UNIVERSITY OF EDUCATION, WINNEBA

THE IMPACT OF TEACHING STRATEGY BASED ON MULTIPLE INTELLIGENCE APPROACH ON THE ACADEMIC ACHIEVEMENTS OF SHS STUDENTS IN SCIENCE

DZIWORNU KOFI AGBITOR

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DZIWORNU KOFI AGBITOR
(220032196)

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DECLARATION

STUDENT'S DECLARATION

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

SIGNATURE: ……

DATE: …….

SUPERVISOR'S DECLARATION

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

NAME OF SUPERVISOR: DR. MICHAEL GYAN

SIGNATURE: ……

DATE: ……...

DEDICATION

I dedicate this work to God Almighty, my parents, Mr. Patrick Agbitor and Madam Comfort Agbitor, and my siblings, Patience Agbitor, Beatrice Agbitor, Prosper Agbitor, Rose Agbitor and Godwin Agbitor and to my family.

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LIST OF ABBREVIATIONS

MIIOC	Multiple Intelligence Inventory Observation Checklist
MI	Multiple Intelligence
PRESSAT	Pre-test Students‟ Science Achievement Test
POSSAT	Post-test Students‟ Science Achievement Test

ABSTRACT

The purpose of this study was to investigate the effects of a Teaching Strategy based on Multiple Intelligence on students‟ academic achievement in science courses. One hundred and twenty (120) students from two different classes (Experimental N=60 and Control N=60) participated in the study. Two second-year classes in the Asuansi Technical Institute which comprised Electrical Engineering Technology and Fashion Design Technology students were selected using purposive sampling for the study. They were later categorized into a control group and the experimental group. The group which was assigned as the experimental group was instructed through a Teaching Strategy based on Multiple Intelligence whereas the other group was traditionally instructed. This experimental study lasted six weeks. To assess the superiority of the Multiple Intelligence Teaching Strategy, a ten-item science achievement test was given. The hypotheses were tested using an independent sample t-test. The p-value for the post-test was 0.0001 which is less than 0.05. These results showed that there was a statistically significant effect of treatment on students' achievement in science. This means that students who were instructed through a Teaching Strategy based on Multiple Intelligence achieved a higher score. Students responses were given by using self-assessment and all the students said the lesson gave them knowledge and skills that are useful for their lives, they are clear with the explanations given, they didn‟t find difficulties to understand the lesson, enjoyed the activities, have great fun and can complete assignments given. At the end of the study, it was revealed that the students who were exposed to Multiple Intelligence instructional approach have enhanced knowledge in the lesson given. It was, therefore, concluded that a Teaching Strategy based on Multiple Intelligence significantly enhanced students' learning of science, regardless of the preferred learning style of students.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter presents the background to the study. It also states the problem, the purpose of the study, the objectives of the study, the research questions that will guide the study, null hypothesis and the significance of the study. It also contains delimitations and limitations of the study.

1.1 Background to the Study

Every instructor in one way or the other has applied multiple intelligence in their classrooms. Various insights have been made in the training framework for some time now. “Each classroom in a school is an intelligence garden. While plants look the same from a distance, each grows differently and produces a different fruit” (Uselis et al., 2020, p. 367-372). I found out that each student in the classroom comes from a different background and has different abilities, diverse in thinking and behaviour.

According to (Mantiri, 2013), people do not learn from just one or two routes of information. Mantiri believes that we all have different ways of learning that are independent of each other. This notion was in direct conflict with the standard intelligence theory which states that our intelligence is all related and correlated. Gardner (2015) challenged the traditional views of intelligence and argued there are eight discrete “intelligences” in human beings. Gardner broadly defined intelligence as a bio-psychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture (Davis et al., 2011). Intelligences are not things that can be seen or counted. Instead, they are potentials presumably, neural ones that will or will not be activated, depending upon the values of a particular culture, the opportunities available in that

culture, and the personal decisions made by individuals and/or their families, school teachers, and others. Gardner‟s theory was originally intended for the field of psychology but has received a great deal of attention in the field of education (Gardner, 2015).

In the 21st century, teachers are to use the diversity of students to teach and meet the needs of every student. Gohar and Sadeghi (2015) indicated that the various insights proposed by Howard Gardner imply that typical Intelligence Quotient (IQ) assessments are excessively Restrictive. Researchers conducted by Amponsah (2020) have used teaching strategies like collaboration, cooperative learning and conceptual change texts to help improve students‟ understanding of the material taught. This is ultimately not enough as there are other intelligences ignored in using these methods to enhance students‟ conceptual understanding of topics taught. Thus, a teacher must create tasks that encompass all sorts of intelligences to encourage intellectual competency in his or her students.

Gardner's Multiple Intelligence theory, according to Yalmanci and Gozum (2013), has two significant educational benefits. For starters, it lays the way for educational programmers to be organised in a way that helps learners realise their full potential and achieve their goals. Also, it allows teachers to reach out to more active students because learning would be more appealing if learners were instructed using these intelligences. This happens when an educator's lesson plan includes a wide range of activities connected to several types of levels of intelligence (Carlin et al., 2013). As a result, determining how much a teacher's inclinations, such as their dominant form of intelligence, are impeding their capacity to implement Multiple Intelligence-inspired teaching is crucial. Several researchers have delved at the theory's

implications for teaching and learning in a range of topics, including Language, Psychology, and Science, since Gardner's publication of the Multiple Intelligence theory. Multiple intelligence theory should be instituted in classrooms in a range of methods, such as brain-based learning strategies, study groups, video games, and modules, according to Abdi et al., (2013), Chuang et al., (2010), and Azid et al., (2016). Correspondingly, Madkour and Mohammed (2016), Amponsah, et al., (2021), and Yurt and Polat (2015) found that integrating learning strategies with learners' intelligence enhanced learners' learning and emotional intelligence, which had a positive impact on learner achievement. Prior research has tended to focus on the effect of learning practices on student achievement.

Over the years, studies have been conducted about the use of multiple intelligences at the elementary, senior high school, and university levels of education. For instance, Sener and Çokçaliskan, (2018) examined the use of multiple intelligences in the university classroom. The findings of the study showed that the majority of the teachers in the study used logical-mathematical, linguistic, and interpersonal intelligences more than other intelligences. Luo and Huang (2019), studied the linkage between English teachers‟ multiple intelligences and teaching strategies. The study revealed that teachers use linguistic, interpersonal, and intrapersonal teaching strategies frequently in teaching the English language. In California, Al-Wadi (2011), investigated teachers‟ perceptions about the use of multiple intelligences in teaching. The findings showed that teachers use linguistic intelligence frequently but musical and naturalistic were the least used intelligence.

Davis (2017), posits that teachers usually use spatial, logical-mathematical, and linguistic intelligences to teach students how to draw, think, and write. In Turkey,

Saban and Bal (2012), studied teaching strategies used in teaching mathematics by focusing on multiple intelligence theory. In their study, it was found that teachers regularly use linguistic, logical-mathematical, interpersonal, and naturalistic intelligences. Moreover, Sulaiman et al. (2011), examined teaching styles in primary and secondary school teachers based on the theory of multiple intelligences. The findings of their study revealed that teachers use spatial, naturalistic, logical-mathematical, interpersonal, and musical intelligence in teaching.

On their part, Sener and Cokcaliskan (2018), found that naturalistic, visual, and kinaesthetic intelligences of students received the highest score. In a quantitative study, Lopez and Patron (2012), investigated the various intelligences students employ in their Business Statistics courses. The findings showed that students were higher in interpersonal intelligence and lower in linguistic and spatial intelligence. Similarly, Menevis and Ozad (2014), explored the difference in multiple intelligences based on age and gender. This study revealed that there were statistically significant differences in the use of linguistic, bodily-kinesthetic, existential, musical, interpersonal, intrapersonal, and naturalistic intelligence based on gender. Additionally, Lawrence (2014), investigated prospective teachers‟ multiple intelligences and found that male and female prospective teachers demonstrated significantly different verbal-linguistic intelligence. Furthermore, it was discovered that first-year and second-year prospective teachers exhibited significantly different musical intelligences.

In Malaysia, Sulaiman et al. (2010), examined multiple intelligence-based teaching strategies among Science and Mathematics secondary school teachers. Their study discovered that intrapersonal and logical-mathematical intelligence were the most

commonly used teaching strategies employed by teachers. Their study focused on Science and Mathematics teachers but did not look at the differences in the multiple intelligences teaching strategies between male and female teachers.

In a different context, Massey examined the impact of training teachers in multiple intelligences instructional strategies in Central Florida. The study showed that the teaching experience of the teachers was a major determinant in teachers‟ use of multiple intelligences. Additionally, it was found that neither the ages of the teachers nor the ages of the students proved to be a major factor.

Additionally, Kaewkiriya et al. (2016), suggest that as technology progresses, the application of multiple intelligences approach in teaching students in the classroom should keep pace. Hence, there is a need for teachers to apply the multiple intelligences approach in their lessons.

Gardner‟s eight intelligences are bodily-kinaesthetic, interpersonal, intrapersonal, linguistic, logical-mathematical, musical, naturalistic (added later), and spatial intelligence.

1.2 Statement of the Problem

The traditional method of teaching (standing in the front of the classroom and lecturing) is not a very effective way for many students to learn as it typically only caters to one of Gardner‟s intelligences. It has been discovered that 70% of teaching is still done through lecturing (Bordei & Ghiatau, 2014). Not only does this lack student engagement, but it also meets the needs of just a small percentage of the class. Yet teachers are expected to guide all students to understanding the presented content. Because of this most students do not benefit from classroom instruction, and find it difficult to understand the concepts being taught and this is not different from Asuansi

Technical Institute. Because traditional lecturing does not meet those expectations, teachers are encouraged to find ways to present content to students which will differentiate and meet the specific needs of each learner in the classroom. One way to meet the needs of a higher number of students is to regularly incorporate the Multiple Intelligences Theory into the teaching of science.

The researcher‟s observation in the technical school made him realise that the traditional methods of teaching the science concepts is making it difficult for the students to understand concepts. Since Gardner publicised the Multiple Intelligences (MI) theory, several studies have investigated the implications of the theory to be applied in teaching and learning activities in various subjects, including language, psychology and science. Yurt and Polat (2015), Madkour and Mohammed (2016) and Sánchez-Martín, Álvarez-Gragera et al., (2017) found that adjusting learning strategies with students‟ intelligence has improved learning, motivation and emotional intelligence to positively impact student achievement. Therefore, this study aims to investigate the impact of teaching strategies based on multiple intelligence approaches on the academic achievement of Secondary School students in science.

1.3 Purpose of the Study

The study seeks to find out the impact of teaching strategies based on multiple intelligence approaches on students‟ academic performance in science.

