A teacher's teaching approach is a significant factor that can influence students' motivation to learn, which in turn influences their performance. Teaching methods that actively involve students can boost motivation (Keraro, Wachanga & Orora 2007). Academically motivated students are those who can maintain high ability and competence in their work.

Mastery learning encourages students to stay engaged and motivated due to the positive reinforcement of achieving mastery. Mastery learning has been successfully applied in engineering (Johnson et al., 2014), math (Groen et al., 2015), and physics (Oerther, 2019), as well as other Science, Technology, Engineering and Mathematics (STEM)

disciplines. Generally, the mastery learning environment, when implemented skilfully, reduces fear and improves motivation and attitudes among students taking.

According to Okeke (2007), gender refers to the set of social and cultural traits linked to individuals being male or female. It is essential to understand that gender is separate from biological sex, which is determined universally. In other words, while biological sex is based on physical and physiological attributes, gender is shaped by societal norms and expectations surrounding masculinity and femininity.

The impact of gender attributes on biology achievement and content retention when taught using the Mastery Learning Approach (MLA) is a subject of interest. Nnaka (2008) observed that girls often face discouragement in science classes, while other studies (Nbina and Wagbara, 2012) found that girls perform well in certain science concepts and exhibit positive attitudes towards chemistry. However, conflicting findings by Madu (2004), Iweka (2006), Okeke (2007), and Onimisi (2006) suggest that gender may have insignificant effects on science achievement. Okoro (2011) argued that, instructional approaches influence gender differences in academic achievement, with cooperative learning benefiting females and competitive or individualized learning favouring males. Given the inconsistent results and the lack of a conclusive consensus, further research is needed to explore the influence of gender on students' biology achievement, retention, and motivation.

Therefore, the present study aimed to investigate the effects of the mastery learning approach on senior high school students' academic performance and motivation in biology, while also exploring the potential interaction between gender and teaching approaches. This research seeks to contribute to the ongoing examination of gender effects in different societal contexts and verify findings in the literature.

1.2 Problem Statement

Biology performance in secondary schools has been low due to students' inability to understand and master topics and concepts in biology before progressing to higher levels, although, the subject is popular among secondary schools. This is due to the fact that, most teachers in the senior high schools use the traditional lecture approach to teach these concepts with less or no emphasis on the mastery of these concepts. Gabel (2016) claimed that, the lecture method is not appropriate for teaching sciences in the high school's curriculum. Similarly, Ebele (2017) explained that, the use of inappropriate teaching methods and approaches results in poor performance and lack of interest in biology by students.

Biology remains a preferred option among the various science disciplines, however, it still records very low performance according to the statistics of the Chief examiner's Report (WAEC, 2018). This situation may not be favourable to the nation's educational transformation agenda and the development of a scientific and technological nation.

Using the mastery learning approach is crucial in effectively overcoming this challenge. The purpose of mastery learning approach is to ensure that students truly master each subject material before moving on to the next one. This enhances understanding of concepts and motivate students to learn. In a traditional model, students who do not master the content in the set amount of time are rarely, if ever, given additional time and opportunity to re-learn what they missed.

Therefore, the researcher intend to investigate the effect of the mastery learning approach on the academic performance of senior high school students and their motivation in biology.

1.3 Purpose of the study

The purpose of the study was to look at the effect of the mastery learning approach on senior high school students' academic performance and motivation in biology.

1.4 Research Objectives

The objectives of the study were to assess the:

1. effect of the mastery learning approach on the performance of senior high school students
2. effect of the mastery learning approach on the motivation level of senior high school students
3. differential effects of mastery learning approach on the male and female experimental group of students' performance in biology

1.5 Research Questions

The study seeks to find answers to the following questions:

1. What is the effect of the mastery learning approach on the performance of senior high school students?
2. What is the effect of the mastery learning approach on the motivation level of senior high school students?
3. What are the differential effects of mastery learning approach on the experimental group male and female students' performance in biology?

1.6 Hypotheses

The study was guided by the following null hypotheses:

Ho1: There is no statistical significant difference in mean achievement scores between senior high school students taught biology using the mastery learning approach and those taught using the lecture method.

Ho2: There is no statistical significant difference between the level of motivation of senior high school students taught biology using the mastery learning approach and those taught using lectures.

Ho3: There is no statistical significant difference between the performance of male and female students taught using a mastery learning approach.

1.7 Significance of the Study

The outcomes of this research hold significant potential for various stakeholders involved in Ghanaian biology education. Firstly, researchers in the field of education will benefit from gaining valuable insights into the effectiveness of the mastery learning approach on students' academic performance and motivation. The study's findings could serve as a basis for future investigations and contribute to the broader body of knowledge on innovative teaching methodologies.

Policymakers in the Ghanaian education system can utilize the results to make informed decisions about curriculum development and instructional practices. If the mastery learning approach proves to be beneficial, policymakers may consider its implementation on a broader scale, potentially leading to improvements in overall student achievement and learning outcomes in biology education.

For teachers, this research could offer practical implications and guidance for their instructional strategies. Understanding how the mastery learning approach impacts student learning and motivation can help teachers tailor their classroom practices to better engage students and foster a deeper understanding of biology concepts. It may also encourage professional development initiatives that promote effective teaching techniques.

Students stand to benefit immensely from the findings as well. If the study shows that the mastery learning approach enhances academic performance and motivation, students can experience a more conducive and supportive learning environment. This approach might empower them to take ownership of their learning and progress at their own pace, leading to increased self-confidence and a greater passion for biology.

Furthermore, the study's examination of the potential interaction between gender and teaching approaches can shed light on any disparities or unique learning needs among male and female students. Addressing these differences can help promote gender equity in biology education and create a more inclusive learning environment for all students.

In summary, the findings of this study could have far-reaching implications for researchers, policymakers, teachers, and students in Ghanaian biology education. By fostering a better understanding of effective teaching practices and their impact on student learning and motivation, this research can contribute to the ongoing efforts to enhance the quality of education and create positive learning experiences for students in the country.

1.8 The Study's Scope

The purpose of this study was to look into the effect of the Mastery Learning Approach on the academic performance and motivation of senior secondary form two biology students. Nsaba Presbyterian Senior High School second-year science students in the Agona East District of Ghana are eligible for the study. The SHS 2 students are chosen because they are settled and not taking final exams like SHS 3 students. SHS 1 students are new to the system and not settled, so it would not be appropriate to use them for this study. SHS 2 Biology Syllabus concepts will be studied. The content scope of the study was a System which covered topics such as; basic concepts in the digestive system,

general processes, functions and identifying some possible diseases associated with the human digestive system. The preference of this concept was chosen by the researcher, due to its complex nature and also how easily it is segmented into subheadings. Again, it was chosen because it can be divided into distinct but progressive units of knowledge. The Mastery Learning Approach implementation strategy is consistent with this. Gender differences in academic performance, learning retention, and motivation in biology were also investigated in the study.

1.9 Limitations of the Study

It could have been very appropriate and beneficial to include form one and form three students the school but this could not materialized due to the fact that form one students are new to the school system and not settled, so it would not be appropriate to use them for this study and form three students were also preparing for their final exams. So form two students were chosen because they were settled and not taking final exams like the form three students. Moreover, other factors such as financial constraints, time and distance also affected the study.

1.10 Operational Terminologies

Mastery Learning Approach (MLA): Breaking down digestive system into units, each with its objectives and evaluation, allows students to study content unit after unit and receive corrective instruction until they master it.

Performance: Refers to the execution or accomplishment of a task, action, or activity. Biology Academic Performance Test (BAPT)

Lecture Approach: Is a teaching and instructional method where a teacher or lecturer presents information to a group of students or learners in a one-way communication

format. Schools teach biology students using a modified lecture method without special remediation.

Experimental group: Is a group of study participants or subjects who are exposed to the experimental treatment, intervention, or condition that is being tested or studied. Mastery Learning Approach students.

Control group: It is a group in an experiment that is used as a baseline for comparison with the experimental group, which receives the treatment or intervention being studied. Traditional-taught students.

1.11 Organization of the Study

The study has five chapters, with details below:

Chapter One covers the study's background, problem, objectives, research questions, significance, scope, limitations, and organization. The second chapter is a literature review with an introduction, key concepts, theoretical review, conceptual review, empirical review, and conceptual framework. Research design, population, sample and sampling procedures, research instruments, data sources, and data analysis make up the third chapter, the research methodology. The fourth chapter will interpret the analysis's findings. The fifth chapter summarizes findings, conclusions, and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

The second chapter deals with the review of related literature which is based on the following subheadings:

1. Theoretical frame work of mastery learning approach
2. Teaching of Biology as a discipline in science education
3. The conceptual frame work of mastery learning approach
4. Essential elements of mastery learning approach
5. Effect of the mastery learning approach
6. Empirical evidence of mastery learning
7. Students' academic performance in Biology
8. Motivation and performance in Biology
9. Gender Differences in Students' Attitudes towards Biology

2.1 Theoretical Framework of Mastery Learning

The theoretical framework of this study drew upon relevant theories to support its conceptual framework. These theories include Skinner's operant conditioning theory, and Bloom's theory of mastery learning, Keller's personalized system of instruction, Block's mastery learning model, as well as Social learning theory and Self-determination theory.

These theories were selected to provide a solid foundation for understanding the research context and its key variables.

2.1.1 Skinner's Operant Conditioning Theory (1948)

B.F. Skinner is widely recognized as the originator of Operant Conditioning, a theory that asserts that behaviours are influenced by their consequences. According to Skinner's theory, behaviours that are followed by positive outcomes are more likely to be repeated (Skinner, 2014). This theory, rooted in behaviourism, suggests that learning is manifested through observable changes in behaviour in response to stimuli.

The relevance of Skinner's operant conditioning theory to the present study lies in its connection to the concept of mastery learning. Mastery learning aligns with the principles of operant conditioning by focusing on overt behaviours that can be observed and measured (Skinner, 2014). In the context of this study, mastery learning involves breaking down the subject matter into smaller units and ensuring that students demonstrate a clear understanding of each unit before progressing to the next. This approach allows for the measurement of mastery and facilitates a systematic and progressive learning experience.

By employing mastery learning in this study, the researcher aimed to stimulate learning and assess students' responses to investigate the effect of the mastery learning approach on the academic performance and motivation of Senior High School biology students. The researcher structured the content into discrete units, requiring students to master each unit before advancing. This methodology enabled the examination of how mastery learning influenced the targeted variables within the study area.

2.1.2 Bloom's Theory of Mastery Learning (1968)

Benjamin S. Bloom is widely recognized as a prominent figure in the development and promotion of mastery learning. Bloom's (1968) theory of school learning emphasizes that almost all students have the potential to achieve mastery if provided with suitable

conditions and opportunities for learning. He argues that traditional instructional approaches, which assume a normal distribution of aptitude among students, result in only a few students attaining mastery, while others perform poorly based on their aptitudes. However, by implementing mastery learning and tailoring instruction to match students' needs and allowing sufficient time for learning, a significant percentage of students (up to 80% or even 95%) can attain mastery.

Mastery learning is founded on the belief that given the necessary time and appropriate learning conditions, virtually all students can achieve high levels of learning. To implement mastery learning, Bloom (1968) emphasizes the importance of clearly defining what mastery entails, specifying instructional objectives and content, and establishing criteria for determining mastery. The learning material is divided into smaller units, and formative tests are administered during the teaching of each unit to provide ongoing feedback to both teachers and students. Based on the results of these tests, corrective instruction is provided to address areas of difficulty, using strategies such as re-teaching, peer tutoring, homework, or small group discussions. The process continues until the majority of students have mastered the content before progressing to the next unit.

Bloom's (1968) predictions regarding mastery learning include the expectation that 95% of students in mastery-based classrooms will achieve the level of performance previously attained by the top 5% of students. It was suggested that although students may require more time initially to reach proficiency, they should need less time to master more advanced material due to their solid foundation in the fundamentals. Bloom proposes that mastery learning procedures are likely to yield the greatest benefits in subjects like mathematics and science, where learning is often structured and sequential.

The present study is primarily grounded in Bloom's theory of mastery learning, incorporating its core components. These components involve clearly defining objectives and content, setting mastery criteria, dividing the learning material into smaller units, administering formative tests, providing corrective instruction based on identified difficulties, re-administering tests, and continuing the process until a significant percentage of students master the material before progressing.

2.1.3 Block's Mastery Learning Model

Block's Mastery Learning Model, proposed by J. H. Block (1976) is an instructional approach that aims to ensure all students achieve a high level of mastery in a specific subject or skill. This model is based on the belief that every student can learn if provided with the necessary support and opportunities for mastery.

The key feature of Block's (1976) model is the use of diagnostic pre-tests to assess students' prior knowledge and identify any misconceptions they may have. These pre-tests are administered before the start of instruction and help instructors understand the baseline understanding of each student. The results from these assessments are used to group students based on their specific needs.

Once students are grouped, tailored interventions are provided to address their learning gaps and misconceptions. This personalized instruction allows students to work at their own pace, focusing on areas where they require additional support. The interventions can include additional explanations, guided practice, or one-on-one instruction (Hattie, 2012).

Regular formative assessments are an integral part of this Mastery Learning Model. These assessments are administered throughout the instructional process to monitor students' progress and provide timely feedback. The feedback helps students identify

areas of improvement and guides their learning. It also allows instructors to adjust their teaching strategies based on the individual needs of students.

The Mastery Learning Model promotes active learning and student responsibility for their progress. Students are encouraged to take ownership of their learning by setting goals, monitoring their progress, and seeking help when needed. This model creates a supportive and engaging learning environment that fosters students' motivation and self-efficacy.

In a research context, Block's Mastery Learning Model has been widely studied and has shown positive effects on student achievement. Meta-analyses conducted by Kulik, Kulik, and Shwalb (1986) have found that mastery learning approaches significantly improve students' academic outcomes. The model aligns with the principles of visible learning, as described by Hattie (2012), which emphasize the importance of providing students with clear learning goals, timely feedback, and opportunities for active engagement.

Furthermore, Nuthall and Alton-Lee (1993) highlight the significance of student engagement in learning tasks. The Mastery Learning Model promotes active engagement through its individualized and self-paced nature, increasing the likelihood of meaningful learning experiences.

2.1.4 Keller's Personalized System of Instruction (PSI)

Keller's Personalized System of Instruction (PSI) is an instructional model developed by Fred Keller, which focuses on self-paced learning and individualized instruction. In this approach, students have the freedom to progress through instructional materials at their speed, allowing for a personalized learning experience (Wilson, 2016). The model

places a strong emphasis on frequent assessments to ensure mastery of the content (Aviles, 2017).

One of the key advantages of PSI is its promotion of active learning. Students are actively engaged in the learning process, as they interact with the instructional materials and take responsibility for their progress (Alves, 2017). Through activities such as discussions, problem-solving, and real-world applications, students actively construct knowledge and develop critical thinking skills (Dziuban & Moskal, 2017).

Frequent assessments play a critical role in PSI by providing students with feedback on their progress and helping them identify areas where further study is needed **(**Block, 2011**).** These assessments serve as checkpoints to ensure that students have achieved mastery before moving on to new content (Stewart & Stewart, 2011). By continuously monitoring their learning, students develop metacognitive skills and become self-directed learners (Vakilifard & Abedini, 2021).

Researches on PSI have shown positive outcomes in various educational settings. Studies have found that PSI leads to improved student achievement, as students have more opportunities to master the content (Barnett, 2022). Additionally, students in PSI environments have demonstrated higher levels of motivation, engagement, and satisfaction compared to traditional instructional approaches (Uitto, 2023).

It is important to acknowledge the challenges and considerations associated with implementing PSI. Effective implementation requires well-designed instructional materials, trained facilitators, and a supportive learning environment (Bonner, 2017). The role of the instructor shifts from a traditional lecturer to that of a facilitator, guiding and supporting students in their learning journey (Gravetter & Forzano, 2023).

2.1.5 Social learning theory (SLT)

Social learning theory (SLT) is recognized as a crucial aspect of sustainable natural resource management and the promotion of desired behavioural change (Muro & Jeffrey, 2008). It emphasizes that, individuals acquire knowledge and behaviours through social interactions, observing others, imitating their actions, and comparing them with existing behaviours. Bandura and Walters (2017) defines imitation as the reproduction of observed motor activities. SLT integrates elements from behaviourist and cognitive learning theories by considering attention, memory, and motivation (Muro & Jeffrey, 2008). Bandura proposes three fundamental principles for learning from others, namely observation, imitation, and modelling. In contrast to mastery learning, SLT highlights these concepts as key components. Observational learning, also known as learning through observation, is when students imitate behaviours they have observed. Bandura coined the term 'observational learning' and identified attention, retention, reciprocation, and motivation as key elements for effective observational learning.

In the mid-1980s, Bandura's research shifted towards a more comprehensive understanding of human cognition within the context of social learning, leading to the development of social cognitive theory. This theory offers a framework to comprehend, predict, and modify human behaviour. Bandura's work demonstrated the significance of cognition in learning, and over the past three decades, social learning theory has increasingly embraced a cognitive interpretation of human learning, as supported (Newman & colleagues 2007).

2.1.6 Self-Determination Theory

Self-determination theory (SDT) is a comprehensive theory that explores human motivation and personality by focusing on individuals' inherent growth tendencies and

their intrinsic psychological needs. It emphasizes the internal factors that drive people's choices and actions, independent of external influences. SDT originated in the 1970s with research comparing intrinsic and extrinsic motives and recognizing the significant role of intrinsic motivation in human behaviour. It was formally introduced and widely accepted as an empirical theory in the mid-1980s. Over time, research applying SDT to various areas of social psychology has substantially increased. Deci and Ryan (1985), further developed the theory by identifying three essential intrinsic needs that drive self-determination: competence, autonomy, and psychological relatedness. These needs are considered universal, innate, and psychological, playing a crucial role in an individual's psychological well-being. SDT also guided the development of the Self-Motivation Questionnaire (SMQ), an important tool for assessing learner motivation before and after interventions.