1.4 Objectives

The study outlines the following objectives:

1. To identify the knowledge level of the students in the concept of the human circulatory system in science.

2. To determine the impact of teaching strategy based on multiple intelligence approach on the academic performance of students.
3. To determine the perceptions of students on the use of the multiple intelligence approach

1.5 Research Questions

1. What is the difference in performance between control and experimental groups on the intelligence test scores?
2. What is the impact of the multiple intelligence approach on the academic performance of the students?
3. What are the perceptions of students who have been exposed to the multiple intelligence approach of teaching and learning in science?

1.6 Null Hypotheses

Ho1: There is no statistically significant difference between the academic achievement of students of control and experimental groups on pre-test in the human circulatory system.

Ho2: There is no statistically significant difference between post-test scores of students taught the human circulatory system by a traditional method and those taught the human circulatory system by using a multiple intelligence approach.

1.7 Significance of the Study

This research would provide empirical evidence on the impact of the application of multiple intelligence approaches in the teaching and learning of science. Findings would augment the pool of data required by other educational researchers in their bid to design interventions to solve educational problems in science.

1.8 Delimitations

Only 120 students will be used for the study. Again, the study will be focused on only second-year students of Asuansi Technical Institute. The study will focus on the human circulatory system out of the many concepts in science.

1.9 Limitations

The limitations of the study were absenteeism of some of the students during the period of the study which meant that some of the students would not benefit from the intervention that was designed, the results cannot be generalised to the entire region because the sample was from only one school and time.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This chapter deliberates on the literature relevant to the study. The chapter reviews relevant literature that provides support for the study under the following subheadings: Theoretical Framework of Multiple Intelligence Approach, Teaching Based on Multiple Intelligence Approach, Traditional or conventional Teaching Approach In Science and Multiple Intelligence Approach Integration in Science Education.

2.1 Theoretical Framework of Multiple Intelligence Approach

Howard Gardner, a professor at Harvard University's School of Education, published the book Frames of Mind: The Theory of Multiple Intelligences. In this book, Gardner (2011) criticizes the definition of intelligence as a single, general capacity manifested in certain linguistic and logical abilities that can be measured in a number (the Intelligent Quotient, or IQ) a definition that has dominated American education. Until that time, the IQ test was thought to be psychology‟s biggest success because intelligence seemed to be something quantifiable. However, now it is believed that this type of test cannot measure or quantify all intelligences. Gardner developed a theory with Multiple Intelligences because he felt that the current psychometric tests only examined the Linguistic, Logical, and some aspects of spatial intelligence, whereas the other facets of intelligent behaviour such as athleticism, musical talent, and social awareness were not included (Almeida, et al., 2010). Gardner (2011) views intelligence as multifaceted. Gardener‟s model is based on findings from both cognitive science (the study of the mind) and neuroscience (the study of the brain). Gardener‟s approach is called “Theory of Multiple Intelligences”. This theory

suggests that intelligence is the ability to solve problems and difficulties in a particular domain. This is an inborn attribute of the individual and the general faculty of intelligence does not change much with age or with training or experience (Gardner, 2011). Multiple intelligence is a set of aptitudes and skills in which each human being possesses various types of learning styles. Vauzy (2018), said that multiple intelligences are tools to receive new information as an elective learning style, working style and self-innate power. The type of people‟s intelligence does not only indicate their capacity, but it also points out how they choose their learning style and empower their strengths as well as minimize their weaknesses.

2.2 Teaching Based on Multiple Intelligence

In many cases, Multiple Intelligence Approach is a strategy that has been used for decades by good teachers. In other cases, the theory of multiple intelligence offers teachers an opportunity to develop innovative teaching strategies that are relatively new to the educational scene. Multiple Intelligence theory suggests that no one set of teaching strategies will work best for all students at all times. All children have different proclivities in the eight intelligences, so any particular strategy is likely to be highly successful with one group of students and less successful with other groups. For example, teachers who use the Rhythms, Songs, Raps, and Chants strategy as a pedagogical tool will probably find that musically inclined students respond while non-musical students remain unmoved. Similarly, the use of pictures and images in teaching will reach students who are more spatially oriented but perhaps have a different effect on those who are more physically or verbally inclined. (Alyamani et al., 2021).

Gardner proposed the theory of multiple intelligences in the early 1980s as an alternate to conventional teaching strategies that require students to learn and comprehend in several ways. Gardner (2011) proposed that students had a range of intelligences rather than a single intelligence. His theory is that everyone has intelligences, but that one of these is more prominent in each individual. Based on the foregoing parameters, he identified eight separate intelligences: "logical-mathematics (number smart), verbal-linguistic (word smart), bodily-kinaesthetic (body smart), musical–rhythmic (music smart), interpersonal intelligence (interpersonal intelligence) (e.g., social skills), intrapersonal (e.g., insight, metacognition, self-smart), visual/spatial intelligence, the naturalist (nature smart) and existential intelligence" (Cherry, 2021)

2.2.1 Teaching Strategies for Linguistic Intelligence.

Verbal-linguistic intelligence; Gardner clarified this insight as affectability to the composed and communicated in language (Hali, 2017). This insight is for the most part worried about the capacity to fathom and make language effectively both orally and recorded as a hard copy. Artists, essayists, etymologist columnists, and dialect instructors are barely any instances of individuals who have verbal-semantics insight.

Table 2.1: Activities and Treatments for Linguistic Intelligence

Activities	Treatment
Storytelling	*When using storytelling in the classroom, you weave essential concepts, ideas, and instructional goals into a story that you tell directly to students. Although storytelling is usually thought of as a means of conveying knowledge in the humanities, it can be applied in mathematics and science as well. For example, to teach the idea of multiplication, you can tell students the story of brothers and sisters who have magical powers: whatever they touch multiplies (e.g., for the first child, it doubles; for the second, it triples; and so on). To convey the notion of centrifugal force, you can take students on a mythical journey to a land where everything spins around very rapidly from the centre outward. Prepare for storytelling by listing the essential elements you'd like to include in the story. Then use your imagination to create a special land, a group of colourful characters, or a whimsical plot to carry the message home. It may help to visualize the story at first and then practice telling it to a spouse or a mirror. Stories needn't be especially original or fabulous for children to benefit from them. Students are often impressed simply by a teacher's willingness to be creative and speak from the heart about a subject.*
Brainstorming	*The brainstorming can be about anything: words for a class poem, ideas for developing a group project, thoughts about the material in a lesson being taught, suggestions for a class picnic, and so forth. The general rules for brainstorming are: participants share whatever comes to mind that is relevant, no put-downs or criticisms of any idea are allowed, and every idea counts. You can place ideas at random on the board or screen or use a special system such as an outline, a mind-map, or a Venn diagram to organize them. After everyone has had a chance to share, look for patterns or groupings in the ideas, and invite students to reflect on the ideas, or use the ideas in a specific project (such as in a group poem). This strategy allows all students who have an idea to receive special acknowledgement for their original thoughts.*
Tape Recordings	*Students can use tape recorders to "talk out loud" about a problem they are attempting to solve or a project they are planning to do. In this way, they reflect upon their problem-solving processes or cognitive skills. They can also use tape recorders to prepare for writing, helping to loosen the soil, so to speak, of their topic. Students who are not good writers may also want to record their thoughts on tape as an alternative mode of expression. Some students may use the tape recorder to send "oral letters" to other students in the class, to share personal experiences, and to get feedback about how they are coming across to others in the classroom.*
Journal Writing	*The domain can be broad and open-ended ("Write about anything you're thinking about or feeling during the class day") or quite*

	specific ("Use this journal to keep a simulated record of your life as a farmer during the 1800s as part of our history course"). Journals can be kept in math ("Write down your strategy for solving this problem"), science ("Keep a record of the experiments you do, hypotheses you're testing, and new ideas that emerge from your work"), literature ("Keep an ongoing record of your responses to the books you're reading"), or other subjects. They can be kept entirely private, shared only between teacher and student, or regularly read to the class. They can also incorporate multiple intelligences by allowing drawings, sketches, photos, dialogues and other nonverbal data. (Note that this strategy also draws heavily upon intrapersonal intelligence in so far as students work individually and use the Journal to reflect upon their lives.)
Publishing	*Publishing takes many forms. Students can submit their writing to a class or school newspaper, a city newspaper, a children's magazine, or some other publishing source that accepts student work. Students' writing can also be published using desktop publishing software such as Microsoft Publisher, Print Shop, or Print Explosion and then bound in book form and made available in a special section of the class or school library.*

Armstrong, T. (2009).

2.2.2 Teaching Strategies for Logical-Mathematical Intelligence

The capability to calculate and comprehend situations or conditions competently is referred to as logical-mathematical intelligence. Learners with this kind of know-how are good at looking for instances and correlations, as well as analytical thinking and reasoning (Pehlivan & Durgut, 2017). This form of understanding is linked to deductive reasoning. This is something that people who work in logical and numerical domains should have.

Table 2.2: Activities and Treatments for Logical Mathematics Intelligence

Activities	***Treatments***
Calculation and Quantifications	*In line with school reform efforts, teachers are being encouraged to discover opportunities to talk about numbers both inside and outside the math and science arena. In subjects such as history and geography, you may focus regularly on important statistics: lives lost in 12 wars, populations of countries, and so forth. But how do you accomplish the same aim in literature? You shouldn't force connections that simply aren't there. It's surprising, however, how many novels, short stories, and other literary works refer to numbers. In a novel by Virginia Woolf, To the Lighthouse, there is a mention of 50 pounds to fix a greenhouse roof. How does that figure translate into U.S. dollars? In a short story by Doris Lessing, "Through the Tunnel," a boy must count to see how long he can stay underwater and then compare that to the amount of time it takes experienced divers to swim through a submerged tunnel. Each of these passages provides the basis for mathematical thinking. It is a good idea, however, to keep alert for interesting numbers and intriguing math problems wherever they may be found. By tuning into the numbers amid nonmathematical subjects, you can better engage highly logical students, and other students can learn to see that math belongs not just in math class but in life*
Classification and Categorization	*The logical mind can be stimulated anytime information is put into some kind of rational framework, whether the data be linguistic, logical-mathematical, spatial, or any other kind. For example, in a unit on the effects of climate on culture, students might brainstorm a random list of geographic locations and then classify them by type of climate (e.g., desert, mountain, plains, or tropical)*
Socratic Questioning	*In Socratic questioning, the teacher serves as a questioner of students' points of view. The Greek sage Socrates is the model for this type of instruction. Instead of talking to students, the teacher participates in dialogues with them, aiming to uncover the rightness or wrongness of their beliefs. Students share their hypotheses about how the world works, and the teacher guides the "testing" of these hypotheses for clarity, precision, accuracy, logical coherence, or relevance through artful questioning.*

Armstrong, T. (2009).

2.2.3 Teaching Strategies for Spatial Intelligence

Visual or spatial intelligence is defined as the capacity to perceive, alter, and create images. This intellect is commonly found in sculptors, architects, designers, and artists (Hegarty, 2010). Learners with this kind of intelligence are frequently excellent in visual arts classes. Visually intelligent learners learn by watching videos on specific topics.

Table 2.3: Activities and Treatments for Spatial Intelligence

Activities	***Treatments***
Visualization	*An application of this strategy involves having students create their own "inner blackboard" (or movie or video screen) in their mind's eye. They can then place on this mental blackboard any material they need to remember: spelling words, math formulas, history facts, or other data. When asked to recall a specific body of information, students then need only call up their mental blackboard and "see" the data inscribed on it*
Colour Cues	*Use a variety of colours of chalk, markers, and transparencies when writing in front of the class. Provide students with coloured pencils and pens and coloured paper on which to write assignments. Students can learn to use different coloured markers to "colour code" the material they are studying (e.g., mark all the key points in red, all the supporting data in green, and all the unclear passages in orange). Use colour to emphasize patterns, rules, or classifications during instruction (e.g., colouring all that's red in a phonics lesson,). Finally, students can use their favourite colours as a stress reducer when coping with difficult problems (e.g., "If you run into a word, problem, or idea you don't understand, imagine your favourite colour filling your head; this can help you find the right answer or clarify things for yourself")*
Picture Metaphors	*The educational value of using metaphors lies in establishing connections between what a student already knows and what is being presented. Think of the key point or main concept you want students to learn. Then, link that idea to a visual image. Construct the complete metaphor yourself or have students develop their own (e.g., "If the major organs in the body were animals, which ones would they be?")*
Idea Sketching	*This strategy can be used to evaluate a student's understanding of an idea, to emphasize a concept, or to give students ample opportunity to explore an idea in greater depth. Here are some examples of subjects or concepts you might have students choose to illustrate: gravity, probability (in math), fractions, democracy, ecosystem, and continental drift. Following up the drawing activity with a discussion of the relationship between the drawings and the subject matter is important*
Graphic Symbols	*Requires you to practice drawing at least some part of your lessons—for instance, by creating graphic symbols that depict the concepts to be learned.*

Armstrong, T. (2009).

2.2.4 Teaching Strategies for Bodily-Kinaesthetic Intelligence

The term "bodily kinaesthetic intelligence" relates to how the body is mostly used to make statements. It's also known as the ability to use the body and its parts to solve issues or create goods Gardner, (2011). This group includes athletes, professional dancers, physical education instructors, and mechanics.

Table 2.4: *Activities and Treatments for Body Kinaesthetic intelligence*

Activities	***Treatments***
Body Answer	*Ask students to respond to instruction by using their bodies as a medium of expression. The simplest and most over used example of this strategy is asking students to raise their hands to indicate understanding.*
Classroom Theatre	*Classroom Theatre can be as informal as a one-minute improvisation of a reading passage during class or as formal as a one-hour play at the end of the semester that sums up students' understanding of a broad learning theme. It can be done without any materials. Students may themselves act in plays and skits, or dramatizations in miniature (e.g., showing how a battle was fought by putting miniature soldiers on a plywood battle field and moving them around to show troop movements). To help older students who may initially feel reluctant to engage in dramatic activities, try some warm-up exercises.*
Kinaesthetic Concepts	*Concepts strategy involves introducing students to concepts through physical illustrations or asking students to pantomime specific concepts or terms from the lesson. This strategy requires students to translate information from linguistic or logical symbol systems into purely bodily-kinaesthetic expressions. The range of subjects is endless*
Hands-on Thinking	*Many educators have already provided such opportunities by incorporating manipulative (e.g., Cuisenaire rods) into math instruction and involving students in experiments or lab work in science. You can extend this general strategy into many other curricular areas as well. At a rote level, students can study spelling words or new vocabulary words by forming them in clay or with pipe cleaners. At a higher cognitive level, students can express complex concepts by creating clay or wood sculptures, collages, or other assemblages.*

Armstrong, T. (2009).

2.2.5 Teaching Strategies for Musical Intelligence

Musical intelligence refers to the capacity to understand or discern pitch, rhythm, and the emotions of sound. It is displayed by musicians, singers, composers, and music enthusiasts in general Gardner, (2011).

Table 2.5: Activities and Treatments for Body Musical intelligence

Activities	***Treatments***
Rhythms, Songs, Raps, and Chants	*Take the essence of whatever you are teaching and put it into a rhythmic format that can be either sung, rapped, or chanted. At a rote level, this can mean singing the times tables to the tune of a popular song.*
Super memory Music	*Students should be in a relaxed state (putting heads on desks or lying on the floor) while the teacher rhythmically gives the information to be learned (e.g., spelling or vocabulary words, history facts, science terms) against the musical background*
Musical Concepts	*Convey musically the idea of a circle, begin humming at a certain tone, drop the tone gradually (indicating the gradual slope of the circle) to a low note, and then gradually move up toward the original tone*
Mood Music	*Locate recorded music that creates an appropriate mood or emotional atmosphere for a particular lesson. Such music can even include sound effects (nonverbal sounds are processed through the musical intellect), nature sounds, or classical or contemporary pieces that facilitate specific emotional states. For example, just before students are about to read a story that takes place near the sea, play a recording of sea sounds (waves crashing up against the shore, etc.)*

Armstrong, T. (2009).

2.2.6 Teaching Strategies for Interpersonal Intelligence

Interpersonal intelligence; persons, according to Sharma, R. (2020), are pleasant and engage in social activities. These individuals appreciate student engagement, information exchange, and group study.

Table 2.6: Activities And Treatments for Interpersonal intelligence

Activity	***Treatments***
Peer Sharing	*Sharing is perhaps the easiest of the Multiple Intelligence strategies to implement. All you need to do is say to students, "Turn to a person near you and share. "The blank space can be filled with virtually any topic. You might want students to process material just covered in class ("Share a question you have about what I just presented").*
People Sculptures	*For a unit on inventions, students can create people sculptures of different inventions, complete with moving parts. In algebra class, students can create people sculptures of different equations, each person representing either a number or a function in the equation. Similarly, in language arts, students can build people sculptures to represent spelling words (each person holding up a letter), sentences (each student representing a word), or whole paragraphs (each person taking responsibility for a complete sentence). Assign a student to help "direct" the activity, or let the components of the sculpture organize themselves*
Cooperative Groups	*The use of small groups working toward common instructional goals is the core component of the cooperative learning model. Such groups generally work most effectively when they have three to eight members. Students in cooperative groups can tackle a learning assignment in a variety of ways*

Armstrong, T. (2009).

2.2.7 Teaching Strategies for Intrapersonal Intelligence

Intrapersonal intelligence is defined as the ability to have self-awareness and recognize similarities and differences between persons. Gardner defines self-awareness as the ability to understand and respect one's sentiments, emotions, desires, strengths, and motives (Perez & Ruz, 2014).

Table 2.7: Activities and Treatments for Intrapersonal intelligence

Activities	Treatments
One-Minute Reflection Periods	*A one-minute reflection period can occur anytime during the school day, but it may be particularly useful after the presentation of information that is especially challenging or central to the curriculum. During this one-minute period (which can be extended or shortened to accommodate differing attention spans), there is to be no talking and students are to simply think about what has been presented in any way they'd like. Silence is usually the best environment for reflection, but you occasionally might try using background "thinking" music as an option.*
Personal Connections	*The big question that accompanies strongly intrapersonal students through their school career is: "What does all this have to do with my life?" Most students have probably asked this question in one way or another during their time in school. It's up to teachers to help answer this question by continually making connections between what is being taught and the personal lives of their students. This strategy, then, asks you to weave students' personal associations, feelings, and experiences into your instruction. You may do so through questions ("How many of you have ever . . . ?"), statements ("You may wonder what this has to do with your lives. Well if you ever plan on . . ."), or requests ("I'd like you to think back in your life to a time when . . .").*
Choice Time	*Giving students choices is as much a fundamental principle of good teaching as it is a specific intrapersonal teaching strategy. Essentially, choice time consists of building opportunities for students to make decisions about their learning experiences. Making choices is like lifting weights*
Goal-Setting Sessions	*The goal-setting sessions may last only a few minutes, or they may involve in-depth planning over several months. The goals themselves can relate to academic outcomes ("What grades are you setting for yourself this term?"), wider learning outcomes ("What do you want to know how to do by the time you graduate?"), or life goals ("What kind of occupation do you see yourself involved with after you leave school?"). Try to allow time every day for students to set goals for themselves. You may also want to show students different ways of representing those goals (through words, pictures, etc.) and methods for charting their progress along the way (through graphs, charts, journals, and time lines).*

Armstrong, T. (2009).

2.2.8 Teaching Strategies for Naturalistic Intelligence

Naturalistic knowledge is the ability to discern and organize the regular reality in which people live. Sener and Çokçaliskan, (2018) quoted Teele Sarah that these people live in harmony with the natural world. Astronomers, zoologists, and microbiologists, among others, require a highly advanced type of intelligence.

Table 2.8: Activities and Treatments for Body Kinesthetic intelligence

Activities	***Treatments***
Nature Walks	*Nature walks make a superb preparation forgetting your class ready to do creative writing, drawing, or other activities*
Windows onto Learning	*As with nature walks, looking out a window can be used to set a scene for literature, history or scientific observation. Other subjects can take what's beyond the window as a starting point, a place to briefly stop during a lesson, or a final stopping point*
Pet-in-the-Classroom	*First of all, having a pet in the classroom automatically creates for many naturalistically inclined students a "safe place" where they can go to have a relationship with the natural world and to feel a sense of caring for nature's beings (some of these kids maybe our future veterinarians!). Second, many specific instructional uses can come from having a pet in the classroom. The scientific skill of observation can be developed by having kids keep notes on a pet's behaviour*

Armstrong, T. (2009).

2.3 Traditional teaching approach in science

In the context of this study „traditional teaching approaches" refer to the usual methods used by educators to teach science subjects, which could involve occasional reference to real-life applications of science. A review of the literature seems to suggest that science teaching methods differ between primary school and high school. Many reports and studies (Bellocchi et al., 2014; Hong & Chang-Chian, 2008; Aremu & Salami, 2013) imply that at the primary school level, science teaching mostly involves pupil-centred and activity-based teaching, entailing frequent practical activities, and providing more freedom for pupil investigations. In contrast, science teaching at the high school level usually involves educator-centred instruction, dominated by "chalk and talk" teaching, lecturing, note copying by learners, factual knowledge, abstract concepts, and cookbook practical lessons and demonstrations (Matthews, 2014; Aremu & Salami, 2013; Kazeni & Onwu, 2013; Guler, 2013).