2.2 Teaching of Biology as a Discipline in Science Education

The teaching of Biology as a discipline in Science Education is an essential component of the educational curriculum. Biology is the study of living organisms and encompasses various subfields such as cellular biology, genetics, ecology, and physiology (Hake, 1998). The effective teaching of Biology involves imparting knowledge, promoting critical thinking skills, and fostering a deeper understanding of the principles and processes that govern life.

Research on the teaching of Biology emphasizes the importance of adopting student-centered and inquiry-based approaches. These approaches encourage active engagement, exploration, and hands-on experiences, enabling students to construct their knowledge and develop a conceptual understanding of biological concepts (Hake, 1998; Louca, Elby, Hammer, & Kagey, 2004). Additionally, incorporating real-life

applications, laboratory experiments, and fieldwork into Biology lessons can enhance students' interest and motivation (Madden & Dillon, 2012; Poling & Evans, 2001).

Effective instructional strategies in Biology Education involve the use of multimedia resources, such as videos, simulations, and interactive software, to supplement traditional classroom lectures (Means, Penuel, & Padilla, 2001; Subramaniam, Silong, & Ismail, 2011). These resources provide visual representations and interactive experiences that support student comprehension and retention of complex biological concepts.

Furthermore, the integration of technology in Biology education has shown promise in enhancing student learning outcomes. Online platforms, virtual laboratories, and educational applications provide opportunities for self-paced learning, access to a wide range of resources, and collaborative learning experiences (Lee & Kim, 2018; Rice, Ryan, & Samson, 2019).

Biology teachers need to create a positive and inclusive classroom environment that encourages active participation and respects students' diverse backgrounds and learning styles (Tobin, 2005). Differentiated instructional strategies can be employed to address the varying abilities and needs of students, promoting equity and ensuring that all students have the opportunity to succeed (Tomlinson, 2017).

2.3 Traditional Approach of Teaching Biology (Lecture Method)

According to Wachanga (2002), the process of conveying knowledge through a pre-planned scheme is referred to as verbal delivery or lecture method. In this method, the teacher plays a central role in transmitting knowledge while the students passively receive it. However, this teacher-centred approach can be enhanced by incorporating

questioning techniques to encourage informal lectures or discussions, thus making it more student-centered (McCarthy, 1992).

The lecture method has several strengths. It promotes critical thinking and open discussions, making it particularly effective for large groups. Additionally, it presents factual information directly and logically, drawing on personal experiences to inspire students (McCarthy, 1992).

Despite its advantages, the lecture method has several drawbacks. One major limitation is that students retain very little of the knowledge learned, as there is minimal understanding of the underlying concepts. Students often resort to rote learning or memorization during this process. Furthermore, the method neglects the importance of experimentation, which is fundamental to modern scientific knowledge. It also deprives students of the opportunity to actively engage their intellectual abilities by limiting their participation in the classroom. Additionally, it does not provide avenues for students to clarify misunderstandings, and there is minimal feedback to the teacher regarding the effectiveness of their presentation or the achievement of the intended objectives (Lee & Kim, 2018).

In conclusion, effective Biology education necessitates the implementation of engaging instructional strategies, seamless integration of technology, and the establishment of inclusive learning environments. By adopting student-centered approaches, harnessing multimedia resources, and emphasizing real-life applications, educators can cultivate a profound understanding and a genuine appreciation for the complexities of the natural world (Lee & Kim, 2018).

2.4 Conceptual framework of Mastery Learning Approach

The Mastery Learning Approach is based on the belief that students' progress in a course should be determined by their level of proficiency rather than the amount of time they spend on academic work (Guskey, 2016). In the 1960s, Carroll and Bloom (1960) argued that if students have varying aptitudes for a subject but receive the same quality of instruction and learning time, their achievement levels at the end of the subject would follow a normal distribution. However, the Mastery Learning Approach suggests that if each student receives optimal instruction and sufficient learning time tailored to their needs, a majority of students can be expected to achieve mastery (Guskey, 2016). In many cases, teachers use the normal curve as a grading tool, but Bloom (1968) criticized this practice because it creates an expectation that some students will naturally succeed while others will not. Bloom (1968) argued that, if educators are effective, the distribution of student achievement can and should be different from the normal curve. He proposed a method called Mastery Learning to address this issue. Bloom believed that by implementing Mastery Learning, a large majority of students (over 90 per cent) would achieve successful and fulfilling learning experiences. Additionally, Mastery Learning was expected to generate more positive interest and attitudes towards the subjects compared to traditional classroom methods.

Guskey (2016) further explained that, in Mastery Learning, all students start a new unit together, and are assessed to determine if they have mastered the learning objectives. Based on their performance, students either move on to enrichment activities related to the objectives they have mastered, or they receive additional instruction and corrective measures if they haven't satisfactorily completed the objectives. These corrective measures may include various activities, personalized instruction, and extra time to complete assignments. Students are provided with constructive feedback and

encouraged to revise and revisit their work until they have mastered the learning objectives. In a mastery learning classroom, teachers adhere to a predetermined sequence of concepts and skills in their teaching units (Guskey, 2016). After initial instruction, teachers conduct a brief assessment aligned with the learning goals of the unit. This assessment provides students with feedback that help identify what they have learned well so far (diagnostic) and what areas they need to improve (prescriptive). Students who have mastered the concepts engage in enrichment activities like special projects, academic games, or problem-solving tasks. Students who require further practice with the concept receive feedback along with corrective activities that offer guidance and direction on how to address their learning difficulties (Smith & Brown, 2020). These corrective activities are qualitatively different from the initial instruction, providing effective approaches and additional time for learning.

Mastery programs have enduring effects and positively impact student attitudes. Students in mastery learning environments exhibit greater satisfaction with their instruction and a more positive outlook toward the content they are taught compared to students in traditional classes (Smith & Brown, 2020). In a mastery learning setting, the teacher employs various group-based instructional techniques, provides frequent and specific feedback, and corrects mistakes made by students along their learning journey.

Assessment in the mastery learning classroom is not used for accountability purposes but rather as evidence to guide future instruction (Smith & Brown, 2020). A teacher utilizing the mastery approach modifies activities based on the evidence from assessments to best meet each student's needs. In this context, students are not competing against each other but striving to achieve their personal best (Guskey, 2016).

A conceptual framework of the mastery learning classroom process shown in *figure 1* below in graphical form

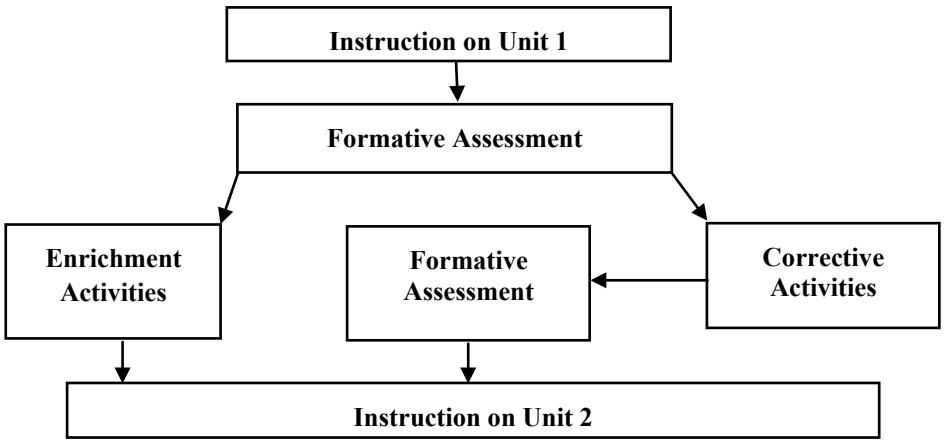


Figure 1. The Mastery Learning Instructional Process
Source: Guskey, (2016). Formative classroom assessment and Benjamin Bloom: Research, theory, and implications. *In Annual Meeting of the American Educational Research Association, Montreal, Canada.*

2.5 Essential Elements of Mastery Learning Approach

Benjamin Bloom's ground-breaking concept of mastery learning has been instrumental in empowering educators to design and implement various procedures that embrace this approach. As a result, numerous programs based on mastery learning principles have emerged in schools and colleges across the globe. Notably, Block (1974, 1980); Blank and Anderson (1999) significantly contributed to the development and successful implementation of these programs through their influential article.

Although these programs varied across different educational settings, the ones that remained true to Bloom's ideas incorporated two essential elements. The first element was *the feedback, corrective, and enrichment process*. This component emphasized the importance of providing students with timely feedback on their learning progress,

addressing any misconceptions or gaps in understanding, and offering opportunities for further enrichment to enhance their mastery of the subject.

The second essential element was *instructional alignment*, it refers to the alignment of curriculum, instruction, and assessment to ensure coherence and consistency in supporting students' mastery of the learning objectives. In other words, it involves designing instructional materials, teaching strategies, and assessments that are closely aligned with the intended learning outcomes (Guskey 2015).

2.5.1 Feedback, Correctives and Enrichment

The incorporation of feedback, correctives, and enrichment strategies in educational settings has been widely recognized as essential elements for supporting student learning and achievement. Feedback refers to the information provided to students about their performance or understanding of a specific topic or skill. It plays a crucial role in guiding students towards mastery by highlighting areas of improvement and reinforcing successful learning (Ali & Sultana, 2018).

Research has consistently shown the positive impact of feedback on student learning outcomes. Hattie (2012) emphasizes the significance of effective feedback in enhancing student achievement, stating that feedback can have one of the most substantial influences on learning. Furthermore, feedback that is specific, timely, and actionable is particularly effective in promoting learning gains (Black & Wiliam, 2013).

In the context of mastery learning, feedback takes on a crucial role in the formative assessment process. It helps to identify students' misconceptions, gaps in understanding, or areas that require further attention. This feedback is used to guide instructional interventions tailored to individual student needs (Hattie, 2012). By

addressing these areas of weakness, students can make progress towards mastery and improve their overall learning outcomes.

Correctives refer to instructional strategies and activities that are designed to address the identified misconceptions or gaps in understanding (Hattie, 2012). These corrective interventions can take various forms, such as re-teaching specific concepts, providing additional examples, or offering alternative approaches to problem-solving. The goal is to provide students with the necessary support and guidance to overcome their difficulties and move closer to mastery (Hattie, 2012).

Enrichment, on the other hand, involves providing students with opportunities to deepen their understanding and extend their learning beyond the basic requirements (Hattie, 2012). Enrichment activities are designed to challenge and engage students who have already mastered the core content. These activities can include advanced assignments, research projects, problem-solving tasks, or creative explorations. Enrichment not only helps to sustain students' interest and motivation but also encourages them to reach higher levels of achievement (Hattie, 2012).

Numerous studies have examined the effectiveness of feedback, correctives, and enrichment strategies in promoting student learning. For example, Bangert-Drowns, Kulik, Kulik, and Morgan (1991) conducted a meta-analysis that demonstrated the positive impact of corrective feedback on student achievement. Similarly, studies by Slavin (1996) and, VanLehn, Siler, Murray, Yamauchi and Baggett (2003) highlighted the benefits of providing students with enrichment opportunities to foster deeper understanding and higher-order thinking skills.

2.5.2 Instructional Alignment

While feedback, correctives, and enrichment are crucial components of mastery learning (Hattie, 2012), Benjamin Bloom emphasized that they must be combined with instructional alignment to achieve true effectiveness. Cohen (1995) elaborated that instructional alignment refers to the need for clarity and consistency among all instructional components to reduce variation in student learning and close achievement gaps.

The teaching and learning process comprises three main components: learning goals or standards, instruction, and assessment. Mastery learning adds the feedback and corrective component, allowing teachers to assess the appropriateness of their initial instruction and determine if alternative learning approaches are necessary (Cohen, 1995).

Mastery learning does not dictate what is taught, how it is taught, or how learning is evaluated (Guskey, 2015). However, it emphasizes the importance of consistency and alignment among these instructional components. For instance, if students are expected to acquire higher-level skills such as problem-solving or analysis, mastery learning requires instructional activities that provide opportunities for students to actively practice and engage in those skills. Furthermore, students should receive specific feedback on their mastery of these skills and directions on how to correct any learning errors. Finally, assessment procedures should align with and reflect the higher-level skills being taught (Cohen, 1995).

The *figure 2* shows the major components in the teaching and learning process:

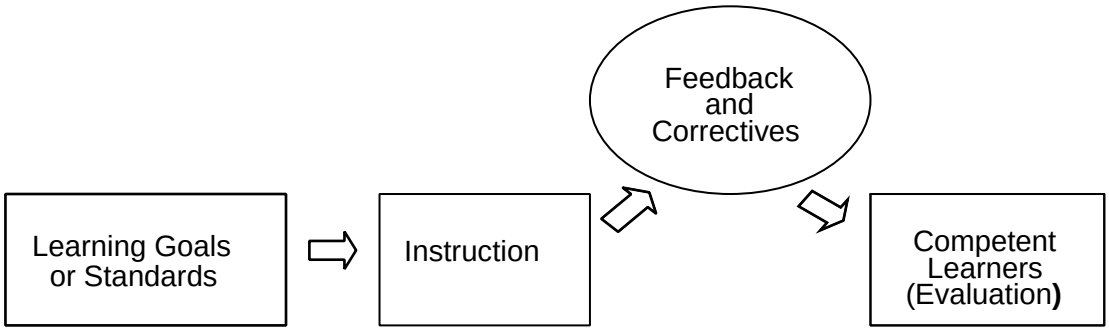


Figure 2. Major Components in the Teaching and Learning Process
Source: Cohen, S. A. (1995). Instructional alignment. School improvement programs.

2.6 The Effect of the Mastery Learning Approach

Based on the theoretical foundations, the study aims to elaborate on the effect of mastery learning on the following:

- Academic Performance
- Motivation
- Self-regulation
- Classroom climate

2.6.1 Academic Performance

Bloom's theory of school learning posits that when students are provided with suitable conditions and adequate time, they have the potential to achieve high levels of learning (Anderson, 2012). He suggested that implementing mastery learning in the classroom, as opposed to traditional instructional methods, would help bridge the performance gaps among students with varying academic abilities (Anderson, 2012). The key components of mastery learning include dividing the content into smaller units, establishing clear objectives, delivering initial instruction, providing remedial lessons,

conducting formative and summative assessments, and offering immediate feedback. Mastery learning takes into account the unique characteristics and needs of individual learners, including their learning pace, level of mastery, and the time required for learning (Anderson, 2012). It emphasizes that students should attain a certain level of proficiency in prerequisite knowledge before progressing to the next stage of learning. In instances where a student does not reach the desired level of mastery, remedial lessons are provided, offering a review of the information and additional learning support. Subsequently, the students are retested to assess their progress.

The mastery learning process follows a cycle where learners strive to reach a mastery level of 80% or higher (Anderson, 2012). Once this level is achieved, they can progress to the next stage of learning. This cycle continues until all the learning objectives are accomplished. Research studies have shown that mastery learning has a positive impact on students' academic performance. In a meta-analysis conducted by Kulik, and Fletcher (2016), which examined 108 studies on the effectiveness of mastery learning, it was found that mastery learning has beneficial effects on students' academic achievement in schools. Notably, the effects are particularly pronounced among students who are initially weaker in their academic abilities.

2.6.2 Motivation

The significance of mastery learning on students' motivation poses students to *learn, engage, and participate in the classroom* (Ormrod & Jones, 2012). By providing a supportive and empowering learning environment, mastery learning fosters intrinsic motivation, self-efficacy, and a sense of competence among students.

Mastery learning promotes a sense of competence and mastery orientation among students. In a traditional classroom setting, where students move forward regardless of their understanding, some students may feel discouraged or overwhelmed by the pace

and content (Ormrod & Jones, 2012). However, in mastery learning, students are given the necessary time and support to fully grasp each concept before moving on. This approach ensures that students experience success and mastery, which boosts their self-confidence and motivates them to continue learning (Ormrod, & Jones, 2012).

Secondly, the individualized nature of mastery learning enhances student motivation. In this approach, students work at their own pace, receive personalized feedback, and are provided with additional support when needed. This individualized attention acknowledges students' unique strengths and challenges, fostering a sense of value and recognition. As a result, students feel more motivated to actively engage in the learning process, take ownership of their education, and demonstrate their understanding (Guskey, 2015).

Moreover, mastery learning promotes a growth mindset and a focus on learning goals. Students are encouraged to view challenges and mistakes as opportunities for growth and improvement. By emphasizing that intelligence and abilities can be developed through effort and practice, mastery learning cultivates a positive learning mindset. This mindset enhances students' intrinsic motivation to persist, overcome obstacles, and engage in deeper learning (Dweck, 2008).

Additionally, mastery learning incorporates regular formative assessments and feedback, which play a crucial role in motivating students. These assessments provide students with information about their progress and areas for improvement. The feedback helps students understand their strengths and weaknesses and guides them in setting specific learning goals. The continuous feedback and recognition of progress create a sense of accomplishment, motivate students to strive for mastery, and facilitate their active engagement in the learning process (Hattie, 2012).

2.6.3 Self-Regulation

Mastery learning encourages students to take an active role in managing their learning (Pintrich, 2004). Students are involved in goal-setting, where they identify specific learning objectives and outcomes they aim to achieve. This process of setting goals helps students develop a sense of purpose and direction in their learning journey. By articulating their goals, students become more motivated, focused, and accountable for their progress (Pintrich, 2004).