In a typical high school science class, the educator provides a few examples or solves a few problems on the board, and in some cases performs experimental demonstrations. Learners in such classes listen to the educator and write notes, but hardly ever ask questions or make remarks (Graham, (2016); Yashima et al., 2016). For example, a study conducted by Pelger and Nilsson (2018) stated that Lyons found science teaching at the high-school level involved the transmission of knowledge from expert sources (educators and text books) to mainly passive recipients (the learners). The following phrases were used by learners who participated in Lyons study to describe the presentation of science lessons. This is it, this is how it is, this is what you learn; it is like that, learn it because it is right, there is nothing to discuss; it happened, accept it (p. 591).

This perception of science lessons seems to imply that learners see science as a body of knowledge to be committed to memory, without understanding or questioning. In addition, a report by the Organization for Economic Cooperation and Development (OECD) Global Science Forum states that most learners at high-school level are of the view that science teaching lacks a sense of community, does not reflect their experience of the world or contemporary research, involves too much repetition, does not provide a good overview of the subject, and offers little room for discussion. Other researchers (Khan, 2021) have indicated that the traditional ways of teaching science usually involve little active learning, and frequently cause learners to become disengaged and unmotivated.

Nonetheless, science instruction at high school is not always conducted as depicted above. In some cases, science educators teach effectively, resulting in enhanced learner performance in science subjects, as evident in some high schools that perform

consistently well in science (for example, in the South African context, Grey College, King Edward VII School, Hilton College, and St John‟s College). Despite these high-achieving schools, most high schools in South Africa persistently perform poorly, especially in rural schools (Kazeni & Onwu, 2013). The methods used to teach science in such schools could be major determinants of performance.

A review of the literature suggests that the traditional ways of teaching science often fail to sufficiently develop learners‟ understanding of scientific concepts (Allen, 2008; Koenig et al., 2012; Ding & Mollohan, 2015; Carr et al., 2011). For instance, Carr and Taasoobshirazi, (2017) think that traditional ways of teaching science, which usually involve memorization of concepts and computations, often result in learners‟ failure to comprehend the deeper conceptual connections within the problems. This way of teaching, according to these authors, encourages poor problem-solving approaches and limited comprehension of learned concepts and ideas.

Michael Allen points out that, in most cases, school science aims to deliver a body of “right answers”, in which currently established theories and concepts are transmitted to learners as if they were absolute irrefutable truths to be learned as examinable facts (Kazeni, 2012). This approach to science teaching is likely to encourage learners to memorize and recall scientific concepts for the sake of passing examinations, rather than foster a deep understanding of the concepts. Several other reports and studies (Vázquez-Bernal & Jiménez-Pérez, 2023; Guler, 2013; Vlckova, et al., 2019) have indicated that most learners find the study of science difficult because science teaching lacks inspiration.

2.4 Multiple Intelligence Approach Integration in Science Education

In an educational environment, Multiple Intelligence encourages instructors to create multi-faceted curricula and engaging learning experiences. The following section provides a quick glimpse into two examples of Multiple Intelligence-based science curricula. These examples will connect the more abstract theoretical idea of Multiple Intelligence with „practical" classroom applications. In an elementary unit on rain forests, Multiple Intelligence-based instruction was delivered through a variety of learning experiences. Students at Westmark School in Encino California learned about rainforests by transforming their classroom into a rainforest. Students used wall decorations, music, sound effects, flora, and humidifiers to create a realistic setting where they could learn about the rainforest experientially (Köksal Akyol, 2018).

Students were involved in other Multiple Intelligence-based activities like searching through magazines for photos, navigating internet sites for information about rain forests, learning about rain forest bugs, insects, and arachnids from a visiting entomologist, learning about rain forest animals by meeting and touching a giant iguana and a Capuchin monkey, and participating in units taught by a high school student. The Multiple Intelligence-based curriculum helped the students truly experience a rainforest by incorporating an array of intelligences, Multiple Intelligence and Student Performance in educational mediums, and engaging activities. The students were immersed in interesting and exciting activities guided by an entomologist and exposed to elements of real-life including insects and animals.

The Multiple Intelligence-based rainforest unit was infused with real-world connections that made the information „come-alive". At New City School in St. Louis, Missouri, first-grade students engaged in a Multiple Intelligence-based study of

plants. Students were exposed to a variety of literature about plants including fiction books like Miss Rumphius and reference books about flowers, trees, and plants (Peifer, 2012). Students wrote poetry and stories about plants, created flower patterns in math, utilized the scientific method, conducted experiments with plants, and gained "first-hand experience with germination, plant growth, pollination, and seed formation" (p. 32). The students visited a Botanical garden, met a local landscape architect, and created an incredible plant museum where visitors could learn about plants through a variety of intelligences. Like the rainforest unit, the plant unit engaged students through interesting, practical, and useful learning activities and helped the students internalize information to help them understand pertinent science content and the real world. These two examples demonstrate how Multiple Intelligence can be used to create powerful, engaging curricula and educational experiences.

Application of MI theory in classroom activities has been reported by other studies such as Winarti et al., (2019), Hanafin (2014), Ghamrawi (2014), Madkour and Mohamed (2016) and Shánchez-Martín et al. (2017). Those researches indicated that the implementation of MI-based learning strategies in schools not only improves learning outcomes but also students‟ interest, motivation, and emotional intelligence. Students‟ retention increases as the improvement of their self-esteem. Research conducted by Ghamrawi (2014) on the child‟s ability to learn vocabulary proved that the application of Multiple Intelligence theory does not make children learn words faster, but improves children‟s retention in learning. However, the previous research on multiple intelligences was more focused on the impact of the learning method on students‟ interests, motivation, self-esteem, and learning outcomes.

CHAPTER THREE

METHODOLOGY

3.0 Overview

The approach used to accomplish the goals of the research is described in this chapter. The following seven topics are considered in this regard: Study location, target population, variables, sample size and sampling methods, research tools, data analysis, and ethical issues.

3.1 Research Design

The exact techniques and procedures used in a research study to address a research issue are referred to as the research design (Privitera, 2014). It is a detailed documentation of the plan for the collection, measurement and analysis of data. Research design is the arrangement of conditions for the collection and analysis of data in a manner that aims to combine relevance to the research purpose. It constitutes the blueprint for the collection, measurement, and analysis of data (Saunders et al., 2023). This is used to structure the research and show how all the major parts of the research project, the samples or groups, measures, interventions, and methods of assignment work together to address the central research questions.

This study employed an action research design and had a control and experimental group design with a pretest and posttest. This study was designed with a pre-test and post-test to find out the impact of Multiple Intelligence Approach on students' academic performance in science before and after treatment. This research method was used because it enabled the researcher to assess shifts in students' performance in science, if any, the treatment had on the subjects. In this kind of study, a control group is chosen whose traits and functioning are similar to those of the experimental group.

Before and after the experimental group receives the intervention, data collection is done similarly in both groups. Any differences between the control and experimental groups' performances are compared in the analysis. The benefits of this form of design include the ability to study relationships in contexts where control and manipulation, two conditions necessary for a valid experiment are not present (Dannels, 2018). According to Campbell and Stanley, as cited by Ayittey (2015), several factors affect the internal and external validity of experimental designs. Relevant to internal validity, there are eight different factors. These include history, maturation testing, instrumentation, statistical regression, differential selection, experimental mortality and selection-maturation interaction. If these factors are not controlled in the design, they may produce adverse effects which confound the effects of the independent variables. As a way of controlling these factors, two groups will be used in the study instead of only one group, which would have suffered from the above factors. Intact classes were used as experimental and control groups for the study. Participants in the experimental group were taught the „human circulatory system", using the Multiple Intelligence Approach, while those in the Control group were taught the same concept in the SHS integrated science syllabus using the traditional instructional approach.

A sequence of instructive events by Darwazeh, (2017) served as the basis for the Multiple Intelligence-strategy created in this study. The Multiple Intelligence approach has six steps, including (1) Self-reflection, when students describe themselves, their study habits, their interests, etc. (2) Teachers introduce the topic through activities that incorporate all components of MI, (3) Students formulate questions about the subject, (4) practices that incorporate all aspects of Multiple Intelligence deepen the concept, and (5) Using tasks to demonstrate understanding of

the concepts that are appropriate for the students' main types of intelligence, and (6) wrapping up the lessons. Stages 1 through 4 were completed in groups with a variety of dominating types of intelligence, whereas stage 5 was completed individually. For example, students with linguistic and kinesthetic intelligence were asked to design games, while students with musical intelligence were asked to compose music, while students with visual-spatial intelligence were asked to paint, and students with intrapersonal intelligence were asked to draw a simple bouquet or students with linguistic and kinesthetic intelligence were asked to plan further study. One teacher and five observers participated in the teaching and learning process. Six weeks were used for the process. The teacher used the designated teaching technique while the observers observed the teaching and learning process.

3.2 Study Area

Asuansi Technical Institute which is the first Technical Institute in West Africa, is located at Asuansi, which is 25.6 km from Cape Coast, Oguaa in the Abura Asebu Kwamankese District, in the Central Region of Ghana, and covers an area of 10 hectares. Asuansi has a population of 2209 (PHC 2010) and is situated at an altitude of 77 meters above sea level. Its DMS (Degrees Minutes Seconds) coordinates are 5°18'0" N and 1°13'60" W, or 5.3 and -1.23333 (in decimal degrees). Its Joint Operation Graphics reference is NB30-12, and its UTM position is XL98. The main occupation of Asuansi inhabitants is farming.

The institution was established by the Late Nana G. H. Amo the then chief of Asuansi on 12th August 1917 and named Asuansi Rural School to equip the youth with numeracy and literacy skills up to standard 4 (now JHS). Late Nana Amo managed the school until 1920 when the Education Department (the Ministry of Education)

took over and appointed a British officer Mr. H. G. Andren as the officer in charge of the school. In 1922 the school was converted to a government Junior Trade School. The aim was to encourage education. The first Black Principal of the school was Mr Otu Adams from 1958 to 1971. The curriculum was planned to train students in Agriculture, Carpentry, Masonry and Metalwork. In 1963 the name of the school was changed to Asuansi Technical Institute.

3.3 Population of the Study

The target population defines those units for which the finding of the study is meant to generalize (Ackerman et al., 2019). Because the purpose of this study was to find out the impact of teaching strategy based on multiple intelligence approaches in science on senior high school students' academic achievement, the population of the study was all the students in Asuansi Technical Institute. However, the target population was all the Form 2 students. The accessible population was made up of students who study Electrical Engineering Technology and Fashion Design Technology from the selected school. From this population, the sample was selected for the study.

3.4 Sample and Sampling Technique

According to Pandey and Pandey, (2015), sampling means selecting a given number of subjects from a defined population as representative of that population. It works to obtain accurate and reliable information about the population with a minimum of cost, time and energy and to set out the limits of accuracy of such estimates. It makes exhaustive and intensive study possible with much less time, money and material, (Pandey & Pandey, 2015). Two Form 2 classes in the school were sampled by purposive sampling technique. Being purposeful when choosing individuals who can

shed light on your study question is advised by Creswell (2014). Selecting participants through deliberate sampling includes thinking about how they might add to your analysis. Using purposeful sampling strategies ensures that the perspectives of the students recruited provide the information needed to enhance your conclusions. Then, each of the two classes was placed into either the experimental or the control group for the study by simple balloting with a flip of a coin. This was necessary to give the two classes equal chances of being either in the experimental or control group. Each class selected formed the intact group used for the study. Participants in this study were all of a similar educational background as they had all passed the Basic Education Certificate Examination (BECE) at the Junior High School (JHS) level as well as their year one integrated science examination. Also, they had some basic knowledge of the concept of the human circulatory system as they had been introduced to it both at the JHS and SHS levels in integrated science. Each intact group selected for the study had 60 students. The sample size was, therefore, 60 in the control group and 60 in the experimental group making a total of 120 participants.

3.5 Instrumentation

The Data Collection Instruments used were "Multiple Intelligence Inventory Observation Check List", Pre-test Students" Science Achievement Test (PRESSAT) and Post-test Students" Science Achievement Test (POSSAT) and observation. The Multiple Intelligence Inventory Observation Checklist developed by Davis et al., (2011), Long et al., (2013), and Berlian et al., (2008) were able to collect the data on students" Multiple Intelligence. The PRESSAT and POSSAT were both developed by the researcher.

The multiple intelligence inventory observation check list was used to collect data on students‟ intelligences during the intervention.

Eight components make up the "Multiple Intelligence Inventory Observation Checklist". Logical/mathematical, bodily/kinesthetic, visual/spatial, interpersonal, intrapersonal, musical, and naturalist intelligences. Each intelligence's subtitle has eight statements.

The Multiple Intelligence Inventory comprises 64 questions that are organized into 8 categories based on the types of Multiple Intelligence: linguistic, kinesthetic, musical, visual-spatial, intrapersonal, interpersonal, logical-mathematical, and naturalist. The survey used a Likert scale with four response possibilities for each of the eight questions: completely agree (score 4), agree (score 3), disagree (score 2), and completely disagree (score 1).

The PRESSAT was used to assess the participants‟ knowledge and difficulty with the concept of the „Human Circulatory System‟ to have a baseline about all participants before the implementation of the interventions. The POSSAT was, however, designed to measure participants‟ achievement after the implementation of the interventions. The two tests were both made up of Multiple Choice Test items consisting of ten (10) questions covering the content of the human circulatory system. Each of the multiple-choice items in the PRESSAT and POSSAT has a stem about an aspect of the concept of the human circulatory system followed by four options or alternatives. The options comprised one correct answer and three plausible distracters. Each correct answer circled or chosen was awarded one mark, resulting in a total score of 10 marks. Preceding the test items of each test instrument was a portion that briefly stated the purpose of the test and also asked participants to provide personal data, such as age

and gender. This portion also contained instructions to answer the items. Questionnaires were also administered to participants of the study. The questionnaire was used to elicit information on participants‟ perceptions of the use of teaching strategy based on a multiple-intelligence approach.

3.6 Validity and Reliability of the Instruments

The instrument's validity and reliability were evaluated before 1t was used to establish its accuracy and consistency. Cresswell (2015) asserts that having valid and reliable measures is the aim of good research. If the findings are indeed about what they seem to be about, that is what validity is all about (Hayashi et al., 2019). Validity, according to Treagust et al., (2014), is founded on the idea that a certain tool measures what it claims to. By first giving the identical exam items to thirty Mechanical Engineering Technology students at the same level at the same school, the validity of the test was established. To enable the researcher to remove and change implausible items and responses, the scripts were evaluated and subjected to test item analysis. This made it possible to give the test a fair amount of time. The degree to which assessment results are the same when the same tasks are completed on the same or different occasions or when a different but equivalent task is completed on the same or different occasions is the definition of reliability, according to Dzakadzie (2015). The test-retest approach was used to evaluate the item's reliability to guarantee the consistency of the test results. The test was given once and then again after a week. This guaranteed that the time between the first test and the second test was brief enough to prevent memory loss which could have led to a poor reliability coefficient.

3.7 Data Collection Procedure

The data collection procedure was divided into three phases: pre-intervention phase, intervention phase and post-intervention phase. The PRESSAT was administered to the students of both control and experimental groups as the test to obtain relevant information about the knowledge level of students in both groups before the intervention. Research assistants were employed in the study. They were Integrated Science Teachers in the school used for the study. These teachers were exposed to the aim of the study and were taught how to teach using multiple intelligence approaches. Students of the experimental group were taught „human circulatory system and functions of the heart". Those in the control group, however, were taught using conventional methods. At the end of a three-week experimental teaching period, the POSSAT was administered to students in both the experimental and control groups simultaneously with the help of the research assistants/teachers. The whole data collection procedure took a period of six weeks; one week each for the administration of the PRESSAT and POSSAT, three weeks for the experimental teaching, and one week for the administration of the questionnaire to collect data on students" perception of multiple intelligence teaching approach. Three lessons where taught during the intervention stage. The entire data collection process is summarized in the table below:

Table 3.1: Data Collection Process

Pre-intervention Phase	Familiarization, Visits, Administration of PRESSAT
Intervention Phase	Administration of Interventions, observation
Post-intervention Phase	Administration of Post-Test Instrument – POSSAT, Questionnaires

Summary of the various activities that took place during the intervention process are below:

Table 3.2: Activities Applied In The Intervention Process

Interpersonal Intelligence	All the activities carried out in a group work A group of six where each group has 10 members
Linguistic intelligence	The lesson started with a reading session where members from each group read about the structure of the heart, functions of the parts of the heart and the path of blood through the heart. The linguistic student loves this activity so much.
Musical and linguistic intelligence	Student created a lyric about the parts of the heart and how blood flow through the heart and combined them to form songs of their choice. Some also formed poem and recital it
Body kinaesthetic and logical Mathematics Intelligence	The students had a small investigation to Mathematics intelligence. They measured and compared their resting and heart rate after doing some activities. They used a stop watch to count their heart beats per minutes when at rest, walking and running to have different pulse rate and made a comparison using a graph and symbol
Visual spatial	students observed a diagram of the human heart, drew it, coloured and labelled it
Intrapersonal Intelligence	students were given a self-reflection to get their response to the teaching and learning process in the classroom.

Source: Field Study (2023)

Details of the lesson plan for the teaching and learning is found at appendix J.

3.8 Data Processing and Analysis

The study employed a quantitative and qualitative methods of data analysis. Frequency distribution tables were used to present the data. The statistical package for social sciences (SPSS) and Microsoft data analysis tool pack were used to present descriptive statistics of the data such as mean, standard deviation and standard error. Also, data obtained from participants in both experimental and control groups on the POSSAT were analysed statistically using an independent sample t-test. The difference between the mean scores of both groups on the pre-test-post-test scores was tested at a 0.05 significant level. The independent sample t-test was also used to investigate whether any differences existed between the experimental and control groups‟ mean scores on the POSSAT. This was done to answer the research questions and either reject or fail to reject the null hypotheses formulated for the study. The independent sample t-test was applied.

3.9 Ethical Consideration

The chosen school's principal gave authorization for access to the children there. In this regard, a letter was produced outlining the goals of the study and the reasons why data from the students was required. Following that, consent was given for data to be gathered. Additionally, during the familiarization visits, the researcher described the study's goal to the participants and informed them that any information they provided would be kept anonymous and confidential.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.0 Overview

This chapter presents data gathered in the study. It discusses the results yielded at the pre-intervention, intervention and post-intervention levels of the study.

4.1 Demographic Characteristics of Participants

This section of the study presents the preliminary analysis of the profile of the participants. The biographic data reflects the profile of the participants in terms of their age and gender.

Table 4.9: Biodata of the Participants

	Frequency (Percentage, %)		
	Control	**Experimental**	**Total**
Gender			
Male	35 (53.8)	30 (46.2)	65 (100.0)
Female	25 (45.5)	30 (54.5)	55 (100.0)
Age			
Less than 14years	2 (40)	3 (60)	5 (100.0)
14-17years	39 (47.0)	44 (53.0)	83 (100.0)
18-20years	17 (56.7)	13 (43.3)	30 (100.0)
21 and above	2 (100.0)	0 (0.0)	2 (100.0)

Source: Field Study (2023)

From Table 4.1 above, it can be seen that out of the total participants used for the analysis, 65 were male students whereas 35 (53.8%) were in the control group while 30 (46.2%) were in the experimental group. Also, there were 25 (45.5%) and 30 (54.5%) female students in the control and experimental groups respectively. This gave a total of twenty (55) female students who participated in the study. It can be concluded that more male students participated in the study than female students. It can also be seen that the ages of the students range from below 14 years to above 21 years, and the most frequent age range was those within the age bracket of 14-17

years with a frequency of 39 (47.0%) in the control group and 44 (53.0%) in the experimental group, giving a total of eighty-three students of the total sample under study. This shows that most of the students who participated in this study were adolescents.

4.2 Observation

During the intervention, the observation check list was used to check the students multiple intelligences and it was found out that, three students representing 5% each had intrapersonal intelligence and naturalistic intelligence respectively, nine students representing 15% each had body kinesthetic intelligence, linguistic intelligence, logical mathematics and visual spatial intelligence, six students representing 10% had interpersonal intelligence and twelve students representing 20% had musical intelligence.

The dominant intelligences are musical intelligence, linguistic intelligence, logical mathematics and body kinesthetic intelligence.

Beside the development of Multiple Intelligence, the effectiveness of Multiple Intelligence based learning strategy in this study was also tested upon the improvement of students‟ Science Process Skills during and after the intervention. The Science Process Skills are the unique skills resulted from science lesson. Padilla (1990) stated that students cannot be expected to excel at the skills if they have not experienced or been allowed to practice. Instead students need to be given opportunities to work with these skills in different content areas and contexts. By giving students repetitive exercises to train science process skill, they will be trained and mastered it. However, the Science Process Skills were embedded within the

learning. It was revealed that all the students representing 100% were able to classify, make conclusions, make predictions, ask questions and analyze scientific concepts

4.2 Students Marks at Pre-Test for Control and Experimental Groups

Research Question One: What is the difference in performance between control and experimental groups on the intelligence test scores?