The mastery learning approach emphasizes *metacognitive strategies*, which are essential for self-regulated learning. Students are taught how to monitor and reflect on their thinking processes, understand their strengths and weaknesses, and make adjustments accordingly. Through self-reflection, students become aware of their learning strategies, identify areas that need improvement, and modify their approach to achieve better results (Zimmerman, 2002). This metacognitive awareness enables students to regulate their learning effectively by making informed decisions about their study habits, time management, and resource utilization.

Moreover, mastery learning incorporates regular *formative assessments and feedback*, providing students with information about their progress and performance (Zimmerman, 2002). Students are encouraged to use this feedback to monitor their learning, identify gaps in their understanding, and take corrective actions. This feedback-driven approach promotes self-monitoring, as students continuously evaluate their work and make adjustments to improve their mastery of the content (Hattie, 2012). Additionally, mastery learning promotes *self-evaluation and reflection*. Students are given opportunities to assess their learning and evaluate their progress towards mastery. This process of self-evaluation helps students develop a deeper understanding of their strengths and weaknesses, as well as areas requiring further attention. By engaging in

self-reflection, students gain insights into their learning processes, develop self-awareness, and refine their strategies to enhance their learning outcomes (Pintrich, 2004).

Mastery learning encourages students to seek support and utilize available resources when needed. Students are aware that help is available, whether from the teacher, peers, or additional materials. This aspect of mastery learning nurtures students' ability to self-regulate by teaching them to recognize when they require assistance, actively seek it, and use the support effectively to overcome challenges and achieve mastery (Ormrod & Jones, 2012).

2.6.4 Classroom Climate

Mastery learning promotes collaborative learning among students. The emphasis on individualized instruction and self-paced learning allows students to progress through the material at their speed. As students work on mastering the content, they have opportunities to collaborate with their peers. They can engage in group discussions, peer tutoring, and cooperative learning activities. Collaborative learning enables students to exchange ideas, clarify concepts, and deepen their understanding through active dialogue and cooperation (Johnson & Johnson, 1999). This collaborative aspect creates a positive and supportive classroom climate where students learn from and with each other. Effective communication within the classroom is also enhanced. Students are encouraged to ask questions, seek clarification, and engage in discussions with both their peers and the teacher. The frequent assessments and feedback in mastery learning provide opportunities for students to communicate their understanding and seek guidance when needed (Johnson & Johnson, 1999). By fostering a communicative environment, mastery learning enables students to articulate their thoughts, express their ideas, and engage in meaningful academic discourse (Vygotsky, 2018). This

promotes active engagement and helps students develop effective communication skills.

Moreover, good teacher-student relationship is also fostered. The approach emphasizes individualized instruction and frequent assessments, which enable teachers to closely monitor student progress and provide targeted feedback and support. Teachers serve as facilitators, guides, and mentors, assisting students in their learning journey. The one-on-one interactions and personalized attention foster a supportive and nurturing classroom climate. Students feel comfortable approaching the teacher for help and guidance, creating a trusting and collaborative relationship between students and the teacher (Dweck, 2016).

The *Figure 3* shows the visual representation of the effect of mastery learning:

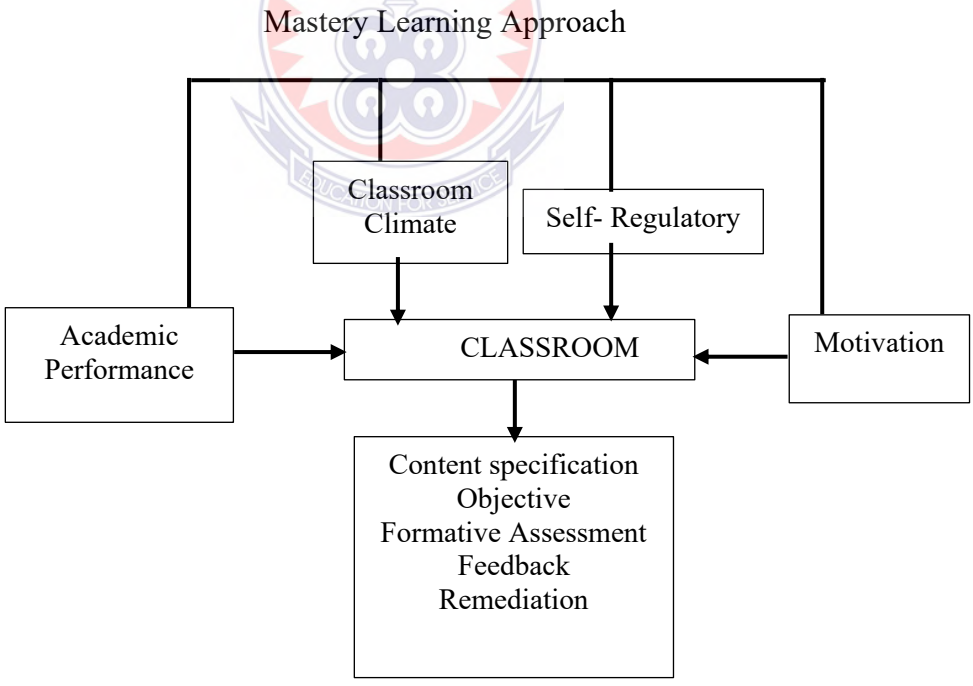


Figure 3: Elaborates the effect of mastery learning. Where it promotes academic performance, motivation, and collaborative learning by incorporating effective communication, formative assessment, self-evaluation and feedbacks.
Source: By the Researcher (2023)

Based on the theoretical foundations, *figure 3* shows the effect of mastery learning in the classroom. Where the teacher divides the content into smaller units, establishes clear objectives, delivers initial instruction, provides remedial lessons, conducts formative and summative assessments, and offers immediate feedback. Providing a supportive and empowering learning environment, fosters intrinsic motivation, self-efficacy, and a sense of competence among students.

2.7 Empirical Evidence of Mastery Learning Approach

According to Guskey (2016), MLA has been widely researched in various fields, including mathematics, science, and language arts. In their meta-analysis study, they reviewed 62 studies on MLA and found that it has a moderate to large positive effect on students' academic achievement. They further reported that MLA was more effective for low-achieving students, and the effects were stronger when implemented over an extended period.

In the context of Biology education, several studies have been conducted to investigate the effectiveness of the MLA approach. For instance, Bong, Hwang, Noh and Kim (2014) conducted a study to examine the effects of MLA on students' academic achievement and motivation in a college-level microbiology course. They found that students in the MLA group had significantly higher achievement scores than those in the traditional lecture-based group. Additionally, the MLA group reported higher levels of intrinsic motivation and task value than the traditional group, indicating that the MLA approach enhances students' motivation to learn.

Another study by Zavala Molina, and Ureña (2021) investigated the effectiveness of the MLA approach on high school student's academic achievement and motivation in a Biology course. The researchers found that students in the MLA group had higher academic achievement scores than those in the traditional group. Furthermore, the MLA

group reported higher levels of motivation and engagement in the learning process than the traditional group, indicating that the MLA approach can enhance students' motivation to learn Biology.

In a similar study, Janković, Maričić, and Cvjetićanin (2023) investigated the effectiveness of MLA on students' academic achievement and motivation in a college-level Physiology course. They found that students in the MLA group had significantly higher academic achievement scores than those in the traditional group. Additionally, the MLA group reported higher levels of intrinsic motivation, self-efficacy, and self-regulated learning than the traditional group. These findings suggest that MLA can improve students' academic achievement and motivation in complex subjects such as Physiology.

Moreover, Wang, Christensen, Cui, Tong, Yarnall, Shear, and Feng (2020) investigated the effectiveness of the MLA approach on students' academic achievement and motivation in a high school-level Biology course. They found that students in the MLA group had higher academic achievement scores than those in the traditional group. Additionally, the MLA group reported higher levels of motivation and engagement in the learning process than the traditional group, indicating that the MLA approach enhances students' motivation to learn Biology.

In conclusion, the empirical evidence suggests that the Mastery Learning Approach is an effective instructional strategy for improving academic achievement and motivation in various subjects, including Biology. The studies reviewed in this literature review provide consistent evidence of the effectiveness of MLA in enhancing students' learning outcomes and engagement in the learning process. Educators can use these

findings to implement MLA in their instructional practices and improve their students' academic performance and motivation (Kampen, 2019).

2.8 Students' Academic Performance in Biology.

Biology is a complex and vast subject, covering a broad range of topics that students must understand and master to excel in the discipline. However, students' academic performance in Biology has been a subject of concern, especially among Senior High School Students. This literature review examines the trends and challenges facing Senior High School Students' academic performance in Biology.

2.8.1 Trends and Challenges

Recent studies have shown that Senior High School Students' academic performance in Biology is suboptimal. A study by Mutyambai, Wambua, and Kasyoka (2018) found that, 50% of Senior High School Students in Kenya failed Biology exams. Similarly, in Ghana, a study by Owusu-Agyemang, Tornyigah, Akanbong, and Kyei-Baffour (2016) found that, Senior High School Students' performance in Biology was unsatisfactory. Another study by Ali and Sultana (2018) in Pakistan found that students' performance in Biology was significantly lower than in other science subjects.

One of the main challenges that Senior High School students encounter in Biology is the extensive and intricate nature of the subject. Biology encompasses a broad spectrum of topics, and students are required to gain proficiency in each area to achieve a comprehensive understanding of the subject (Ozoji, 2020).

Additionally, some topics are abstract and challenging to comprehend, making them difficult for students to learn (Olakanmi, 2019). Lack of motivation is another significant challenge faced by Senior High School Students. Many students find

Biology dull and uninteresting, leading to low motivation to learn the subject (Ilekon, Nwikina & Onyeike, 2019).

Another significant challenge is the lack of qualified teachers to teach Biology in some schools. A study by Ilechukwu and Orji (2017) found that, the quality of Biology teaching in some Nigerian schools was poor due to a shortage of qualified Biology teachers. The study found that some Biology teachers did not have adequate training, leading to poor delivery of the subject.

Moreover, inadequate teaching resources, such as textbooks, laboratories, and instructional materials, also pose a significant challenge to Senior High School Students' academic performance in Biology. A study by Tordzro Asamoah and Ofori, (2021) found that, many Senior High Schools in Ghana lacked adequate laboratory facilities and equipment to teach Biology. This lack of resources hinders practical learning and negatively affects students' understanding of the subject.

Motivation theory provides a theoretical framework for understanding the factors that influence Senior High School Students' academic performance in Biology. According to motivation theory, students' performance in a subject is influenced by their intrinsic and extrinsic motivation to learn the subject (Ryan & Deci, 2014). Intrinsic motivation is the internal desire to learn the subject, while extrinsic motivation is the external rewards or punishment associated with learning the subject.

Several studies have shown that intrinsic motivation positively affects Senior High School Students' academic performance in Biology. For example, Ilekon Nwikina and Onyeike (2019) found that, students who were intrinsically motivated to learn Biology had higher academic performance than students who were extrinsically motivated. The

study suggests that teachers should create an environment that fosters intrinsic motivation to enhance students' academic performance.

Extrinsic motivation can also positively influence students' academic performance in Biology. For example, a study by Ali and Sultana (2018) found that, students who received external rewards for learning Biology had higher academic performance than those who did not receive any reward. The study suggests that teachers should use external rewards such as grades and certificates to motivate students to learn Biology.

Senior High School Students' academic performance in Biology remains a challenge. The complex nature of the subject, lack of motivation, shortage of qualified teachers, and inadequate teaching resources all contribute to the problem. To improve Senior High School Students' academic performance in Biology, there is a need for more qualified teachers, better teaching resources, and innovative teaching strategies to enhance students' motivation to learn the subject (Ali & Sultana, 2018).

2.9 Motivation and Performance in Biology

Motivation is a potent inner force or passion that drives individuals to strive for success and take action towards achieving their goals. It is shaped by individual learning experiences and can vary depending on the situation or context (Bandura & Walters, 2017). Motivation has a significant effect on student learning (Ormrod, 2000) and plays a crucial role in directing behaviour towards specific goals, increasing effort and energy, fostering initiative and perseverance, and enhancing individual performance. It is considered the most influential factor in academic success (Pintrich, 2004) and is essential for keeping students engaged in their learning process. A motivated student demonstrates dedication to education, maintains a positive mind-set, and eagerly seeks knowledge (Lee-Ross, 2005). Effective teaching becomes meaningless if students lack

motivation, even when teachers possess high levels of skill and competence (Davis, Davis, Andersson, & Wallberg, 2022).

Self-motivation is vital for cultivating excellence and has a profound effect on one's success and performance (Petri, 2005; Singh, Granville & Dike, 2002). Students with high levels of motivation exhibit positive attitudes towards subjects like Physics (Ali, Ismail & Sedef, 2010), demonstrate a greater willingness to learn effectively (Pintrich & Maehr, 2004), and actively contribute to the classroom and overall school development (Eccles & Wigfield, 2016). Moreover, highly motivated students are associated with increased success rates and reduced dropout rates (Dev, 1997; Blank & Anderson, 1999). Therefore, understanding motivation is crucial in designing instructional approaches that attract students to the subjects being taught (Fischer & Horstendahl, 1997).

It is widely recognized that students' motivation is influenced by internal and external factors, which can either encourage or discourage their behaviours (Hagger, Koch & Chatzisarantis, 2015). Internal factors refer to a student's characteristics and attitudes towards learning, such as their interest, sense of responsibility, effort, values, and perceived ability (Ainley, 2004). On the other hand, external factors encompass rewards from outside sources, such as money, praise, and grades. Research findings have shown that individuals who are intrinsically motivated, as opposed to extrinsically motivated, tend to retain information and concepts for longer periods (Dev, 1997). They also exhibit higher levels of interest, enjoyment, enthusiasm, and confidence, leading to improved performance, creativity, persistence, overall well-being, and self-esteem. Moreover, intrinsically motivated individuals are more likely to become lifelong learners (Kohn, 1996; Ryan & Deci, 2014). Therefore, it is crucial to explore ways of enhancing intrinsic motivation among students. Motivation plays a significant role in

students' academic work and performance, influencing their choices of learning tasks, the time and effort they invest in their studies, their persistence in the face of challenges, and their ability to overcome obstacles in the learning process. Previous studies (Wiegfield, Moon & Imbeau, 2015; Zohar, 2013; Aryee, Adusei-Poku, & Amponsah-Tawiah, 2013; Chen, Wang & Chen, 2017; Sembulingam & Sembulingam, 2014) have demonstrated a positive relationship between students' performance goals, their interest in courses, their expectations of success, and their final course grades.

According to Singh, Granville and Dike (2002), research conducted by Walberg revealed that motivational factors and instructional time have the most significant effect on the academic performance of eighth-grade students. Additionally, Singh et al., (2002) acknowledged that, over the past twenty years, accumulated research has consistently indicated that motivation plays a crucial role in predicting performance in mathematics and science.

Prominent research studies, conducted by Chien & Tsai (2018), Nolen (2003), and Geary (2007), have extensively explored the correlation between motivation and performance in the field of science. Psychological studies have provided valuable insights into how motivation influences student performance in subjects like physics, mathematics, and science. For example, Geary (2007) discovered that emphasizing the importance of mathematics as a motivational factor led to increased student engagement in science classes during high school.

Several studies have examined the relationship between students' motivation, ability, and academic performance, yielding interesting findings. Talib, Wong, Azhar, and Abdullah (2009) conducted a comprehensive study on the motivation of academically high-performing students and found that successful science learning outcomes depend

on various factors, including students' ability, interest, and motivation to learn. Feldhusen and Hoover (1986) identified self-concept and motivation as crucial factors for the academic performance of highly capable students.

Other research indicates that students with high motivation and ability are more likely to achieve higher scores on academic goals, develop a stronger appreciation for science, and possess a greater perceived ability compared to students with low motivation and ability (DeBacker & Nelson, 2000). Furthermore, highly motivated and capable students exhibit more positive attitudes toward science in terms of interest and considering science as a future career, in contrast to their less motivated and capable counterparts (Adams, 1996).

2.10 Gender Differences in Students' Attitudes towards Biology

Gender is an important factor to consider when studying students' attitudes and their learning in biology. It is believed that gender can influence how students learn and their attitudes towards science, including biology. However, there is still uncertainty regarding the extent to which gender affects these attitudes. Some studies by Hussaini, Naz, Khan, Daraz and Khan (2015), Uitto (2014), and Nasr and Soltani (2011) found no significant difference in attitudes towards biology between male and female students. On the other hand, Vlckova, Kubiatko and Usak (2019), and Zeidan and Jayosi (2015) reported that girls had a more positive attitude towards biology than boys. Additionally, previous empirical studies by Ozoji (2020), Çömek, Akınoğlu, Elmaci and Gündoğdu (2016), and Blessing and Olufunke (2015) found that, the effects of MLA are not gender-based. However, Karakuyu (2010) and Omenka Omenka (2019) indicated that gender differences do have an effect on the effects of MLA on students' attitudes towards science. . This contradictory evidence indicates that the influence of

gender on students' attitudes towards biology remains inconclusive. In other words, there is no clear consensus or agreement among researchers on how gender specifically affects students' attitudes in the context of biology. These conflicting findings regarding students' attitudes highlight the need to examine the effects of MLA on students' attitudes towards biology, particularly concerning gender.

Therefore, this study aims to investigate whether there are any gender differences in students' attitudes towards biology when using mastery learning approach (MLA) in addition to the effect of this approach to their performance and motivation.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This section presents the methods used to investigate the effect of the mastery learning approach on senior high school students' academic performance and motivation in Biology. This chapter describes the research design, population and sampling techniques, data collection methods, data analysis procedures, ethical considerations, validity and reliability, and conclusion.