Tables 4.13 and 4.14 were obtained when 10 test items on the human circulatory system named the Pre-test Students‟ Science Achievement Test (PRESSAT) were administered to the control and experimental groups. The data contains the raw scores in class intervals of three, their corresponding frequency and respective percentages.

Table 4.2: Students' Performance at Pre-test in the Human Circulatory System

Group	N	0-4 (%)	5-7 (%)	8-10 (%)	Total (%)
Experimental	60	76.7	18.3	5.0	100
Control	60	66.6	26.7	6.7	100

Source: Field Study (2023)

From Table 4.2 above, the highest marks between the intervals of 8-10 were scored by 6.7 % of control group students, while 5.0 % of the experimental group students scored within the same range. 26.7 % of students in the control group scored marks ranging between 5 and 7, while 18.3 % of experimental students scored within this range. This translates to mean that 26.7 % and 18.3% of the students in control and experimental groups respectively scored marks that could be considered average. The lowest marks ranging from 0 to 4 were scored by 66.6% of students in the control group and 76.7% of students in the experimental group. It could be seen from the results shown above that the majority of students from the control and experimental groups failed the test before the intervention. However, the role of pre-tests in

improving performance is less clear, as Shivaraju, (2017) found that a pre-test did not lead to a measurable increase in learning.

Table 4.10: Students' performance before the intervention

Class Interval	Control Pre-Test	Experimental Pre-Test
Below Average (0-4)	40	46
Average (5-7)	16	11
Above Average (8-10)	4	3
Total	60	60

Source: Field Study 2023

The figure below shows the performance of students from both control and experimental groups who have not yet been exposed to the multiple intelligence approach.

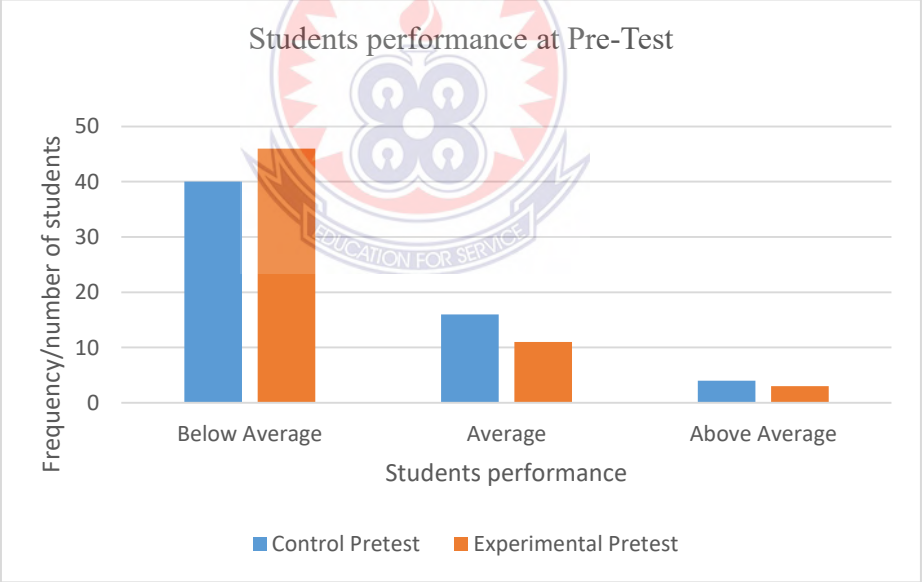

Figure 4.1: Comparison of Students' Performance Before the Intervention

From figure 4.1 above, the highest marks between the intervals of 8-10 were scored by four students of the control group, while three students of the experimental group scored within the same range. 16 students in the control group scored marks between five and seven, while 11 students in the experimental group scored within the same range. The lowest marks ranging from 0 to 4 were scored by forty (40) students in the

control group and forty six (46) students in the experimental group. This translates to mean that 4 and 3 of the students in control and experimental groups respectively scored marks that could be considered above average, 11 and 16 of the students in control and experimental groups respectively scored marks that could be considered average and 40 and 46 of the students in control and experimental groups respectively scored marks that could also be considered as below average. From the results shown above, this means that the majority of students from the control and experimental groups failed the test before administering the intervention. Burrus et al., (2013) found students failed the pre-test because of time management, stress and anxiety, which affect them significantly.

4.3 T-test Analysis of Pre-test

With the administration of the Students' Science Achievement Test (PRESSAT), the researcher was interested in finding out whether students from both groups (control and experimental) had an equal understanding of the human circulatory system before the implementation of the multiple intelligence strategy in teaching the experimental group. Therefore, T-test analysis was performed on the PRESSAT scores to determine whether there is a significant difference

Table 4.11: T-test Analysis of Control and Experimental groups at Pre-test in human circulatory system

Group	N	Mean	S.D	df	t	P-value
Experimental	60	3.68	1.692	59	0.672	0.504
Control	60	3.88	1.851			

Significance at 0.05; p<0.05 Source: Field Study (2023)

Table 4.4 shows some statistical tendencies of the pre-test. Students in the experimental group had a mean with standard deviation (Mean=3.68; SD=1.692).

That of the control group gave a mean and standard deviation (Mean=3.88; SD=1.851). So, the mean score of the test results shows the low knowledge students had of the concept of the human circulatory system before the use of the traditional method of teaching.

The first hypothesis states that there is no statistically significant difference between the academic achievement of students of control and experimental groups on the pre-test. Results from the t-test analysis shown in the table above give a t-value of 0.672 and a P-value of 0.504 at a 95% significance level. Since the P-value (0.504) is greater than the level of significance (0.05), we fail to reject the null hypothesis, implying that there was no significant difference between the control and experimental groups before the implementation of the experiment. Silva and Almeida (2017) collectively suggest that innovative teaching methods can enhance students' understanding of the human circulatory system.

4.4 Findings

It was found out that, there was no significant difference between the control and experimental groups before the implementation of the experiment. This shows that the knowledge level of the students in the concept of the human circulatory system was low before the use of the multiple intelligence approach.

4.5 Students Marks at Post-Test for Control and Experimental Groups

Research Question Two: What is the impact of the multiple intelligence approach on the academic performance of the students?

The test named Post-test Students‟ Science Achievement Test (POSSAT) was administered to the control and experimental groups to ascertain their achievement after the experimental process. It consisted of ten multiple-choice questions and was

based on the content that had been taught. The data contains the raw scores in class intervals of 3 and their corresponding percentages. It was intended to answer the following research question: "What is the impact of the multiple intelligence approach on the academic performance of the students?"

Table 4.12: Students' Performance at Post-test in human circulatory system

Group	N	0-4 (%)	5-7 (%)	8-10 (%)	Total (%)
Experimental	60	10.0	23.3	66.7	100
Control	60	5.0	73.3	21.7	100

Source: Field Study (2023)

In figure 4.2, a comparison of the performance of students who were taught with the traditional method and students who were exposed with multiple intelligence approach is shown below;

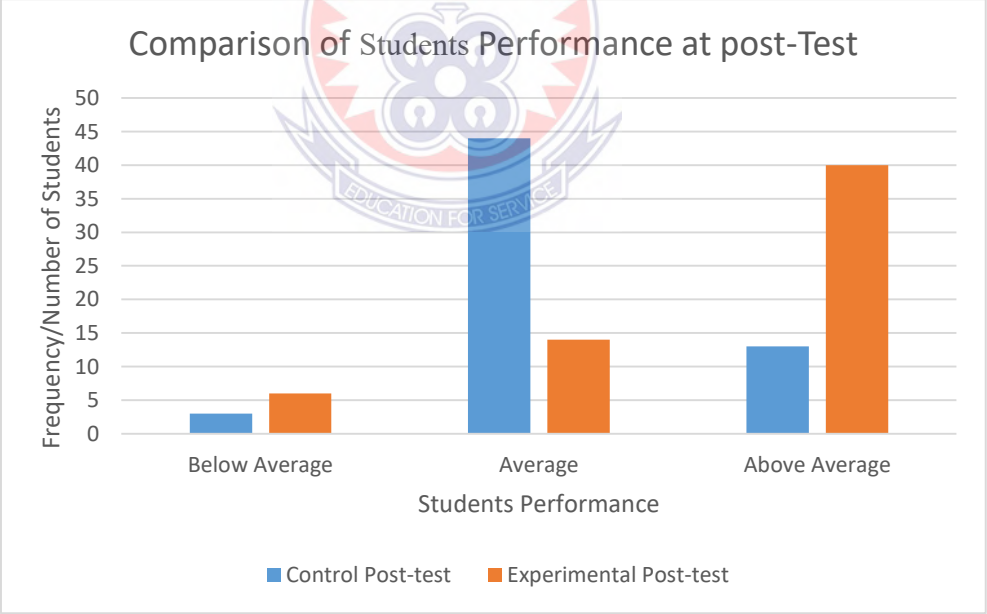

Figure 4.2: Comparison of Students Performance after they have been exposed to the teaching strategy based on multiple intelligence approach

From figure 4.2 above, the highest marks between the intervals of 8-10 were scored by 21.7 % of control group students. 66.7% of the experimental group students scored within the same range. 73.3 % of students in the control group scored marks ranging between

five and five, while 23.3 % of experimental students scored within this range. This in essence means that 73.3 % and 23.3% of the students in the control and experimental groups respectively scored marks that could be considered average. The lowest marks ranging from 0-4 were scored by 5.0% of students in the control group and 10.0% of students in the experimental group. Thus, approximately half of the sample scored average marks while a substantial percentage of students failed. The results observed above clearly indicate that many of the students in the control group failed the test after the use of the traditional method of teaching. Also, the analysis above shows that about 90 % of the students in the experimental group passed the test after the use of the multiple intelligence approach in teaching the concept. This is an indication of the effectiveness of the teaching strategy based on a multiple-intelligence approach. Marwah (2020) provides strong evidence for the effectiveness of the multiple intelligences approach in enhancing students' learning outcomes.

Table 4.13: Performance Of Students At Post-Test

Class Interval	**Control Post-test**	**Experimental Post-test**
Below Average (0-4)	3	6
Average (5-7)	44	14
Above Average (8-10)	13	40
Total	**60**	**60**

Source: field study (2023)

From table 4.6 above, thirteen (13) students of the control group, while forty (40) students of the experimental group scored the highest marks between the intervals of 8-10, which is above average. On average, 44 students in the control group scored marks between five and seven, while 14 students in the experimental group scored marks within the same range. The lowest marks ranging from zero to four which is below average, were scored by three students in the control group and six students in

the experimental group. The results observed above clearly indicate that many of the students in the control group failed the test after the use of the traditional method of teaching. Also, the analysis below shows that about 90 % of the students in the experimental group passed the test after the use of the multiple intelligence approach in teaching the concept. This is an indication of the effectiveness of a teaching strategy based on a multiple-intelligence approach.