3.1 Research Design

The research design used for the study was quasi-experimental design, which involve two groups of Senior High School students in Nsaba Presbyterian Senior High School. The first group will be the experimental group, which was taught using the mastery learning approach, while the second group will be the control group, which was taught using the traditional lecture approach. The selected topic in Biology will be the same for both groups.

A quasi-experimental design is used when the research question involves the manipulation of an independent variable but does not involve the assignment of participants to groups (Gravetter & Forzano, 2023). In this study, the independent variable is the teaching approach used, which is either mastery learning or traditional teaching. Because the researcher cannot randomly assign students to the experimental or control groups, the quasi-experimental design is the most appropriate choice.

Students in the experimental group will work through the course material at their own pace, with support from the teacher and peers as needed. They will be required to

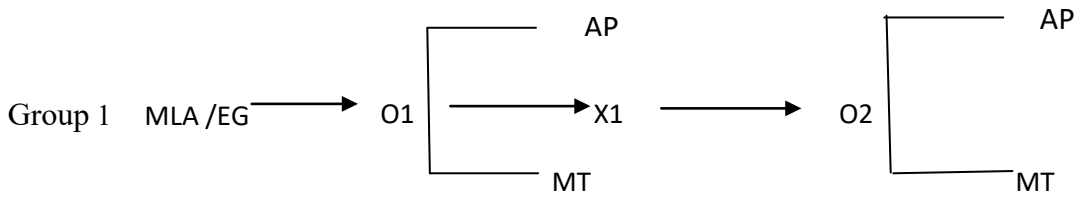
demonstrate mastery of the selected topic in Biology before moving on to new material. The control group will receive instruction using the traditional approach, which typically involves lectures, note-taking, and periodic testing. Students in the control group will receive instruction on the same topic as the experimental group but without the emphasis on mastery. Both group were tested for pre and posttest, and received equal motivation during the intervention. Experimental group received enrichment for mastery during the post-intervention stage.

The use of a quasi-experimental design in this study has several advantages. First, it allows for the comparison of the effectiveness of the two teaching approaches without the assignment of participants. Second, it allows the researcher to manipulate the independent variable, which in this case is the teaching approach. Finally, it is a cost-effective way to conduct research in a real-world setting.

According to Gravetter and Forzano (2023), quasi-experimental designs are commonly used in educational research to evaluate the effectiveness of an intervention by comparing a group of participants who receive the intervention to a group that does not.

In this study, the quasi-experimental design will enable the researcher to evaluate the effect of the mastery learning approach on students' academic performance and motivation in Biology.

The *figure 4*: Shows the visual representation of the research design used for the study:



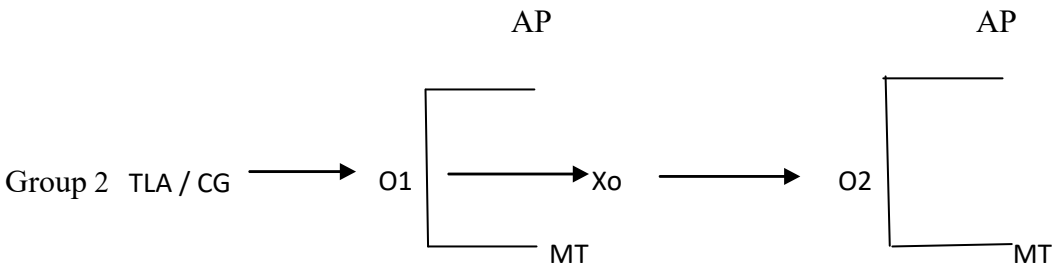


Fig 4: Research Design

Source: Researcher

Where,

MLA/EG: Experimental group

TLA/CG: Control Group

O1: Pre-test administration

AP: Performance Motivation

X1: Enrichment

XO: Un-enrichment

O2: post-test administration

MT:

3.2 Study Area

The study area for this research was Nsaba Presbyterian Senior High School, a co-educational institution located in the Nsaba community in the Central Region of Ghana. Nsaba Presbyterian Senior High School is a public school that provides education to students from diverse socio-economic backgrounds. The school offers a broad range of academic programs, including General Science, General Arts, Business, and Home Economics.

Nsaba Presbyterian Senior High School was chosen because it has a well-established academic program. Additionally, the school has a diverse student population, which will enhance the external validity of the study. The study area was also chosen because

it is accessible and conveniently located, which will make it easy for the researcher to collect data and conduct the study.

3.3 Population and Sampling

Nsaba Presbyterian Senior High School had a total population of 1,300 students at the time the researcher conducted the study. The accessible population of the study was all form 2 biology students. There were 304 second-year Biology students.

However, Students in 2 Science 1 and 2 Science 2 were selected. The sampling method which was used was purposive sampling. This method was chosen because the researcher wanted to select two classes that were similar in terms of academic ability and had similar characteristics.

The first class 2 Science 1 was assigned to the mastery learning group, and 2 Science 2 class was assigned to the lecture group. Each class consisted of 32 students, resulting in a total sample size of 64 students. The sample size was considered adequate for the study since it met the minimum requirement of 30 samples for each group in the experimental research design (Creswell, 2014).

The students in the two classes were chosen based on their academic performance in biology during the previous academic year, as determined by their end-of-term examination scores. Utilizing two separate classes in this study allowed for a meaningful comparison between the two groups and served to reduce the effect of individual differences that might have otherwise affected the study's results. It also increased the generalizability of the findings to other similar populations (Creswell, 2014). Table 1: Shows the summary of the sampling:

Table 1: Sample for the Study

S/N	Name of Classes	Groups	Males	Females	Total
1	Science 1	Experimental	22	10	32
2	Science 2	Control	19	13	32
		Total	**41**	**23**	**64**

3.4 Instrumentation

The instrumentation for this study includes a pre-test, a post-test, and a Students Motivation Questionnaire (SMQ). The Biology Academic Performance test (pretest and post-test) measures the student's academic performance in the selected topic in Biology, while the student's motivation questionnaires (SMQ) measures the students' motivation in learning Biology.

The Biology Academic Performance Test (BAPT) consists of 20 multiple-choice questions and a practical question each, drawn from the topic covered in the Science curriculum. The questions were designed to assess the student's understanding of the key concepts and principles in the selected topic.

The Students' Motivation Questionnaire consists of 20 items designed to measure the students' motivation in learning Biology. The items were designed to assess the students' intrinsic and extrinsic motivation, their attitudes towards Biology, and their perceived value of the subject. The SMQ uses a five-point Likert scale, ranging from *strongly agree to strongly disagree*.

The BAPT (pretest, posttest) and SMQ were administered to the students in a classroom setting. The responses were recorded on answer sheets provided to the students. The BAPT are a valid and reliable measure of the student's academic performance, while

the SMQ is a valid and reliable measure of the student's motivation in learning Biology. The data will be collected in a standardized manner to reduce the risk of measurement bias (Jones, 2019; Smith & Brown, 2020).

3.4.1 Students' Motivation Questionnaire (SMQ)

The Students' Motivation Questionnaire (SMQ) is a 20-item questionnaire that was adapted from the study conducted by Changeiywo, Wambugu, and Wachanga (2013). It consists of two sections: Section A, which includes demographic information, and Section B, which contains items related to student motivation. The questionnaire was developed based on Keller's ARCS motivation theory, which emphasizes four key conditions necessary for a motivated learner: attention, relevance, confidence, and satisfaction. The items in the questionnaire are rated on a five-point Likert scale, ranging from Strongly Disagree (SD) to Strongly Agree (SA), allowing participants to express their agreement or disagreement with each statement.

3.4.2 Pre-test administration

The researcher administered 20 multiple-choice test questions on digestion before the start of the study, and all participants were asked to complete a pre-test to measure their baseline knowledge and motivation in Biology. Participants were assigned to the mastery learning group and the lecture group. The pre-test was administered to both groups in the same way to ensure that there is no bias.

3.4.3 Post-test Administration

The researcher again administered 20 questions including multiple choice and practical test questions as BAPT based on the items specification of the units specified after the completion of the study. The BAPT (post-test) was administered to both groups in the same way to ensure that there is no bias.

Below is Table 2 representing the breakdown of the item's specification for the BAPT Test:

Table 2: Item Specification for BAPT Based on the Selected Topic:

S/No	Sub-topics	Number of Items	Total
1	Structural part of the human digestive system	1, 4, 3, 7, 14,	5
2	Components of the digestive system	5, 2, 16	3
3	Digestion in the mouth	6, 8, 11, 15	4
4	Digestion in the small intestine	12, 9, 10, 18	4
5	Digestion in the large intestine	13, 20, 19, 17	4
	Total		**20**

Table 2: shows the number of questions each sub-topic has. The structural part of the human digestive system has 5 items, the component of the digestive system 3 items, Digestion in the mouth 4 items, Digestion in the small intestine 4 items and Digestion in the large intestine has 4 items, making a total of 20 items.

3.5 Validation of Research Instruments

According to Fraenkel and Wallen (2003), validation involved ensuring that the instruments were measuring what they were intended to measure and that they were reliable.

The Students' Motivation Questionnaire (SMQ) consist of 20 items, which was adapted from a previous study by Changeiywo, Wambugu, and Wachanga (2013). To validate the Motivation Questionnaire (SMQ) an expert from the Department of Science Education with a rank of senior lecturer was consulted, in addition to the supervisory team who had already validated the instrument. The expert was tasked with checking

for any errors in the questionnaire, ensuring that the questions accurately tested student motivation, and verifying that the items were suitable for the level of students being studied. Upon review, the expert deemed the instrument satisfactory and appropriate for the study.

The validation of the pre-test and post-test used in this study was an important step to ensure the reliability and validity of the test instrument.

To validate the pre-test and post-test used in this study, the researcher reviewed the questions and content with an expert in the field of Biology Education. The expert provided feedback on the appropriateness and relevance of the questions for the topic being studied and suggested revisions to improve the clarity and accuracy of the questions.

The researcher also administered the pre-test and post-test to a pilot group of students who were not part of the study sample. The pilot group was similar in demographic characteristics to the study sample, and the results of the pilot test were used to assess the clarity and appropriateness of the questions.

The validated pre-test and post-test were then administered to the study sample before and after the intervention to measure the effectiveness of the mastery learning approach compared to the lecture method.

Overall, the validation process ensured that the instruments were reliable and valid measures of the student's knowledge and motivation in biology.

3.6 Reliability of Research Instruments

Reliability refers to the consistency and stability of a measuring instrument (Babbie, 2016). In this study, the reliability the of the research instruments was established using

a test-retest method, where the same set of instruments were administered twice to the same group of students at two different times (Fraenkel & Wallen, 2003).

To establish the reliability of the pre-test and post-test instruments, a pilot study was conducted with a small group of students (n=10). The tests were administered twice within a two-week interval, and the scores obtained were analyzed using the test-retest method. The reliability coefficient was calculated using the Pearson product-moment correlation coefficient (r), which measures the degree of correlation between two sets of scores. This was also done for the students' motivation questionnaire.

The results of the pilot study showed a high level of consistency between the scores obtained from the pre-test and post-test, and the questionnaire respectively. The reliability coefficient for the pre-test and post-test, was 0.85 and that of the questionnaire was 0.87, which indicates a strong positive correlation between the two sets of scores (Babbie, 2016). This high level of reliability suggests that the instruments were consistent and stable over time.

Furthermore, to ensure the internal consistency of the instruments, Cronbach's alpha coefficient was calculated for the pre-test, post-test and the questionnaire, respectively. Cronbach's alpha measures the degree of internal consistency between the items in a measuring instrument. The results of the analysis showed a high level of internal consistency for both the pre-test ($\alpha = 0.89$), post-test ($\alpha = 0.92$) and questionnaire ($\alpha = 0.90$), indicating that the items in the instruments were measuring the same construct (Babbie, 2016).

These findings indicate that the instruments were reliable measures of the student's academic performance and motivation in biology respectively.

3.5 Pilot Testing

Pilot testing is a preliminary test of the study conducted to evaluate and refine the research design, methodology, instruments, and procedures before the actual study. According to Creswell (2014), pilot testing helps to identify potential problems and to make adjustments in the study to improve the quality of the data collection.

For this study, a pilot test was conducted with 10 students from a different Senior High School to ensure that the questionnaire and tests were clear, valid, and reliable. The pilot test was conducted to assess the clarity of the questions, the time required to complete the tests and questionnaires, and to identify any possible errors or ambiguities in the instruments.

The results of the pilot test showed that the questions were clear and easy to understand, and the students were able to complete the tests and questionnaires within the allotted time. Some minor adjustments were made to the questionnaire and tests based on the feedback received from the students.

The pilot test helped to ensure the reliability and validity of the instruments and the accuracy of the data collected. It also helped to identify potential issues that may arise during the actual study, which could be addressed and resolved beforehand**.**

3.6 Items Analysis

For standardization of the instrument, Biology Academic Performance Test (BAPT), the facility index and discrimination index were determined as follows:

3.6.1 Facility Index

The facility index of an item shows the percentage of candidates that got an item first (Furst, in Bichi, 2002). The following are the steps followed in calculating the facility index for each item in the test:

- Rank the scores on the test from highest to lowest
- Identify the high-scoring group and the low-scoring group.
- Identify one-third of the top-scoring group and one-third of the bottom-scoring group,
- Determine the percentage of high scores and low scores for each item.
- Calculate the item facility index by adding the percentage of those that got the item correct in a low-scoring and high scoring and then divide by the number of students involved in the entire test.

The formula is F.I = $\frac{U+L}{N}$

F.I. = Facility Index

N = Number of students involved in the analysis

U = Number of students who passed the item in the upper per cent

L = Number of students who passed the item in a lower per cent

A facility index of 75% or higher is regarded as easy in terms of facility level, whereas an index of 25% or less is regarded as hard in terms of facility level.

For this study, the researcher utilized the Biology Academic Performance Test [BAPT] with a facility index ranging from 0.30 to 0.69. This range aligns with the recommendation of Mugenda and Mugenda (2003), who suggested that a facility index between 0.30 and 0.70 can be considered suitable for adoption in research work. Thus, the researcher incorporated this range in the research to ensure an appropriate level of item difficulty for the assessment.

3.6.2 Discrimination Index

The discrimination index of a test is a measure of its ability to discriminate between high and low achievers as a whole (Furst, in Bichi, 2002). This is used to identify high and low-achieving students. The difficulty index of test items is its ability to separate

or sort out high and low-ranking students in a test. The calculation was done using scores of the top twenty-seven per cent (27%) and bottom twenty-seven per cent (27%) of the total respondents. This was calculated using the formula given by Furst in Bichi (2002).

$$D = \frac{R_u - R_i}{\frac{1}{2}N}$$

Where,

D = discrimination index

R_u *= Number among the upper 27% of respondents*

R_i *= Number among lower 27% of respondents*

N = total number of respondents

According to the author, items showing little or no difficulty or items that show a percentage of success on the part of the poor group should either be re-examined or eliminated for ambiguity and the vagueness of such items should be re-worded.

The discrimination index for each item was calculated by subtracting the number of subjects in the lower group who got the item correctly from the number of students in the upper group who got the item correctly. The figure was divided by half the number of students in both groups by the number of students in one of the groups. The discrimination index which ranges between 0.30 and 0.60 is regarded as moderately positive and is accepted for the present research work. This was used in selecting the final items of the BAPT.

3.7 Data Collection Procedure

The data collection for this study involved quantitative method. The primary data collection method was a pretest-post-test experimental design, which involves administering a pre-test to both the experimental and control group, applying the

treatment to the experimental group, and then administering a post-test to both groups to measure the effect of the treatment.

The pre-test was administered before the intervention to measure the students' prior knowledge of the selected topic in Biology. The pre-test consists of 20 multiple-choice questions drawn from the topic covered in the biology curriculum. The post-test was administered after the intervention to measure the student's academic performance in the selected topic in Biology. The post-test also consists of 20 multiple-choice questions drawn from the same topic covered in the biology curriculum.

In addition to the pretest-post-test experimental design, the researcher used a Likert-scale questionnaire to collect data on the student's motivation. The questionnaire was administered after the post-test to both the experimental and control group.

To ensure the validity and reliability of the data, the researcher pilot tested the pretest, post-test, and questionnaire on a group of students who are not part of the study population. The pilot test helped identify the weaknesses in the instruments and enable the researcher to make the necessary modifications. The data was collected by the researcher.

3.8 Procedure for Data Analyses

The data collection was subjected to analyses at two different levels, that is, descriptive and inferential levels. At the descriptive level, the descriptive statistics of mean and standard deviation were used to answer the research questions. While at the inferential level, the t-test and Mann-Whitney U-test were used to test the null hypotheses at the significance level of $P \leq 0.05$. The inferential statistics level forms the basis to permit decision-making on whether to reject or retain the null hypotheses after being tested;

H01: There is no statistical significant difference between the mean scores of secondary school students taught biology using the mastery learning approach and those taught using the lecture method and this was tested using paired comparative samples t-test statistics

H02: There is no statistical significant difference between the level of motivation of secondary school students taught biology using the mastery learning approach and those taught using the lecture method. H02 is analyzed using Mann-Whitney U-test.

H03: There is no statistical significant difference between the performance of male and female students taught using a mastery learning approach is tested using independent sample t-test statistics.

The statistical software SPSS version 27.0 was utilized for the data analysis of the study.