4.6 T-test Analysis of Post-test

This was done to determine whether there was a significant difference between the mean scores of the control and experimental groups after they were taught using conventional and multiple intelligence approaches respectively.

Table 4.14: T-test Analysis of Control and Experimental groups at Post-test in human circulatory system

Group	N	Mean	S.D	df	t	P-value
Experimental	60	7.93	1.765	59	-6.032	0.0001
Control	60	6.55	1.141			

Significance at 0.05; p<0.05 Source: Field Study (2023)

The results from the table 4.7 above revealed a mean of 6.55 and the standard deviation was 1.141 for students in the control group. A mean of 7.93 and a standard deviation of 1.765 was obtained for students in the experimental group. This indicates the low knowledge students in the control group Bhad on the concept after the use of the traditional method of teaching. The use of innovative teaching methods, such as the multiple intelligence approach and active learning strategies, has been shown to significantly improve student achievement in various subjects (Kumalasari et al., 2017; Rachmadhani and Ardat, 2019). Similarly, the results show the high knowledge students in the experimental group had gained on the concept upon the use of the

multiple intelligence approach. The control group had a mean score of 6.55, Standard Deviation of 1.141 and Standard Error of 0.147. The above table gives a T-value of -6.032 and a P-value of 0.0001. Since the P-value is less than the level of significance (0.05), we reject the null hypothesis, which states that there is no statistically significant difference between academic achievement in the human circulatory system of students taught by conventional method and those taught using multiple intelligence approach concerning their post-test scores. This implies that there is a significant difference between the control and experimental groups after the implementation of the instructional strategies.

Table 4.15: Pre-Test and Post-Test Performance of Students Of The Experimental Group

Class Interval	**Experimental Pretest**	**Experimental Post-test**
Below Average (0-4)	46	6
Average (5-7)	11	14
Above Average (8-10)	3	40
Total	**60**	**60**

Source: field study (2023)

Figure 4.3 below presents the comparison of performance between students of the experimental group who were not exposed to the intervention and students who were exposed to the multiple intelligence approach.

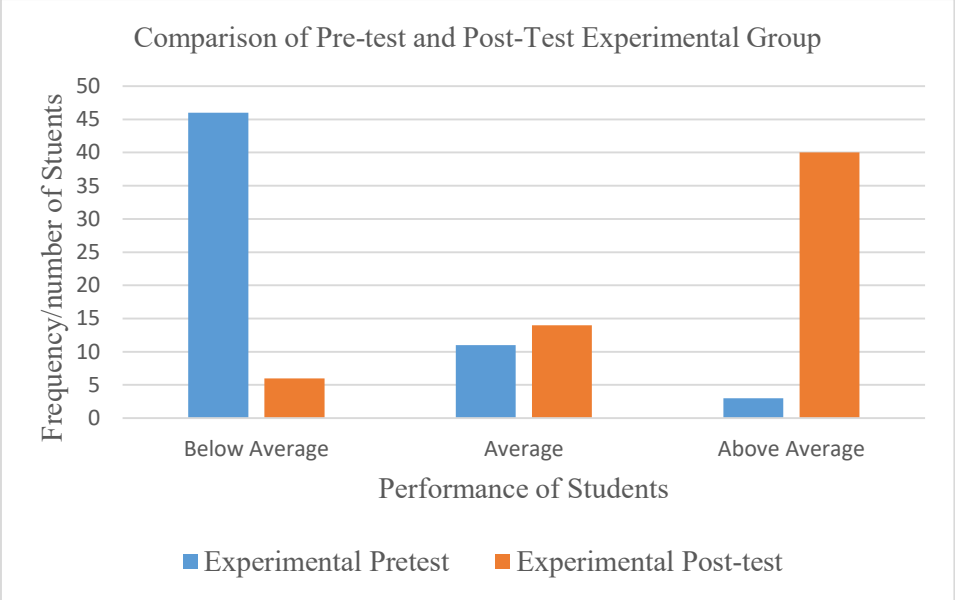

Figure 4.3: Comparison of Pre-test and Post-Test Experimental Group

From the figure above, 46 students who were not exposed to the multiple intelligence approach scored marks between the intervals of zero and four, after the intervention, only six students scored within the same range. Eleven students scored marks between five and seven, before the intervention, while fourteen students scored within the same range after the intervention was administered. Also, only three students were able to score the highest marks between eight and ten because they were not yet exposed to the intervention but after the intervention, forty students were able to score within the same range. This translates to mean that forty six and six of the students before the intervention and after the intervention of the experimental group respectively scored marks that could be considered below average, eleven and fourteen of the students on the pre-test and post-test of the experimental group respectively also scored marks that could be considered as average and finally, three and forty of the students who were not exposed to the multiple intelligence approach and after the exposure to the teaching strategy based on multiple intelligence of the experimental group respectively, scored marks that could also be considered above average. The results above clearly show that the majority of students from the

experimental group failed the test before administering the intervention, while the majority of students in the same experimental group passed the test after the use of the multiple intelligence approach in teaching the concept. This is an indication that the use of a teaching strategy based on a multiple-intelligence approach is effective in enhancing the academic performance of students (Winarti et al., 2019).

4.7 Findings

These findings suggest that the multiple intelligence approach is more effective in improving the students' academic performance.

4.8 Students' Perception of Teaching Strategy Based on Multiple Intelligence

Research Question Three: What are the perceptions of students who have been exposed to multiple intelligence approaches for teaching and learning the human circulatory system?

The following section gathered data regarding students‟ perception of the use of the multiple intelligence approach in teaching the human circulatory system. The data obtained also aided in answering the following research question: "What are the perceptions of students who have been exposed to multiple intelligence approaches in teaching and learning?" See Appendix D for students‟ perceptions.

Table 4.16: Students Perception about the Use of Multiple Intelligence Approach

S/N		RESPONSES			
1.		Very often	often	rarely	never
	Frequency	0.0	11	31	18
	Percentage(%)	0.0	18.3	51.7	30
2.		Engaged and exited	interested and motivated	confused	bored
	Frequency	18	42	0.0	0.0
	Percentage (%)	30	70	0.0	0.0
3.		Yes	No	Somewhat	
	Frequency	60	0.0	0.0	
	Percentage (%)	100	0.0	0.0	
4.		Yes	No	Not sure	
	Frequency	60	0.0	0.0	
	Percentage (%)	100	0.0	0.0	
5.		Yes	No	Neutral	
	Frequency	56	0.0	4.0	
	Percentage (%)	93.3	0.0	6.7	
6.		Yes	No	Not sure	
	Frequency	53	0.0	7.0	
	Percentage (%)	88.3	0.0	11.7	
7.		Encourages teamwork And collaboration	it doesn‟t have significant impact	I prefer to work independently	
	Frequency	55	0.0	5.0	
	Percentage (%)	91.7	0.0	8.3	
8.		Very satisfied	Satisfied	Dissatisfied	Very dissatisfied
	Frequency	36	24	0.0	0.0
	Percentage (%)	60	40	0.0	0.0

Source: field study (2023)

According to the table above, the majority (51.7%) of respondents believe that the multiple intelligence approach is rarely used in the classroom. 70% believe that they become interested and feel motivated when the teacher uses a variety of teaching methods that cater for different intelligences in the classroom. However, all the respondents (100%) believe that the multiple intelligence approach helps them better understand and remember the subject matter. All respondents (100%) agree that the use of multiple intelligence approach has improved their academic performance. Again, 93.3% claimed that the multiple intelligence approach has made their classroom more enjoyable and 88.3% also believe that the multiple intelligence approach has given them a better understanding of their strength and areas for improvement. However, 91.7% of the respondents also believe that the multiple intelligence approach encourages collaboration and teamwork. Furthermore, 60% of the respondents indicated that they are very satisfied with the use of multiple intelligence approaches in the classroom. The majority of respondents believe that the multiple intelligence approach is rarely used in the classroom (Ghaznavi et al., 2021).

4.9 Findings

All the respondents (100%) believe that the multiple intelligence approach helps them better understand and remember the subject matter, they also agree that the use of multiple intelligence approach has improved their academic performance.

CHAPTER FIVE

SUMMARY, FINDINGS AND DISCUSSION

5.0 Overview

This chapter presents a discussion of the findings from the research questions.

5.1 Students' Performance Before Treatment

Research Question One: What is the difference in performance between control and experimental groups on the intelligent test scores?

The pre-test was administered to establish the difference in performance between the control and experimental groups before the intervention. The results obtained from the test indicated the control group had a mean score of 3.88 and the experimental group had a mean score of 3.68. A t-test analysis gave a p-value of 0.504, far greater than the level of significance (0.05), and therefore failed to reject the null hypothesis, which states that there is no statistically significant difference between the academic achievement of students in control and experimental groups on the pre-test. This indicates the magnitude of the students" shortcomings in both groups in understanding the concept.

5.2 Students' Performance After Treatment

Research Question Two: What is the impact of the multiple intelligence approach on the academic performance of the students?

The average score in the control group had a mean score of 6.55, Standard Deviation of 1.141 and Standard Error of 0.147. The average score in the experimental group had a mean of 7.93 and a standard deviation of 1.765 was obtained for students in the experimental group with a standard error of 0.228. The p-value for this outcome was 0.0001. The null hypothesis which states that there is no statistically significant

difference between academic achievement in the human circulatory system of students taught by conventional method and those taught using multiple intelligence approach concerning their post-test scores was rejected because the P-value was less than the level of significance (0.05). The results of Hypothesis Two revealed that there was a significant difference among students‟ achievements in favour of the experimental group against the control group. The results indicated that students exposed to the multiple intelligence approach outperformed those exposed to the conventional teaching methods. This is in agreement with the findings of (Samuel, 2019; AL-Nakhbi & Barza, 2016; Yalmanci & Gozum, 2013; Emendu & Udogu, 2013; Fatokun & Samuel, 2019; Obianuju et al., 2015) who in their separate studies found that the adoption of the Multiple Intelligence instructional strategies greatly improves students‟ achievement. The reason for the improved achievement is that the teacher adopted various instructional approaches that appealed to the students‟ various intelligences, addressing their diverse learning styles and consequently increasing their motivation to learn. Students were given opportunities to actively participate in the class by interacting freely with the teacher and their peers, learning in groups and assessing their performances themselves which improved their verbal-linguistic, logical-mathematical, interpersonal and intrapersonal intelligences, self-esteem, enthusiasm and willingness to take ownership and responsibility for their learning. These in turn lead to a considerable improvement in their cognitive achievement.

5.3 Impact of Teaching Strategy Based on Multiple Intelligence Approach

During the implementation of the interventional strategies, as a researcher, observation of students‟ behaviour during teaching and learning of the topic was paramount in determining the impact of the strategy used as conducting an achievement test to determine the same. Students' class participation, behaviour, and

posture were used as benchmarks for determining their involvement in the lesson, which was considered partly tantamount to the effects of the teaching strategy used.