3.9 Pre-intervention stage

To begin the pre-intervention stage, the BAPT (pre-test) was administered to all 64 students in both classes to measure their baseline knowledge in Biology. The pre-test was composed of questions on the selected topic in Biology that were relevant to the study. The pre-test was administered in a standardized manner to both groups to ensure that there was no bias.

After the pre-test was administered, the 64 students from the two classes were assigned to the mastery learning group and the lecture group. 2 Science 1 was the mastery learning group (experimental) and 2 Science 2 was the traditional learning group (control).

Before the intervention began, the students were informed about the study, its purpose, and their roles as participants. They were also assured of the confidentiality of their responses and that their participation was voluntary.

3.10 Intervention stage

During the intervention stage, both groups received an equal amount of instructional time and access to the same instructional materials. The instructor provided feedback and guidance to the mastery learning group, while the lecture group had limited interaction with the instructor during class time.

After the intervention, a post-test was administered to both groups to measure their knowledge and motivation in Biology. In addition, a questionnaire was administered to the mastery learning group to evaluate their perception and motivation towards the mastery learning method.

3.11 Implementation of the Intervention

During the intervention stage, two instructional methods were implemented: the Mastery Learning Approach (MLA) and the Lecture (Traditional) Method Approach (LMA). Both methods were implemented for a specific period, after which a post-test was administered to assess student knowledge and motivation in Biology.

For the Mastery Learning Group, the implementation of the Mastery Learning Method involved breaking down the subject matter into smaller units, setting clear learning objectives, allowing students to learn at their own pace, and providing immediate feedback. The students were given access to instructional materials and had regular interactions with the instructor to receive feedback and guidance. They were encouraged to use self-assessment tools to monitor their progress and were given ample time to practice and review the material.

For the lecture group, the implementation of the Lecture Method involved the teacher delivering lectures while the students took notes. The instructional materials were the same as those used for the mastery learning group, but the students had limited interaction with the instructor during class time. They were given time to practice and review the material on their own.

The implementation of both methods was monitored to ensure that the procedures were followed consistently and fairly for both groups.

After the intervention period, a post-test was administered to both groups to evaluate their knowledge and motivation in Biology. Additionally, a questionnaire was administered to the mastery learning group to evaluate their perception and motivation towards the mastery learning method.

Overall, the implementation of the intervention stage involved providing equal opportunities for both groups to learn using different instructional methods, monitoring the implementation to ensure fairness, and administering assessments to measure their knowledge and motivation in Biology.

3.11.1 Lesson by Mastery Learning Approach (MLA Group)

Topic: *System*

Subtopic: *Human Digestive System*

Identify key concepts: The researcher identifies the key concepts of digestion such as *enzymes, mouth, stomach, small intestine, and large intestine.*

General Objectives: by the end of the lesson,

"Students will be able to explain the role of enzymes in breaking down food into smaller molecules."

Relevant Previous Knowledge: *Students have understanding of the role enzymes play in digestion and the different types of enzymes involved.*

Instructional materials: *The researcher provides students with access to textbooks, videos, diagrams, and other resources that explain the key concepts and help students to understand them better. The use of videos that shows the process of digestion in the stomach or a diagram that illustrates the parts of the small intestine.*

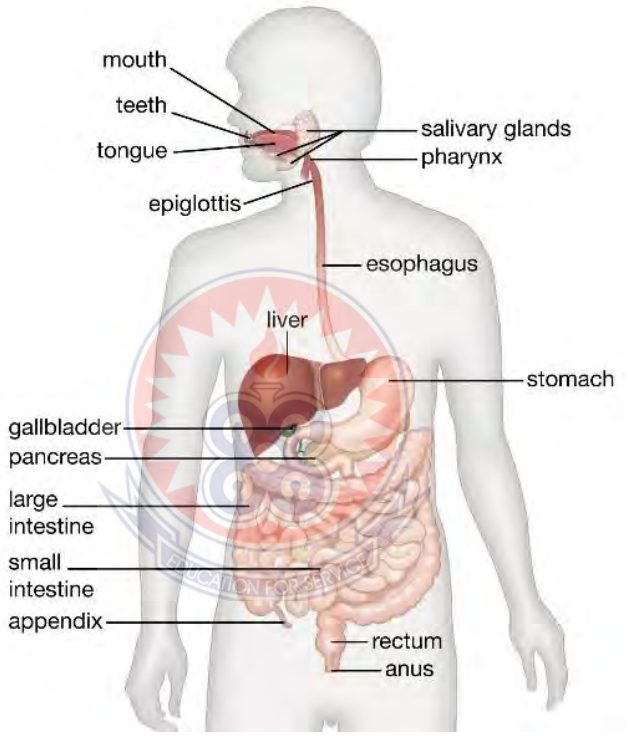


Figure 5: The Human Digestive System
Source: www.britannica.com/science/human-digestive-system

Allow students to learn at their own pace: Students are allowed to learn at their own pace. The researcher provides extra resources for students who require additional support, such as providing additional practice problems or reading materials. For students who have mastered the material, the researcher provided more challenging assignments or activities.

Provide immediate feedback: The research provides regular feedback to students on their progress. This involves reviewing their work, answering their questions, and providing suggestions for improvement. For example, the researcher reviewed a student's answer to a question on the role of enzymes and provide feedback on how to improve their explanation.

3.11.2 Lesson by Lecture Method Approach (LMA Group)

Topic: *System*

Subtopic: *Human Digestive System*

Identify key concepts: The researcher identifies the key concepts of digestion such as *enzymes, mouth, stomach, small intestine, and large intestine.*

General Objectives: *"Students will be able to explain the role of enzymes in breaking down food into smaller molecules."*

Relevant Previous Knowledge: *Students have an understanding of the role enzymes play in digestion and the different types of enzymes involved.*

Instructional materials: *The students should have access to instructional materials such as textbooks, videos, and diagrams to aid their learning. For example, the researcher use a PowerPoint presentation with images and diagrams to help the students visualize the process of digestion.*

Delivering engaging lectures: The researcher begins the lesson by asking the students a thought-provoking question related to digestion, such as "*What happens to the food we eat after we swallow it?"* The researcher uses interactive tools like animations, videos, and real-life examples to capture the students' attention and maintain their interest.

Encouraging active listening: During the lecture, the researcher encourages the students to take notes and ask questions to aid their understanding of the material. For example, the researcher could pause occasionally to check if the students understand the material and ask them to summarize the key points in their own words.

Allowing time for discussion and questions: The researcher asked the students to work in pairs or small groups to discuss the different parts of the digestive system and their functions.

In the post-intervention stage, the researcher will administer tests and questionnaires to measure the academic performance and motivation level of the students in both the mastery learning group and the lecture group.

3.12 Post-intervention Stage

To measure academic performance, the researcher created a test with questions related to the topic of digestion in biology, and administer it to both groups. The test consists of multiple-choice, practical, and essay questions, and cover various aspects of the topic, such as the different parts of the digestive system, the functions of each part, and the process of digestion. Standardized grading system to ensure consistency in grading the tests was be used.

The researcher uses a motivation questionnaire similar to the one used in the pre-intervention stage. The questionnaire consisted of statements related to the student's motivation towards learning biology, such as *"I am interested in learning about biology"* and *"I find biology to be a challenging subject."*

The researcher administered the tests and questionnaires in the post-intervention stage, with the mastery learning group and the lecture group being tested separately. The

researcher ensured that the testing environment is consistent for both groups, to avoid any extraneous variables that could affect the results.

After administering the tests and questionnaires, the researcher analyzed the data to compare the academic performance and motivation levels of the students in both groups. The researcher used statistical analysis to determine if there are any significant differences between the two groups in terms of academic performance and motivation level, and draw conclusions based on the results.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This research focuses on examining how the implementation of the Mastery Learning Approach influences the motivation and academic performance of Senior High School Biology students on the Human Digestive System. The chapter comprises the analysis of collected data, the presentation of results, and a comprehensive discussion. The results are organized based on the research questions and hypotheses that were formulated to guide the study. The chapter is divided into sub-sections that include the following headings:

- Data Analysis and Results Presentation
- Summary of Major Findings
- Discussion of Results

4.1 Data Analysis and Results Presentation

4.1.1 Answering the Research Questions

Descriptive statistics were utilized to provide answers to the three research questions. In addressing the research questions, means and standard deviations were employed, except for the second research question, which involved the use of mean rank and sum of ranks.

Research Question One: *What is the effect of the mastery learning approach on the performance of senior high school students?*

The mean and standard deviation of pre and post-test scores of experimental and control groups are calculated and presented in **Tables 3** and **4** respectively.

Table 3: Means and Standard Deviations of Pre-test Scores of BAPT for Experimental and Control Groups

Group	No. of Students	Mean	Standard Deviation	Mean Difference
Experimental	32	21.29	1.21	0.60
Control	32	21.89	1.46	

In **Table 3**, the results reveal that the experimental group achieved an average score of 21.29 with a standard deviation of 1.21, while the control group obtained a mean score of 21.89 with a standard deviation of 1.46. The calculated mean difference between the two groups was 0.60. Importantly, both groups demonstrated comparable mean and standard deviation values, indicating no significant difference in scores before the intervention. This suggests that both groups of students had not received any instruction on Human Digestive System Concepts, whether through the Mastery Learning Approach or the lecture method (Sundbom et al., 2021).

Table 4: Means and Standard Deviations of Post-Test Scores of BAPT for Experimental and Control Groups

Group	No. of Students	Mean	Standard Deviation	Mean Difference
Experimental	32	24.29	1.62	1.41
Control	32	22.88	3.71	

According to **Table 4**, the experimental group obtained a mean score of 24.29 with a standard deviation of 1.62, while the control group had a mean score of 22.88 with a standard deviation of 3.71. The mean difference between the two groups was 1.41. These findings indicate that students who were taught Human Digestive System Concepts using the Mastery Learning Approach performed better academically, with a mean score of 24.29, compared to the lecture group, which achieved a mean score of

22.88. For example, Ilhan, et al., (2015) found that students taught using dramatization had a significantly higher average score compared to the control group.

Based on the results, it can also be inferred that the experimental group demonstrated a better understanding of the concept compared to the control group following the intervention. The lower standard deviation in the experimental group suggests that their scores were more tightly clustered around the mean, indicating a higher level of consistency and comprehension of the subject matter. Setianingsih (2013) demonstrated that laboratory-based learning improved student activities and learning outcomes.

Research Question Two:

What is the effect of the mastery learning approach on the motivation of senior high school students?

Here, the mean rank of students post motivation scores in the experimental and control groups was compared and presented in **Table 5**

Table 5: Mean Rank of Post Motivation Scores of SMQ for Experimental and Control Groups

Group	No. of Students	Mean Rank	Sum of Rank	Mean Rank Difference
Experimental	32	48.74	1608.50	29.05
Control	32	19.69	669.50	

Based on the data presented in **Table 5**, the experimental group displayed a considerably higher mean rank value of 48.74, with a sum of ranks totalling 1608.50. In contrast, the control group had a lower mean rank value of 19.69, with a sum of ranks totalling 669.50. The substantial difference in mean ranks, which amounts to 29.05,

indicates a significant difference in motivation levels between the two groups (Frederick-Recascino & Schuster-Smith, 2003).

A higher mean rank suggests that, on average, the participants in the experimental group ranked higher in terms of motivation compared to those in the control group. The larger sum of ranks for the experimental group further reinforces this observation, as it signifies a higher overall motivation level among its members during the study. This finding implies that the intervention or treatment applied to the experimental group have positively influenced their motivation (Kyle et al., 2006).

Research Question Three:

What are the differential effects of mastery learning approach on the experimental group male and female students' performance in biology?

To answer this question means and standard deviation of post-test scores generated via BAPT for male and female students in the experimental group were computed and used to draw **Table 6**.

Table 6: Means and Standard Deviations of Post-Test Scores of BAPT for Male and Female in Experimental Group

Group	No. of Students	Mean	Standard Deviation	Mean Difference
Male	22	24.20	1.64	0.20
Female	10	24.40	1.63	

The data presented in **Table 6** indicates that the post-test scores of male and female students in the experimental group, who were taught the Human Digestive System using the Mastery Learning Approach, are quite similar. Specifically, the mean post-test score for male students is 24.20, with a standard deviation of 1.64. On the other hand, the mean post-test score for female students is 24.40, with a standard deviation of 1.63. The

observed mean difference between the two groups is only 0.20, suggesting a minimal discrepancy in their academic performance.

This finding is significant because it highlights that the Mastery Learning Approach seems to be equally effective for both male and female students in the context of biology. Upadhayay & GUraGaiN, (2014) found that male and female students had comparable cognitive functions, while Gidado (2020) found no significant difference in performance between male and female biology students. The approach has resulted in comparable mean academic scores for both genders, indicating that it does not appear to favour one gender over the other in terms of learning outcomes.

4.1.2 Testing Null Hypotheses

H01: *There is no statistical significant difference between the mean scores of students taught using the mastery learning approach and those taught using the lecture method*

A comparative sample t-test was used to test hypothesis 1 using data from test scores of students in experimental and control groups. The result of the analysis is presented in **Table 7.**

Table 7: Results of t-test Analysis of Post PAPT Scores of Students in Experimental and Control Groups.

Group	No. of Students	Mean	S. D	df	t-cal	p	Decision
Experimental	32	24.29	1.62	62	2.18	0.03	Sig[1]
Control	32	22.88	3.71				

Significant at P≤ 0.05 level of significance

Table 7 presents the results of the t-test analysis, with a calculated t-value (t-cal) of 2.18 and a corresponding P-value of 0.03 observed at 62 degrees of freedom. Since the

P-value of 0.03 is less than the chosen significance level (alpha value) of 0.05, it indicates a statistically significant difference in the academic performance of students in the experimental group when compared to the control group (Fiel, 1976). Therefore, the null hypothesis, which assumes no difference between the groups, is rejected.

The significant difference in academic performance is in favour of the experimental group, which was taught using the mastery learning approach, as evidenced by the mean scores. This implies that the experimental group achieved significantly better academic outcomes compared to the control group, who received instruction through the lecture method.

These findings suggest that the mastery learning approach is more effective than the lecture method in improving students' academic performance (Wahyuni, 2017). The results provide valuable insights into the benefits of implementing the mastery learning approach and highlight its potential as a superior instructional method for enhancing student learning outcomes.

H02: *There is no statistical significant difference between the level of motivation of students taught using the mastery learning approach and those taught using lectures.*

Mann-Whitney U-test was used to test this hypothesis using the post-motivation ranking of the students in both experimental and control groups. The details of the result are presented in **Table 8.**

Table 8: Results of Mann-Whitney U-test Analysis of Motivation Scores of Students in Experimental and Control Groups

Group	No. of Students	Mean rank	Sum of Rank	U-test	P	Decision
Experimental	32	48.74	1608.50	74.00	0.001	Sig*
Control	32	19.69	669.50			

**Significant at P≤ 0.05 level of significance*

According to the results presented in **Table 8**, the experimental group obtained a mean rank of 48.74, with a sum of ranks amounting to 1608.50. Conversely, the control group had a mean rank value of 19.69, and the sum of ranks was 669.50. The Mann-Whitney U-value calculated was 74.00. The significance level (P-value) of 0.001 is smaller than the chosen alpha value of 0.05, indicating a highly significant difference in the motivation levels of students between the experimental and control groups. Consequently, this null hypothesis is rejected.

The significant advantage observed in favour of MLA implies that this teaching approach has a positive effect on students' motivation. It suggests that MLA may foster a more engaging and motivating learning environment, leading to higher levels of enthusiasm and interest among students.

These findings highlight a substantial difference in the motivation levels of students in favour of the experimental group, who were taught using the Mastery Learning Approach (MLA) (Frederick-Recascino & Schuster-Smith, 2003). This suggests that MLA significantly enhances students' motivation compared to the lecture method.

H03: *There is no statistical significant difference between the performance of male and female students taught using Mastery Learning Approach.*

To test H03, post-test scores of male and female students in the experimental group generated via BAPT were subjected to t-test statistics. A summary of the analysis is shown in **Table 9**

Table 9: Summary of t-test Analysis of Post BAPT Scores of Male and Female Students in the Experimental Group.

Group	No. of Students	Mean	S.D	df	t-cal	P	Decision
Male	22	24.20	1.64				
				31	-0.36	0.72	Not Sig*
Female	10	24.40	63				

**Not Significant at P≤ 0.05 level of significance*

Based on the results presented in **Table 9,** the statistical analysis indicates that there is no significant difference in the academic performance of male and female students who were taught using the Mastery Learning Approach. The calculated t-value of -0.36 at a degree of freedom of 31 corresponds to a P-value of 0.72. Since the P-value (0.72) is greater than the chosen significance level (alpha) of 0.05, we fail to reject the null hypothesis. In other words, we do not have enough evidence to conclude that there is a significant difference in the academic performance between male and female students in the context of the Mastery Learning Approach (Ghazvini & Khajehpour, 2011).

These findings suggest that the Mastery Learning Approach is effective in improving the academic performance of both male and female students equally. The fact that the approach is "gender-friendly" means that it does not favour one gender over the other in terms of learning outcomes. This is a positive outcome, as it indicates that the teaching method is inclusive and provides an equitable learning environment for all students regardless of their gender.

4.2 Summary of Findings

From the results presented in this study, the summary of the major findings is:

1. A notable distinction exists in the academic achievement scores of Biology students who received instruction through the mastery learning approach compared to those who were taught using the lecture method. The experimental group, which received the mastery learning approach, demonstrated superior performance compared to the control group.
2. There is a noticeable difference in the motivation levels between students who were taught using the mastery learning approach and those who received instruction through traditional lectures. The results clearly show that the group exposed to mastery learning displayed significantly higher motivation levels, indicating a preference for this approach.
3. The academic performance of male and female Biology students who were taught using the mastery learning approach did not exhibit a significant difference. Both genders performed comparably, suggesting that the mastery learning approach is equally effective for both male and female students.

4.3 Discussion of Results

The data obtained from the study were examined and the findings were presented in section 4.1. This section focuses on the analysis and interpretation of the results, organized according to the order of the research hypotheses: Based on the results presented in **Table 7**, the study clearly indicates that the experimental group, which was taught using the mastery learning approach, achieved a notably higher mean score compared to the control group instructed through the lecture method. This significant difference in the academic performance of the two groups suggests that the mastery

learning approach has a considerable effect on students' learning outcomes when compared to the lecture method.

The higher mean score of 24.29 achieved by the experimental group indicates that the mastery learning approach fosters a more effective learning environment, enabling students to grasp the subject matter more comprehensively and perform better academically. This result is of paramount importance, as it provides evidence supporting the effectiveness of the mastery learning approach in enhancing student learning outcomes (Paolini, 2015).

It is essential to consider that, the observed difference in mean scores might be attributed to various factors, such as the personalized and adaptive nature of the mastery learning approach, which tailors instruction to individual students' needs and pace. Furthermore, the significant difference in academic performance between the experimental and control groups indicates that the mastery learning approach offers a more tailored and student-centered learning experience. By allowing students to progress at their own pace and providing personalized support, the mastery learning approach creates an environment that nurtures each student's unique learning capabilities.

Moreover, the continuous assessment and feedback provided in the mastery learning approach allow for timely identification of areas of weakness and the opportunity for targeted interventions. This ongoing feedback loop aids students in addressing their learning gaps promptly, leading to a more comprehensive mastery of the subject matter.

The observed higher mean score of 24.29 of experimental group also implies that the mastery learning approach may contribute to increased student motivation and engagement. When students experience a sense of achievement through their progress

and success in mastering concepts, their enthusiasm for learning is likely to be reinforced

These findings are consistent with the research conducted by Wambugu and Changeiywo (2008), Achufusi and Mgbemena (2012), Agboghoroma (2014), Oluwatosin and Bello (2015) and, Mitee and Obaitan (2015). Wambugu and Changeiywo (2008) discovered that students who were taught Biology using the mastery learning approach achieved significantly higher scores than those taught using the lecture method. Achufusi and Mgbemena's (2012) research demonstrated a significant distinction in the average performance scores between students who were instructed using the mastery learning approach and those who were taught through the lecture method, with the former outperforming the latter. These findings align with the findings of Agboghoroma (2014), who also discovered that students who were taught Integrated Science concepts using the mastery learning approach exhibited better performance compared to their peers taught through the lecture method. The noteworthy discrepancy in academic performance observed in this study may be attributed to the fact that the mastery learning approach actively engages students in the teaching and learning process through various activities.

In **Table 8**, the comparison of motivation levels between the experimental and control groups unveiled a statistically significant difference, highlighting the powerful effect of the mastery learning approach on student motivation. The data demonstrated that students exposed to the mastery learning approach achieved notably higher mean rank values and mean scores compared to their peers taught using the lecture method.

The higher mean rank value of 48.74 indicates that, on average, students in the experimental group ranked higher in terms of motivation compared to those in the

control group. This result signifies a higher overall level of motivation among students who experienced the mastery learning approach, indicating that this instructional method nurtures and sustains their interest, enthusiasm, and drive to learn.

Furthermore, the higher mean score of 48.74 achieved by the experimental group further corroborates the notion that the mastery learning approach effectively fosters greater motivation. The approach's personalized, adaptive, and interactive nature likely resonates with students, inspiring them to actively engage in their learning journey and take ownership of their academic progress.

The Mann-Whitney U-test's U-value confirmed the observed differences in motivation levels between the two groups. This non-parametric test, ideal for comparing small sample sizes or non-normally distributed data, attested to the robustness of the results, indicating that the significant distinction in motivation is unlikely due to random chance.

The evidence of higher motivation levels among students taught using the mastery learning approach highlights its potential to transform the learning experience positively. By acknowledging and integrating students' individual needs and learning styles, the mastery learning approach appears to create a supportive and engaging atmosphere that nurtures intrinsic motivation, a key factor in fostering lifelong learners. These results provide valuable insights into the potential benefits of adopting the Mastery Learning Approach in educational settings and its contribution to enhancing students' overall learning experience.

These findings are in line with the outcomes of earlier studies conducted by Adedeje (2007), Keraro Wachanga, and Orora (2007), Wanjau (2014), and Haruna (2016). The research conducted by Keraro, Wachanga, and Orora (2007) reported a significant

positive effect of the Cooperative Concept Mapping teaching approach on students' motivation. Similarly, Wanjau (2014) found that students who were taught Kiswahili using the mastery learning approach showed a significant improvement in their motivation compared to the control group.

The consistency between these studies reinforces the notion that instructional methods, such as the mastery learning approach and cooperative concept mapping, hold great promise in influencing students' motivation positively. The presence of multiple studies with similar conclusions strengthens the credibility and generalizability of the results, suggesting a potential pedagogical shift towards more engaging and effective teaching approaches.

According to the results presented in **Table 9**, the mean difference value of male and female was 0.2 shows no discrepancy indicating no significant difference was found in the academic performance of male and female students who were exposed to the mastery learning approach. The lack of a significant difference in academic performance based on gender suggests that the Mastery Learning Approach is equitable and does not favour one gender over the other in terms of learning outcomes. This is a positive outcome as it promotes a fair and inclusive learning environment, where both male and female students have an equal opportunity to excel in their studies.

This finding aligns with previous studies conducted by Wambugu and Changeiywo (2008), Agboghrma (2014), and Lamidi et al., (2015). Wambugu and Changeiywo (2008) discovered that gender did not have a significant effect on the academic performance of male and female students who were exposed to the mastery learning approach. Similarly, Agboghrma (2014) found no significant difference in the mean academic performance between male and female students who experienced the mastery

learning approach. However, these findings contrast with the research conducted by Njoku (2007), Appaw (2011), Achufusi and Mgbemena (2012), and **Oredein and Awodun** (2013), who reported significant differences in the performance of male and female students.

In the current study, these findings could be attributed to the fact that the mastery learning approach provides corrective activities and remediation for students who have not achieved mastery of the taught unit. In this study, the reason for this finding could be a result of the suitable methods and materials used to teach the concepts.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

This research aimed to examine the effect of the Mastery Learning Approach on students' motivation and performance in understanding Human Digestive System Concepts in Biology at the Senior High School level in Nsaba, Central Region. This chapter provides a comprehensive overview of the research findings, draws conclusions based on the results, discusses the contributions to the knowledge of the study, and presents recommendations for future research. The chapter is structured into the following sections, summarizing the key aspects of the study's outcomes:

5.1 Summary

This research aimed to examine how the implementation of the Mastery Learning Approach affects the motivation and performance of Senior High School students in Nsaba, Central Region, specifically in understanding Human Digestive System Concepts. The findings are presented in a five-chapter format.

The study was motivated by the underperformance of students in Ghana, which has been attributed to teachers' inadequate fulfilment of their teaching responsibilities, instructional strategies, and low motivation in the learning process. The objectives of the study were to determine how the mastery learning approach affects the academic performance of Senior High School students in Biology, how this approach also affects their motivation levels in the said subject and the effect of the approach on performance of male and female students.

The study focuses on SHS 2 students who offers Elective Biology at Nsaba Presbyterian Senior High School in the Central Region of Ghana.

The extensive literature review was conducted on various topics related to science education, including; the Teaching of Biology as a Discipline in Science Education, the Theoretical Framework of Mastery Learning, the Conceptual Framework and its principles and Empirical evidence of the Mastery Learning Approach (MLA) in Biology education. It addresses the challenges and trends in Senior High School students' Biology performance, emphasising the need for an effective learning approach. It delves into the theoretical underpinnings and implications of motivation and learning for Mastery Learning, exploring how it can enhance students' motivation to learn Biology. Furthermore, it discusses how the Mastery Learning Approach can positively influence students' attitudes towards Biology, which can potentially enhance their interest in the subject. Also examines the cognitive factors that impact Biology learning and how the Mastery Learning Approach can address them.

The research design utilized in this study was the quasi-experimental design. The experimental group received the treatment of the Mastery Learning Approach (MLA) along with motivation enhancement, while the control group solely received the lecture method. A total of 64 students were selected from 2 Science 1 and 2 Science 2 out of a population of 304 second-year Biology students. These classes were pre-tested to ensure their equivalence before the sampling process took place. The researcher validated two instruments, the Biology Academic Performance Test (BAPT) and the Students Motivation Questionnaire (SMQ), with the help of experts to ensure reliable data collection. The mean and standard deviation were used to analyze the data and answer the research questions, while the t-test and Mann-Whitney U-test were employed to test the hypotheses at a significance level of 0.05. The statistical software SPSS version 27.0 was utilized for data analysis.

The findings of the study confirmed a significant difference in the academic performance of students in the experimental group, who were exposed to the mastery learning approach, compared to those in the control group, who received the lecture method alone. The experimental group showed higher academic performance.

Furthermore, the results indicated a significant difference in the motivation levels between students taught using the mastery learning approach and those taught using the lecture method only. The experimental group exhibited higher motivation levels.

Additionally, the findings revealed no significant difference in academic performance and motivation levels between male and female students who were exposed to the mastery learning approach. This suggests that the mastery learning approach is equally beneficial for both genders

In summary, the study confirmed the effectiveness of the mastery learning approach in improving academic performance and motivation levels.

The research findings suggest that the implementation of the Mastery Learning Approach (MLA) has a positive effect on both academic performance and motivation of students in the study of Biology. This study contributes to the existing knowledge in the field of Biology and science education by demonstrating the effectiveness of MLA in comparison to the lecture method, specifically in improving students' performance and motivation in Biology. As a recommendation, the study suggests that Biology teachers incorporate MLA into their teaching practices when delivering Biology lessons.

5.2 Major Findings

1. Students who received instruction through the Mastery Learning Approach (MLA) achieved notably higher academic performance scores compared to students taught using the lecture method.
2. The motivation level of students who were exposed to the Mastery Learning Approach (MLA) was significantly higher than that of students taught solely through the lecture method.
3. The mean scores of male and female students exposed to the Mastery Learning Approach (MLA) did not show a significant difference.

5.3 Conclusion

Based on the results obtained from this research, the following conclusions can be drawn:

1. Students who received instruction on the Human Digestive System using the Mastery Learning Approach (MLA) demonstrated superior academic performance compared to students in the control group.
2. Students exposed to the MLA showed higher levels of motivation compared to their counterparts in the lecture group.
3. Additionally, the findings revealed no significant difference in academic performance and motivation levels between male and female students who were exposed to the mastery learning approach. This suggests that the mastery learning approach is equally beneficial for both genders

In summary, the research findings strongly support the notion that the Mastery Learning Approach (MLA) has a significantly positive effect on both academic performance and

motivation levels of students. The study revealed that students who were taught using the MLA demonstrated notably higher academic achievement scores compared to those who underwent traditional lecture-based instruction. Furthermore, not only did students excel academically, but they also exhibited increased levels of motivation and engagement in the learning process. The MLA emphasizes on personalized learning, continuous feedback, and mastery of each subject or skill contributed to a deeper understanding and a greater sense of accomplishment among students.

5.4 Contributions to Knowledge

The study on the "Effect of Mastery Learning Approach on Academic Performance and Motivation in Biology among Senior High School Students" has made valuable contributions to the field of Biology and Science Education in several ways:

1. This study has demonstrated that teaching the Human Digestive System using the Mastery Learning Approach has a substantial positive effect on students' academic performance mean scores and enhances their motivation levels in Biology at the secondary school level.

2. Educators now have compelling reasons to embrace the Mastery Learning Approach for effective teaching and learning since it promotes active student participation.

3. Biology Academic Performance Test was developed specifically for this study, and its effectiveness in improving students' academic performance was confirmed.

4. The Mastery Learning Approach is inclusive and accommodating for both male and female students, emphasizing the importance of providing equal opportunities for learning and interaction with instructional materials.

5. The findings of this study carry significant implications for Biology teachers, providing them with valuable insights and guidance in their instructional practices. These findings hold significant implications for educators and policymakers, underscoring the importance of implementing student-centered instructional approaches like the MLA to foster better learning outcomes and enhance students' overall enthusiasm for education.

As we continue to explore innovative teaching methods, the Mastery Learning Approach stands out as a promising model that can contribute to the continuous improvement of education systems worldwide.

5.5Recommendations

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

1. Biology instructors should consider implementing the Mastery Learning Approach (MLA) in their teaching of Biology, as it is effective in motivating students.
2. The MLA approach is suitable for both male and female students, indicating that it is a gender-inclusive teaching method. Therefore, it is recommended for use among students of all genders.
3. Educational institutions, such as ministries of education and teachers' training institutes, should organize in-service training programs such as seminars and workshops for Biology teachers, with a specific focus on MLA for the teaching and learning of Biology.
4. Both the Ghanaian government and state ministries of education should actively promote and monitor the implementation of MLA in secondary schools, ensuring its effective use.

5. Curriculum planners should collaborate in the development and integration of MLA into the Biology curriculum at the secondary school level, ensuring that it becomes an integral part of the teaching and learning process.

5.6 Suggestions for Further Studies

The study can be expanded in several ways to enhance its scope and findings.

1. The researcher can consider expanding the scope of the study and increasing the sample size to determine if similar or different results can be obtained.
2. Further investigations can be conducted in both private and other public schools to compare and contrast the effectiveness of the mastery learning approach versus the lecture method. This comparison can also be extended to government and private schools to explore potential variations in results.
3. The study can be extended to include students from tertiary institutions such as Colleges of Education, Polytechnics, and Universities. This would allow for an examination of whether the same variables studied in this research yield similar outcomes at higher levels of education.
4. Replicating this type of study in different regions would provide broader and more generalized insights into the findings.
5. In addition to Biology, similar studies can be conducted in other subject areas such as Mathematics, Physics, and Chemistry, among others, at the secondary school level. This would provide a comparative analysis of the results across different disciplines

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APPENDIX I

NSABA PRESBY SENIOR HIGH SCHOOL

BIOLOGY PERFORMANCE PRETEST (BPT)

SECTION A: Bio-data

Name: …….

Class: …… Date: ……..

Gender: Male [ ] Female [ ]

SECTION B: Instructions

1. Write your name, class and date and tick the gender in the space provided.

2. Read each question carefully.

3. Shade the correct option on your answer sheet.

ATTEMPT ALL QUESTIONS

1. What is the role of enzymes in the digestive system?

a) To absorb nutrients from food
b) To break down food into smaller molecules
c) To transport food through the digestive tract
d) To regulate digestion

2. Which organ produces enzymes for the digestion of proteins?

a) Stomach c) Liver
b) Pancreas d) Small intestine

3. Which enzyme breaks down carbohydrates into simple sugars?

a) Protease c) Amylase
b) Lipase d) Nucleases

4. Where is bile produced and stored?

a) Liver and gallbladder
b) Stomach and pancreas
c) Small intestine and large intestine
d) Appendix and rectum

5. What is the function of bile in the digestive system?

a) To break down fats into smaller molecules
b) To break down proteins into amino acids
c) To absorb nutrients from food
d) To regulate digestion

6. What is the function of the small intestine in the digestive system?

a) To absorb nutrients from food
b) To break down food into smaller molecules
c) To store waste products
d) To regulate the flow of food through the digestive system

7. Which enzyme is responsible for breaking down proteins in the stomach?

a) Amylase c) Lipase
b) Protease d) Nucleases

8. Which organ produces bicarbonate to neutralize stomach acid in the small intestine?

a) Stomach b) Liver
c) Pancreas d) Small intestine

9. What is the function of the large intestine in the digestive system?

a) To absorb nutrients from food
b) To break down food into smaller molecules
c) To store waste products
d) To regulate the flow of food through the digestive system

10. What is the function of the pancreas in the digestive system?

a) To produce enzymes for the digestion of carbohydrates and proteins
b) To produce bile for the digestion of fats
c) To produce bicarbonate to neutralize stomach acid in the small intestine
d) To store nutrients from food

11. Which enzyme breaks down proteins into amino acids?

a) Protease c) Lipase
b) Amylase d) Trypsin

12. Which of the following is not an enzyme involved in the digestion of protein?

a) Pepsin c) Amylase
b) Trypsin d) Chymotrypsin

13. Where does the majority of nutrient absorption occur in the digestive system?

a) Mouth
b) Stomach
c) Small intestine
d) Large intestine

14. What is the function of the gallbladder in the digestive system?

a) To produce bile
b) To store bile
c) To secrete digestive enzymes
d) To absorb nutrients

15. Which of the following is not a function of the liver in the digestive system?

a) Production of bile
b) Storage of glucose
c) Detoxification of harmful substances
d) Secretion of digestive enzymes

16. Which enzyme breaks down starch into maltose?

a) Protease c) Lipase
b) Amylase d) Trypsin

17. Which of the following is not a component of gastric juice?

a) Hydrochloric acid
b) Pepsinogen
c) Mucus
d) Bile

18. Which of the following is not a function of the small intestine?

a) Digestion of carbohydrates
b) Absorption of nutrients
c) Digestion of proteins
d) Absorption of water

19. What is the function of the villi and microvilli in the small intestine?

a) To increase surface area for nutrient absorption
b) To produce digestive enzymes
c) To secrete mucus
d) To break down large molecules into smaller ones

20. Which of the following is not a macromolecule that is broken down during digestion?

a) Proteins c) Carbohydrates
b) Lipids d) Vitamins

APPENDIX II

MARKING SCHEME FOR THE BAPT PRETEST

1. b	6. a	11. a	16. b
2. b	7. b	12. c	17. d
3. c	8. c	13. c	18. d
4. a	9. c	14. b	19. a
5. a	10. a	15. d	20. d

APPENDIX III

NSABA PRESBY SENIOR HIGH SCHOOL

BIOLOGY PERFORMANCE POST-TEST (BPT)

SECTION A: Bio-data

Name: ……

Class: …… Date: ……..

Gender: Male [ ] Female [ ]

SECTION B: Instructions

1. Write your name, class and date and tick the gender in the space provided.

2. Read each question carefully.

3. Shade the correct option on your answer sheet.

ATTEMPT ALL QUESTIONS

1. Which part of the human digestive system is responsible for breaking down food into smaller, more manageable pieces?

a) Stomach

b) Small intestine

c) Large intestine

d) Mouth

2. What are the primary components of the digestive system responsible for digestion and absorption of nutrients?

a) Heart and lungs

b) Liver and pancreas

c) Stomach and intestines

d) Brain and spinal cord

3. Which part of the digestive system is responsible for the mechanical and chemical breakdown of food through chewing and the action of enzymes like amylase?

a) Stomach

b) Liver

c) Mouth

d) Small intestine

4. Where does the majority of nutrient absorption occur in the human digestive system?

a) Stomach

b) Mouth

c) Small intestine

d) Large intestine

5. Which of the following organs secretes bile, a substance that aids in the digestion of fats?

a) Liver

b) Stomach

c) Pancreas

d) Small intestine

6. What is the function of the small intestine in the digestive system?

a) Absorption of nutrients

b) Storage of bile

c) Production of digestive enzymes

d) Mixing and grinding of food

7. The process of breaking down food into simpler substances that can be absorbed by the body is called:

a) Assimilation

b) Absorption

c) Digestion

d) Excretion

8. Where does the final absorption of water and electrolytes take place in the digestive system?

a) Stomach

b) Liver

c) Small intestine

d) Large intestine

9. The process of digestion in the mouth begins with the breakdown of:

a) Fats

b) Proteins

c) Carbohydrates

d) Vitamins

10. What is the function of the large intestine in the digestive system?

a) Absorption of nutrients

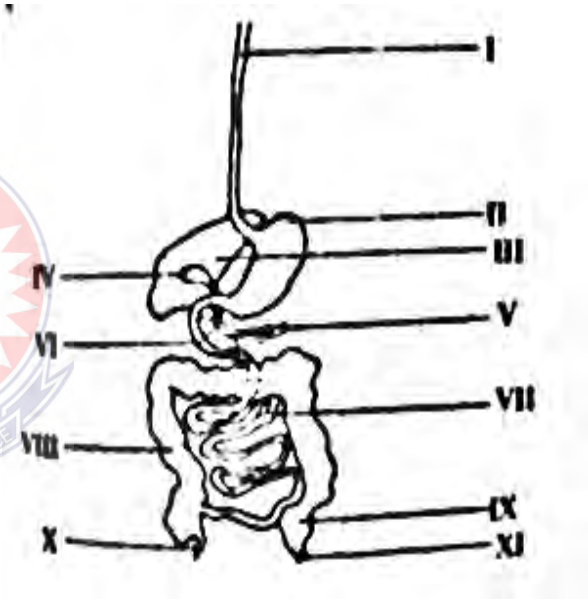
b) Production of digestive enzymes

c) Storage and elimination of waste

d) Mixing and grinding of food

DIGESTION PRACTICAL

1(a) The illustration below is part of the human body. Study the figure carefully and answer the questions that follow



a) Identify the part of the human body illustrated.
b) Name the parts labelled I, II, III, IV, V, VI, VII, VIII, IX and X
c) Describe the digestive process that occur in VI
d) List two enzymes secreted by the part labelled II
e) State one function of each of the two enzymes you have listed in (d (i))

APPENDIX IV

MARKING SCHEME FOR BAPT POSTTEXT

1. d	2. c	3. c	4. c	5. a
6. a	7. c	8. d	9. c	10. c

PRACTICAL

1a Digestive system of human, or the gut or Alimentary Canal

1b I – Oesophagus or Gullet

II - Stomach

III. – Liver

IV – Gall Bladder

V – Pancreas

VI – Duodenum

VII – Ileum

VIII – Colon or Large intestine

IX – Rectum

X – Appendix

1c Digestion process that happens in VI

The Gall bladder releases bile into the duodenum (VI) and pancreas also releases pancreatic juice into it. The bile emulsifies fat that is break fat or oil into small droplets , the bile also changes the PH of food into alkaline by neutralizing the Gastric acid or stomach acid. The pancreatic juice releases Amylase which converts starch to maltose Trypsin which converts proteins into polypeptides. Lipase converts emulsified fats into fatty acids and glycerol

1 d.(i) Enzyme secreted by the parts labelled II Pepsin and renin

1 d (ii) Functions of the enzymes Pepsin changes protein to peptones or polypeptides
Renin clots milk proteins or converts milk proteins into curd protein.

APPENDIX V

STUDENT MOTIVATION QUESTIONNAIRE (SMQ)

Dear Respondent,

The bearer of this research instrument is a Master's student in the Department of Science Education, Faculty of Science Education, University of Education, Winneba. The items presented are designed to determine the degree of your motivation in Biology using a mastery learning approach. You are therefore requested to rate yourself on the questionnaire items. You are guaranteed the utmost confidentiality as the information provided will be used strictly for this research only.

Yours faithfully,

Jennifer Baiden –Amissah

GENDER: MALE [ ] **FEMALE [ ]**

Instruction: *Please tick* **(√)** *the appropriate column that suits your interest.*

Please take note of the following KEYS:

SD-Strongly Disagree,
D- Disagree,
N-Neutral,
A-Agree,
SA-Strongly Agree

QUESTIONNAIRES TO MEASURE STUDENT'S MOTIVATION IN STUDYING BIOLOGY

S/No	ITEM	SA	A	N	D	SD
1	I am interested in learning biology.					
2	I find biology to be a challenging subject.					
3	I am motivated to learn biology.					
4	I enjoy studying biology.					
5	I believe that biology is an important subject to study.					
6	I am confident in my ability to learn biology.					
7	I am willing to put in the effort to succeed in biology.					
8	I believe that my performance in biology is a reflection of my abilities.					
9	I think that biology is a subject that is relevant to my life.					
10	I am interested in pursuing a career in a biology-related field.					
11	I think that biology is a subject that requires a lot of critical thinking.					
12	I believe that biology is a subject that involves a combination of theory and practical application.					
13	I think that biology is a subject that provides insights into the natural world.					
14	I believe that I can develop strong analytical skills through the study of biology.					
15	I am excited to explore the various branches of biology and their applications.					
16	I believe that I can achieve good grades in biology.					
17	I value the skills and knowledge gained through studying biology.					
18	I feel confident in my ability to apply biology concepts to real-life situations.					
19	I enjoy learning new concepts and information in biology.					
20	I am motivated to actively engage in learning biology.					

APPENDIX VI

LESSON PLAN FOR EXPERIMENTAL GROUP

(MASTERY LEARNING) WEEK ONE

Subject:	Biology
Topic:	Structural Parts of the Human Digestive System
Group:	Experimental
Class:	2 SCI 1
Average age:	16 years
Sex:	Co-education (mixed)
Teaching Method:	Inquiry method
Duration:	120min
Instructional Material:	Visual aids (diagrams, charts, or posters) depicting the human digestive system. Handouts with labeled diagrams of the digestive system for students. Projector (optional).
Objectives:	By the end of the lesson, the student will be able to: 1. Identify and label the main structural parts of the human digestive system. 2. Describe the functions of each structural part in the process of digestion. 3. Understand the overall process of food digestion in the human body

Prior Knowledge: Students may have some general knowledge about the digestive system and its role in breaking down food for the body's nourishment.

Introduction: 5 minutes

Begin the lesson by engaging the students with a short video or a real-life example related to the process of digestion.

Ask students if they have any prior knowledge about the human digestive system and what they think its main structural parts are.

Lesson Presentation

Step 1: Overview

Display a labeled diagram of the human digestive system on the board or using a projector.

Briefly explain the primary function of the digestive system: to break down food into smaller molecules for absorption and use by the body.

Point out the major structural parts of the digestive system, including the mouth, oesophagus, stomach, small intestine, and large intestine.

Step 2: Detailed Explanation

Take each structural part one by one and explain its role in the process of digestion:

a) Mouth: Mechanical breakdown of food through chewing, and chemical breakdown with the help of saliva containing enzymes like amylase.

b) Oesophagus: Transports chewed food from the mouth to the stomach through peristalsis.

c) Stomach: Stores and mixes food with gastric juices containing hydrochloric acid and pepsin for further digestion.

d) Small Intestine: Main site for nutrient absorption into the bloodstream, with the help of bile from the liver and digestive enzymes from the pancreas.

e) Large Intestine: Absorbs water and electrolytes, and forms and stores feces for elimination.

Step 3: Interactive Activity

Distribute handouts with labeled diagrams of the digestive system to students.

In pairs or small groups, have students identify and label the structural parts of the digestive system on their handouts.

Conclusion: Review the key points about the structural parts of the human digestive system. Summarize the functions of each part and their contributions to the overall process of digestion. Encourage students to ask any questions they may have about the topic.

Formative Assessment A: Evaluate students' understanding through their participation in the interactive activity and their responses to questions during the lesson. The teacher administered the following question:

- *What is the main function of the stomach in the process of digestion?*

Enrichment activities: The teacher engages the students that attain mastery of unit taught by administering them the following question:

- *Write a short paragraph about the role of a specific structural part of the digestive system in the process of digestion.*

Corrective activities: The teacher assists the students that have not achieved mastery of unit taught to re-teach the unit. They may identify alternative learning resources such as different textbooks, alternative materials or they may simply suggest sources of additional practice.

Formative assessment B: The teacher re-assesses the students that receive remediation to find out whether the unit has been mastered.

LESSON PLAN FOR EXPERIMENTAL GROUP

(MASTERY LEARNING) WEEK TWO

Subject:	Biology
Topic:	Components of the digestive system
Group:	Experimental
Class:	2 SCI 1
Age:	16 years
Sex:	Co-education (Mixed)
Teaching Method:	Discussion method
Duration:	120min
Instructional Material:	Visual aids (diagrams, posters, or slides) Handout with labeled diagrams of the digestive system Projector (optional).

Objectives: By the end of the lesson, the student will be able to:

1. *identify and describe the major components of the digestive system and their functions.*

Prior Knowledge: Students may have some general knowledge about the digestive system and its role in breaking down food for the body's nourishment.

Introduction: Teacher begins the lesson by asking students what they already know about the digestive system. Encourage them to share their prior knowledge and experiences related to digestion.

Introduce the topic of the day: "Components of the Digestive System." Explain that the digestive system is responsible for breaking down food and absorbing nutrients, and it consists of various organs working together to carry out these functions.

Lesson Presentation:

Step 1: Present visual aids, such as diagrams or slides, showing the major components of the digestive system. Highlight the following organs and structures:

Mouth, Oesophagus, Stomach, Small intestine (duodenum, jejunum, ileum), Large intestine (colon), Rectum, Anus, Liver and Pancreas

Step 2: For each component, provide a brief description of its function in the digestive process. Emphasize how these

organs work together to break down food into smaller molecules and absorb nutrients into the bloodstream.

Step 3: Engage students in a discussion by asking questions related to each component. For example:

- *"What is the main function of the stomach in the digestive system?"*
- *"How does the small intestine contribute to the absorption of nutrients?"*
- *"What role does the liver play in digestion?"*

Conclusion: Summarize the main points of the lesson on the components of the digestive system. Review the functions of each organ and how they work together to facilitate digestion. Encourage students to continue exploring the topic on their own and ask questions if they need further clarification. Provide feedback on the mastery assessment sheets and discuss any misconceptions or areas that need improvement.

Formative assessment A: Use the handout with labeled diagrams to reinforce the students' understanding. Ask them to identify the different components of the digestive system on the handout.

Enrichment activities: The teacher engages the students that attain mastery of unit taught by Activity: *"Design Your Digestive System Model"*

Divide the students into small groups.

Provide each group with materials such as colored paper, craft supplies, and labels.

Instruct the groups to create a 3D model of the digestive system, including all the major components they learned about in the lesson.

- *Encourage the students to be creative and add extra details to demonstrate their in-depth understanding of the functions and interactions of the organs.*
- *After completion, have each group present their models to the class and explain their design choices.*

:

Corrective activities: The teacher assists the students that have not attained mastery of unit taught to re-teach the unit. Teacher engage them in Activity: *"Identifying Components of the Digestive System"*

- *Provide individual or small groups of students with a worksheet containing unlabeled diagrams of the digestive system.*
- *Instruct the students to label the different components of the digestive system correctly based on what they have learned in the lesson.*
- *Offer guidance and support as needed, addressing specific misconceptions and providing explanations for correct labeling.*
- *Review the labeled diagrams together as a class, discussing the correct answers and addressing any remaining questions.*

Formative assessment B: The teacher re-assesses the students that receive remediation to find out whether the unit has been mastered.

LESSON PLAN FOR EXPERIMENTAL GROUP

(MASTERY LEARNING) WEEK THREE

Subject:	Biology
Topic:	Digestion in the mouth
Group:	Experimental
Class:	2 SCI 1
Age:	16 years
Sex:	Co-education (Mixed)
Teaching Method:	Discussion method
Duration:	120min
Instructional Material:	Visual aids (diagrams, posters, or slides) Handout with labeled diagrams of the digestive system Projector (optional).

Objectives: By the end of the lesson, the student will be able to:

1. *describe the process of digestion in the mouth*
2. *understand the role of different enzymes in breaking down food.*

Prior Knowledge: Students may have some general knowledge about the digestive system and its role in breaking down food for the body's nourishment.

Introduction: Begin the lesson by asking students what they already know about digestion in the mouth. Encourage them to share their prior knowledge and experiences related to chewing and saliva.

Introduce the topic of the day: *"Digestion in the Mouth."* Explain that the mouth is the first site of digestion in the digestive system, where food is broken down into smaller pieces to facilitate further digestion and absorption.

Lesson Presentation:

Step 1: Present visual aids, such as diagrams, showing the anatomy of the mouth, including the teeth, tongue, and salivary glands.

Engage students in describing the process of digestion in the mouth step by step:

a) Explain that the mechanical process of chewing (mastication) helps break down food into smaller particles, increasing the surface area for enzymes to act upon.

b) Discuss the role of saliva in digestion. Saliva contains enzymes, such as amylase, that start breaking down carbohydrates into simpler sugars.

c) Highlight the importance of taste buds in detecting flavors, which triggers reflexes for swallowing and further stimulates the secretion of saliva.

d) Emphasize the significance of the mouth's role in preparing food for the next stages of digestion in the stomach and small intestine.

Step 2: Divide the class into small groups and provide each group with a mastery assessment sheet containing questions related to digestion in the mouth.

Instruct the groups to work together to answer the questions on the assessment sheet. Emphasize that they should take their time and collaborate to ensure accuracy.

Collect the completed mastery assessment sheets for evaluation.

Conclusion: Summarize the main points of the lesson on digestion in the mouth. Review the process of chewing, the role of saliva, and the functions of the teeth and tongue in the digestive process.

- Encourage students to apply their understanding of digestion in the mouth to their daily eating habits, emphasizing the importance of chewing food thoroughly for optimal digestion.
- Provide feedback on the mastery assessment sheets and discuss any misconceptions or areas that need improvement.

Formative assessment A: Use the handout with labeled diagrams to reinforce the students' understanding. Ask them the following question:

1. *What is the primary function of the mouth in the digestive system?*
2. *Describe the process of chewing (mastication) and its role in digestion.*
3. *Which enzyme present in saliva is responsible for breaking down carbohydrates, and what is its function?*

Enrichment activities: The teacher engages the students that attain mastery of unit taught by Activity: *"Investigating Saliva Enzymes"*

- *Divide the students into small groups.*
- *Provide each group with a sample of different types of food items, such as a cracker, fruit slice, and bread.*
- *Instruct the groups to chew each food item thoroughly while paying attention to any changes in taste and texture.*
- *Have the groups collect samples of their saliva after chewing each food item.*
- *Provide test strips specific to detecting enzymes (e.g., starch indicator for amylase) and demonstrate how to use them.*
- *Guide the students in testing the saliva samples with the appropriate test strips to identify the presence of enzymes.*
- *Engage the groups in discussions about their findings, linking the presence of enzymes to the digestion process in the mouth.*
- *Have each group present their findings to the class and explain the significance of saliva enzymes in digestion.*

Corrective activities: The teacher assists the students that have not attained mastery of unit taught to re-teach the unit. Teacher engage them in Activity: *"Modeling the Digestion Process"*

- *Identify students who may need additional support in understanding the digestion process in the mouth.*
- *Provide these students with a set of labeled diagrams representing the mouth's anatomy and the different stages of digestion.*
- *Instruct the students to create a 3D model or drawing depicting the process of digestion in the mouth, including the role of saliva and enzymes.*
- *Encourage the students to use different colors and labels to highlight the key components and steps of digestion in the mouth.*
- *Offer guidance and explanations as needed while the students work on their models.*
- *Once the models are completed, have the students present their work to the class, explaining the key concepts of digestion in the mouth based on their models.*

Formative assessment B: The teacher re-assesses the students that receive remediation to find out whether the unit has been mastered.

LESSON PLAN FOR EXPERIMENTAL GROUP

(MASTERY LEARNING) WEEK FOUR

Subject:	Biology
Topic:	Digestion in the small intestine
Group:	Experimental
Class:	2 SCI 1
Age:	16 years
Sex:	Co-education (Mixed)
Teaching Method:	Discussion method
Duration:	120min
Instructional Material:	Visual aids (diagrams, posters, or slides) Handout with labeled diagrams of the digestive system Projector (optional).

Objectives: By the end of the lesson, the student will be able to:

1. *explain the role of the small intestine in the digestive process.*
2. *describe the process of digestion in the small intestine, including the functions of enzymes and absorption of nutrients.*
3. *analyze the importance of the small intestine in breaking down food into smaller molecules for absorption.*

Prior Knowledge: Students should have a basic understanding of the digestive system, including the functions of the mouth, stomach, and esophagus. They should also be familiar with the concept of enzymes and their role in digestion.

Introduction: Teacher begins the lesson by reviewing the main components of the digestive system covered in previous lessons.

Introduce the topic of the day: *"Digestion in the Small Intestine"* and its importance in the overall digestive process.

Lesson Presentation:

Step 1: Present visual aids, such as diagrams or animations, illustrating the anatomy of the small intestine and its different sections.

Explain the process of digestion in the small intestine, emphasizing the role of bile and pancreatic enzymes in breaking down fats, proteins, and carbohydrates.

Discuss the process of nutrient absorption in the small intestine and the role of villi and microvilli in increasing the absorption surface area.

Engage students in a hands-on activity, such as a simulation or virtual lab, where they can observe the process of digestion in the small intestine.

Step 2: Divide students into small groups to discuss the key concepts learned during the main activity.

Facilitate group discussions and encourage students to ask questions and clarify their understanding of the topic.

Conclusion: Summarize the main points of the lesson on digestion in the small intestine.

Encourage students to ask any remaining questions and clarify their understanding.

Provide feedback on the formative assessment and highlight areas of improvement.

Formative assessment A: Distribute a short quiz with questions related to the small intestine's role in digestion and nutrient absorption. This will help identify students' prior knowledge and any misconceptions.

Use questioning techniques, such as think-pair-share, to assess students' understanding of the topics covered during the lesson.

Enrichment activities: The teacher engages the students that attain mastery of unit taught by Activity: "Design Your Digestive System Model"

- *Divide students into pairs or small groups.*
- *Provide each group with materials such as craft paper, colored markers, and labels.*
- *Instruct the groups to create a model of the digestive system, focusing on the small intestine's role in digestion and nutrient absorption.*
- *Encourage students to include details about the enzymes, villi, and microvilli involved in the process.*
- *Have each group present their model to the class and explain the key concepts they incorporated.*

Corrective activities: The teacher assists the students that have not attained mastery of unit taught to re-teach the unit. Teacher engage them in Activity: "Small Intestine Review Stations"

- *Identify students who need additional support in understanding digestion in the small intestine.*
- *Create review stations with different activities related to the topic, such as short quizzes, diagrams to label, and concept mapping exercises.*
- *Assign students to work in pairs or small groups and rotate through the review stations.*
- *Provide personalized feedback and assistance to students as they engage with the activities.*
- *Use the review stations as an opportunity to address misconceptions and reinforce key concepts.*

Formative assessment B: The teacher re-assesses the students that receive remediation to find out whether the unit has been mastered.

LESSON PLAN FOR EXPERIMENTAL GROUP

(MASTERY LEARNING) WEEK FIVE

Subject:	Biology
Topic:	Digestion in the large intestine
Group:	Experimental
Class:	2 SCI 1
Age:	16 years
Sex:	Co-education (Mixed)
Teaching Method:	Discussion method
Duration:	120min
Instructional Material:	Visual aids (diagrams, posters, or slides) Handout with labeled diagrams of the digestive system Projector (optional).

Objectives: By the end of the lesson, the student will be able to:

1. *explain the role of the large intestine in the digestive process.*
2. *describe the functions of the large intestine, including the absorption of water and electrolytes.*
3. *analyze the importance of gut microbiota in the large intestine and their role in digestion.*

Prior Knowledge: Students should have a basic understanding of the digestive system, including the functions of the mouth, stomach, and small intestine.

Introduction: Teacher begins by reviewing the main components of the digestive system covered in previous lessons.

Introduce the topic of the day: *"Digestion in the Large Intestine"* and its role in the final stages of digestion.

Lesson Presentation:

Step 1: Present visual aids, such as diagrams or illustrations, to illustrate the anatomy of the large intestine and its location in the digestive system.

Explain the functions of the large intestine, such as the absorption of water and electrolytes from the remaining indigestible food particles.

Discuss the role of gut microbiota in the large intestine and their contribution to breaking down certain substances that the body cannot digest on its own.

Engage students in a hands-on activity, such as a simulation or role-play, to understand how water absorption occurs in the large intestine..

Step 2: Divide students into small groups to discuss the key concepts learned during the main activity.

Facilitate group discussions and encourage students to share their understanding of the topic.

Conclusion: Summarize the main points of the lesson on digestion in the large intestine.

Encourage students to ask any remaining questions and clarify their understanding.

Provide feedback on the formative assessment and highlight areas of improvement.

Formative assessment A: Conduct a brief discussion or quiz to assess students' current knowledge of the large intestine's role in digestion and water absorption.

Use questioning techniques and class discussions to gauge students' understanding of the topics covered during the lesson.

Enrichment activities: The teacher engages the students that have attained mastery of unit taught by Activity: *"Investigating Gut Microbiota"*

- *Provide students with research articles or online resources about the gut microbiota and its importance in digestion.*
- *Assign students to read and summarize the information, emphasizing the role of different types of bacteria in the large intestine.*
- *Encourage students to present their findings to the class or in small groups, highlighting the significance of gut microbiota for overall health.*

Corrective activities: The teacher assists the students that have not attained mastery of unit taught to re-teach the unit. Teacher engage them in Activity: *"Large Intestine Concept Review"*

- *Conduct a concept review session where students can ask questions and receive targeted explanations about the topic.*
- *Offer one-on-one or small group sessions to address specific misconceptions or areas of difficulty.*

- *Provide additional resources, such as videos or interactive online tutorials, to support students' learning.*

Formative assessment B: The teacher re-assesses the students that receive remediation to find out whether the unit has been mastered.

APPENDIX VII

LESSON PLAN FOR CONTROL GROUP

(LECTURE METHOD) WEEK ONE

Subject:	Biology
Topic:	Structural Parts of the Human Digestive System
Group:	Control
Class:	2 SCI 2
Average age:	16 years
Sex:	Co-education (mixed)
Teaching Method:	Inquiry method
Duration:	120min
Instructional Material:	Visual aids (diagrams, charts, or posters) depicting the human digestive system. Handouts with labeled diagrams of the digestive system for students. Projector (optional).
Objectives:	By the end of the lesson, the student will be able to: 1. identify and label the main structural parts of the human digestive system. 2. describe the functions of each structural part in the process of digestion. 3.understand the overall process of food digestion in the human body

Prior Knowledge: Students may have some general knowledge about the digestive system and its role in breaking down food for the body's nourishment.

Introduction: 5 minutes

Begin the lesson by engaging the students with a short video or a real-life example related to the process of digestion.

Ask students if they have any prior knowledge about the human digestive system and what they think its main structural parts are.

Lesson Presentation

Step 1: Overview

Display a labeled diagram of the human digestive system on the board or using a projector.

Briefly explain the primary function of the digestive system: to break down food into smaller molecules for absorption and use by the body.

Point out the major structural parts of the digestive system, including the mouth, esophagus, stomach, small intestine, and large intestine.

Step 2: Detailed Explanation

Take each structural part one by one and explain its role in the process of digestion:

a) Mouth: Mechanical breakdown of food through chewing, and chemical breakdown with the help of saliva containing enzymes like amylase.

b) Oesophagus: Transports chewed food from the mouth to the stomach through peristalsis.

c) Stomach: Stores and mixes food with gastric juices containing hydrochloric acid and pepsin for further digestion.

d) Small Intestine: Main site for nutrient absorption into the bloodstream, with the help of bile from the liver and digestive enzymes from the pancreas.

e) Large Intestine: Absorbs water and electrolytes, and forms and stores feces for elimination.

Step 3: Interactive Activity

Distribute handouts with labeled diagrams of the digestive system to students.

In pairs or small groups, have students identify and label the structural parts of the digestive system on their handouts.

Conclusion: Review the key points about the structural parts of the human digestive system. Summarize the functions of each part and their contributions to the overall process of digestion. Encourage students to ask any questions they may have about the topic.

Formative Assessment: Evaluate students' understanding through their participation in the interactive activity and their responses to questions during the lesson. The teacher administered the following question:

- *What is the main function of the stomach in the process of digestion?*

LESSON PLAN FOR CONTROL GROUP

(LECTURE METHOD) WEEK TWO

Subject:	Biology
Topic:	Components of the digestive system
Group:	Control
Class:	2 SCI 2
Age:	16 years
Sex:	Co-education (Mixed)
Teaching Method:	Discussion method
Duration:	120min
Instructional Material:	Visual aids (diagrams, posters, or slides) Handout with labeled diagrams of the digestive system Projector (optional).

Objectives: By the end of the, lesson the student will be able to:

1. *identify and describe the major components of the digestive system and their functions.*

Prior Knowledge: Students may have some general knowledge about the digestive system and its role in breaking down food for the body's nourishment.

Introduction: Teacher begins the lesson by asking students what they already know about the digestive system. Encourage them to share their prior knowledge and experiences related to digestion.

Introduce the topic of the day: "Components of the Digestive System." Explain that the digestive system is responsible for breaking down food and absorbing nutrients, and it consists of various organs working together to carry out these functions.

Lesson Presentation:

Step 1: Present visual aids, such as diagrams or slides, showing the major components of the digestive system. Highlight the following organs and structures:

Mouth, Oesophagus, Stomach, Small intestine (duodenum, jejunum, ileum), Large intestine (colon), Rectum, Anus, Liver and Pancreas

Step 2: For each component, provide a brief description of its function in the digestive process. Emphasize how these organs work

together to break down food into smaller molecules and absorb nutrients into the bloodstream.

Step 3: Engage students in a discussion by asking questions related to each component. For example:

- *"What is the main function of the stomach in the digestive system?"*
- *"How does the small intestine contribute to the absorption of nutrients?"*
- *"What role does the liver play in digestion?"*

Conclusion: Summarize the main points of the lesson on the components of the digestive system. Review the functions of each organ and how they work together to facilitate digestion. Encourage students to continue exploring the topic on their own and ask questions if they need further clarification. Provide feedback on the mastery assessment sheets and discuss any misconceptions or areas that need improvement.

Formative assessment: Use the handout with labeled diagrams to reinforce the students' understanding. Ask them to identify the different components of the digestive system on the handout.

LESSON PLAN FOR CONTROLGROUP

(LECTURE METHOD) WEEK THREE

Subject:	Biology
Topic:	Digestion in the mouth
Group:	Control
Class:	2 SCI 2
Age:	16 years
Sex:	Co-education (Mixed)
Teaching Method:	Discussion method
Duration:	120min
Instructional Material:	Visual aids (diagrams, posters, or slides) Handout with labeled diagrams of the digestive system Projector (optional).

Objectives: By the end of the lesson, the student will be able to:

1. *describe the process of digestion in the mouth*
2. *understand the role of different enzymes in breaking down food.*

Prior Knowledge: Students may have some general knowledge about the digestive system and its role in breaking down food for the body's nourishment.

Introduction: Begin the lesson by asking students what they already know about digestion in the mouth. Encourage them to share their prior knowledge and experiences related to chewing and saliva.

Introduce the topic of the day: *"Digestion in the Mouth."* Explain that the mouth is the first site of digestion in the digestive system, where food is broken down into smaller pieces to facilitate further digestion and absorption.

Lesson Presentation:

Step 1: Present visual aids, such as diagrams, showing the anatomy of the mouth, including the teeth, tongue, and salivary glands. Engage students in describing the process of digestion in the mouth step by step:

a) Explain that the mechanical process of chewing (mastication) helps break down food into smaller particles, increasing the surface area for enzymes to act upon.

b) Discuss the role of saliva in digestion. Saliva contains enzymes, such as amylase, that start breaking down carbohydrates into simpler sugars.

c) Highlight the importance of taste buds in detecting flavors, which triggers reflexes for swallowing and further stimulates the secretion of saliva.

d) Emphasize the significance of the mouth's role in preparing food for the next stages of digestion in the stomach and small intestine.

Step 2: Divide the class into small groups and provide each group with

a mastery assessment sheet containing questions related to digestion in the mouth.

Instruct the groups to work together to answer the questions on the assessment sheet. Emphasize that they should take their time and collaborate to ensure accuracy.

Collect the completed mastery assessment sheets for evaluation.

Conclusion: Summarize the main points of the lesson on digestion in the mouth. Review the process of chewing, the role of saliva, and the functions of the teeth and tongue in the digestive process.

- Encourage students to apply their understanding of digestion in the mouth to their daily eating habits, emphasizing the importance of chewing food thoroughly for optimal digestion.
- Provide feedback on the mastery assessment sheets and discuss any misconceptions or areas that need improvement.

Formative assessment: Use the handout with labeled diagrams to reinforce the students' understanding. Ask them the following question:

1. *What is the primary function of the mouth in the digestive system?*
2. *Describe the process of chewing (mastication) and its role in digestion.*

3. *Which enzyme present in saliva is responsible for breaking down carbohydrates, and what is its function?*

LESSON PLAN FOR CONTROL GROUP

(LECTURE METHOD) WEEK FOUR

Subject:	Biology
Topic:	Digestion in the small intestine
Group:	Control
Class:	2 SCI 2
Age:	16 years
Sex:	Co-education (Mixed)
Teaching Method:	Discussion method
Duration:	120min
Instructional Material:	Visual aids (diagrams, posters, or slides) Handout with labeled diagrams of the digestive system Projector (optional).

Objectives: By the end of the lesson, the student will be able to:

1. explain the role of the small intestine in the digestive process.

2. describe the process of digestion in the small intestine, including the functions of enzymes and absorption of nutrients.

3. analyze the importance of the small intestine in breaking down food into smaller molecules for absorption.

Prior Knowledge: Students should have a basic understanding of the digestive system, including the functions of the mouth, stomach, and esophagus. They should also be familiar with the concept of enzymes and their role in digestion.

Introduction: Teacher begins the lesson by reviewing the main components of the digestive system covered in previous lessons.

Introduce the topic of the day: *"Digestion in the Small Intestine"* and its importance in the overall digestive process.

Lesson Presentation:

Step 1: Present visual aids, such as diagrams or animations, illustrating the anatomy of the small intestine and its different sections.

Explain the process of digestion in the small intestine, emphasizing the role of bile and pancreatic enzymes in breaking down fats, proteins, and carbohydrates.

Discuss the process of nutrient absorption in the small intestine and the role of villi and microvilli in increasing the absorption surface area.

Engage students in a hands-on activity, such as a simulation or virtual lab, where they can observe the process of digestion in the small intestine.

Step 2: Divide students into small groups to discuss the key concepts learned during the main activity.

Facilitate group discussions and encourage students to ask questions and clarify their understanding of the topic.

Conclusion: Summarize the main points of the lesson on digestion in the small intestine.

Encourage students to ask any remaining questions and clarify their understanding.

Provide feedback on the formative assessment and highlight areas of improvement.

Formative assessment: Distribute a short quiz with questions related to the small intestine's role in digestion and nutrient absorption. This will help identify students' prior knowledge and any misconceptions.

Use questioning techniques, such as think-pair-share, to assess students' understanding of the topic covered during the lesson.

LESSON PLAN FOR CONTROL GROUP

(LECTURE METHOD) WEEK FIVE

Subject:	Biology
Topic:	Digestion in the large intestine
Group:	Control
Class:	2 SCI 2
Age:	16 years
Sex:	Co-education (Mixed)
Teaching Method:	Discussion method
Duration:	120min
Instructional Material:	Visual aids (diagrams, posters, or slides) Handout with labeled diagrams of the digestive system Projector (optional).

Objectives: By the end of the lesson, the student will be able to:

1. *explain the role of the large intestine in the digestive process.*
2. *describe the functions of the large intestine, including the absorption of water and electrolytes.*
3. *analyze the importance of gut microbiota in the large intestine and their role in digestion.*

Prior Knowledge: Students should have a basic understanding of the digestive system, including the functions of the mouth, stomach, and small intestine.

Introduction: Teacher begins by reviewing the main components of the digestive system covered in previous lessons.

Introduce the topic of the day: *"Digestion in the Large Intestine"* and its role in the final stages of digestion.

Lesson Presentation:

Step 1: Present visual aids, such as diagrams or illustrations, to illustrate the anatomy of the large intestine and its location in the digestive system.

Explain the functions of the large intestine, such as the absorption of water and electrolytes from the remaining indigestible food particles.

Discuss the role of gut microbiota in the large intestine and their contribution to breaking down certain substances that the body cannot digest on its own.

Engage students in a hands-on activity, such as a simulation or role-play, to understand how water absorption occurs in the large intestine..

Step 2: Divide students into small groups to discuss the key concepts learned during the main activity.

Facilitate group discussions and encourage students to share their understanding of the topic.

Conclusion: Summarize the main points of the lesson on digestion in the large intestine.

Encourage students to ask any remaining questions and clarify their understanding.

Provide feedback on the formative assessment and highlight areas of improvement.

Formative assessment: Conduct a brief discussion or quiz to assess students' current knowledge of the large intestine's role in digestion and water absorption.

Use questioning techniques and class discussions to gauge students' understanding of the topic covered during the lesson.