In the beginning, the initial knowledge levels of both groups were quite similar. However, after the learning process, students in the experimental group showed an improvement in their academic performance. Students were actively engaged in discussions and eager to contribute by asking questions because the approach sparked their curiosity and appealed to their cognitive impressions as well. These engagements increased their level of understanding and contributed to the success of the lesson.

This was observed in the results obtained in the experimental group after conducting a post-intervention test. The test revealed that the students' performance improved significantly after the intervention strategies. When a student's interest, understanding, and retention abilities improve (Gilakjani, 2012), there is a propensity for academic accomplishment and attitude to improve. This is consistent with Kareem's (2018) observation that using PowerPoint presentations to teach science increases students' attitudes toward science. In contrast, for the control group students, only a little improvement in their academic performance. This difference is caused by different students‟ activities in both groups. In the experimental group, the learning activities were designed to always involve MI as suggested by Abdi & Rostami, (2012) and Louisiana et al., (2020). For instance, at the stage of concept introduction teacher used the real thing to stimulate the Visual spatial intelligence of students. The teacher also used small group techniques to enable interpersonal, kinesthetic and linguistic intelligence. For core activities, students did various activities involving MI such as telling daily activities, formulating questions, writing personal experiences related to the subject matter, writing poems and songs related to the subject matter, as well as doing mini research on the school grounds. In contrast, the control group used

common methods such as lectures, discussions, and demonstrations. At the beginning of the lesson, the teacher asked questions about previous lessons. While in the core activities, students observed the teacher‟s demonstration before discussing, doing worksheets and presenting. Activities done by the students did not cover the eight aspects of MI, as in the experimental group.

The higher percentage increase of the experimental group compared to the control group as indicated by the post-test score between both groups is in tandem with the results of research by Azid and Md-Ali, (2020), Hanafin (2014), Winarti et al. (2019), Widiana and Jampel (2016), and Sánchez-Martín et al. (2017). According to them, the implementation of an MI-based learning strategy will improve several types of intelligence which will in turn improve students‟ academic performance. Besides, the implementation of an MI-based learning strategy will also enhance students‟ emotional and creative thinking abilities.

The enhancement of the academic performance of students in the experimental group is due to repetitive multiple intelligence-based learning activities. The finding concurred with earlier studies conducted by Chuang et al. (2010), Eberle (2011), Nurulwahida & Azman (2014), and Thambu et al. (2021). Thambu et al. (2021) suggested that MI favoured the students with treatment. The students in the treatment group improved on each multiple intelligence profile compared with students in the control group. Therefore, Thambu et al. (2021) recommended that any enrichment activities conducted to enhance teaching and learning should include the MI concept. Knowing the level and type of student intelligence will help the teacher to determine whether the student can follow the lesson, identify the best way for each student, and predict the success or failure of the student after the lesson (Amponsah et al., 2021).

5.4 Students' Perception of Teaching Strategy Based on Multiple Intelligence Approach

Research Question Three: What are the perceptions of students who have been exposed to multiple intelligence approaches for teaching and learning the human circulatory system?

According to the analysis of results on students' perceptions, students had more positive perceptions of the instruction in general. This suggests that after being exposed to new strategy-based teaching, students' attitudes toward instruction improve Research on students' perceptions after being exposed to the multiple intelligence approach in education has shown generally positive outcomes. It has increased students' engagement and motivation. According to (Lazarev et al., 2017), students tend to report higher levels of engagement and motivation when they are taught using the multiple intelligence approach. Students often report feeling more confident and capable when they can demonstrate their understanding through their preferred intelligence(s). This has led to a more positive self-perception and a stronger belief in their abilities. They find the diverse range of activities and teaching methods more interesting and enjoyable compared to traditional instruction. Armstrong in his work found out that, students often develop more positive attitudes towards learning when they experience a teaching approach that aligns with their strengths and preferences. This has led to increased self-efficacy and a greater belief in their ability to succeed academically (Valeriu, 2015). Studies have shown that students tend to have a deeper and more lasting understanding of the material when it is presented using a variety of intelligences. This can result in better retention of knowledge over time (Ghaznavi et al., 2021).

It's important to note that while the multiple intelligence approach has garnered positive feedback from many students, individual responses may vary. Some students may still prefer more traditional methods, and educators must strike a balance between different teaching approaches to cater for diverse learning styles and preferences. Additionally, ongoing research in this field may yield further insights into the effectiveness and impact of the multiple intelligence approach on student perceptions and learning outcomes.

Scholarly research suggests that the multiple intelligence approach can lead to increased engagement, motivation, and understanding among students. It recognizes individual strengths and offers a more diverse range of teaching methods, potentially leading to a more inclusive and effective learning experience. However, it's important to note that both methods have their merits, and a balanced approach that incorporates elements of both can be beneficial for accommodating a wide range of learners.

CHAPTER SIX

SUMMARY, CONCLUSION, RECOMMENDATION AND SUGGESTION

6.0 Overview

This chapter deals with a summary of this research work, the conclusion, recommendations proposed by the researcher and suggestions for further studies.

6.1 Summary of findings

An Action Research design was espoused for this study. The main objective of the study was to assess the impact of teaching strategy based on multiple intelligence approach on students‟ achievement in science. A sample of 120 students was taken; 60 students each in the experimental and control groups. The instruments used for the study were the Pre-test Students‟ Science Achievement Test (PRESSAT) and Post-test Students‟ Science Achievement Test (POSSAT). The Multiple Intelligence Inventory Observation Checklist developed by Davis et al., (2011), Castil, (2016), and Ridwan, (2016) were used to collect the data on students‟ Multiple Intelligences. The PRESSAT was used to assess the participants‟ knowledge and difficulty with the concept of the „Human Circulatory System‟ to have a baseline about all participants before the implementation of the interventions. During the intervention measure, the students in the experimental group were taken through activities based on a multiple intelligence approach while those in the control group were taken through traditional teaching. A post-intervention test (POSSAT) was conducted to measure and compare the level of improvement in students‟ performance in both groups after the intervention strategy had been implemented. SPSS and the Microsoft data analysis tool pack were used to present descriptive statistics of the data such as mean, standa rd deviation, and standard error. Also, an inferential statistical tool (t-test) was

employed to summarize the overall trends in the students′ performance in both control and experimental groups and test the hypotheses.

Students‟ performance was below average in both experimental and control groups before the intervention strategies were implemented. Post-test results from the control group who were taught with the traditional method of teaching indicated that only 21.7% performed above average while a substantial percentage of students failed. In the experimental group, the multiple intelligence strategy aroused students‟ interest and sustained their attention throughout the teaching and learning process. This increased their level of understanding and, therefore, increased their performance in the post-intervention test. About 90% of the students in the experimental group passed the test, with about 66.7% of them performing above average and the remaining 33.3 with average performance. It was therefore noted that when multiple intelligence instructional methods supplant the traditional method of teaching together with the use of appropriate teaching and learning materials in the teaching of science, better results are achieved.

6.2 Conclusion

The goal of the research was to see how teaching strategies based on multiple intelligence approaches affected students' performance in science. According to the findings of the studies, the multiple intelligence approach improves students' academic progress. The findings also demonstrated that this instructional strategy was effective for the high-performance levels of the students who used it. This study results important findings of the feasibility of MI-based learning strategy applied in science lessons

Based on the findings obtained in the study, it can be said that there is a significant difference between the achievement levels of the students who have been educated by teaching Strategy based on Multiple Intelligences and the students who have been educated by the traditional teaching methods. The students who have been educated by Strategy based on Multiple Intelligences have become more successful than the students who have been educated by the traditional teaching methods. The result of the present study are in line with other researchers such as Harriman (2010), Baş, (2010), Abdi et al., (2013), Ruiz & Edunice, (2015), Dolati, (2016), Ünsal & Fen, (2012), Doblon, (2023), Batdı, (2017). When students are offered a variety of learning experiences they become actively engaged and invested in their learning process. Furthermore, students will participate more frequently and retain more knowledge because they understand the material in a more complex way (Mulongo, 2013). Rodin et al., (2013) parallels this idea saying: "Intrinsic motivation, positive self-image, and a sense of responsibility develop when student become stakeholders in the educational process and accept responsibility for their actions" (p. 72). When students understand and apply their intelligence, they become more connected to their learning and invested in their education. Multiple Intelligence-based instruction helps educators engage students through their natural curiosity, monopolize teachable moments, and increase student participation through their excitement. Adarlo et al., (2022) quoted according to Goodnough that "if students become engaged in the learning of science and develop positive attitudes toward science, there is a greater probability that they will develop high levels of scientific literacy".

6.3 Recommendation

From the findings and conclusion of the study, the following recommendations are made:

1. It is recommended that science teachers of the school and educators encourage the adoption of the multiple intelligence strategy in science education because the approach holds more potential in terms of student achievement in science.
2. Educators on a global level should be exposed to literature documenting the incredible effects of multiple intelligence and inspired to utilize this innovative instruction in their classrooms
3. Again, science educators of the district should use learning methods that involve students in the teaching and learning process rather than simply giving them data that may or may not be useful.
4. Circuit supervisors of the district should encourage science teachers to incorporate multiple intelligence strategies into their classroom instructions to improve student's performance in science.
5. Furthermore, teachers should be educated in ways to infuse their curriculum with a multiple-intelligence framework to help create more authentic, engaging learning experiences for students in the classroom.
6. Ministries of Education should collaborate with various academic stakeholders to develop a platform, such as workshops and seminars, to successfully impart teachers' required competencies such as the use of multiple intelligence strategies in the classroom.

6.4 Suggestion for Further Researchers

It is urged that this study be replicated in different settings to substantiate the functionality and effectiveness of the intervention strategies applied.

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APPENDICES

Appendix A

Pre-Test Students Science Achievements Tests (PRESSAT)

Age…….. **Class……..……** **Sex. M [ ] F. [ ]**

CIRCLE THE CORRECT ANSWER **Time: 15 minutes**

1): Which of the following is carried by the heart to all organs of the body through arteries, capillaries and arterioles?

a) Cytoplasm b) Blood c) Bone marrow d) fluid

2): The heart is located in the …….. cavity.

a) Thoracic cavity b) Abdominal cavity c) Pelvic region d) Head cavity

3): The largest artery that carries blood to all parts of the body is called…….

a.) vena cava b). aorta c.) lungs d.) heart

4):…… is the innermost layer of the heart and it is smooth thin lining to reduce friction of blood flow through the chambers.

a) Pericardium b) Endocardium c) Neurocardium d) Mayocardium

5): The right atrium receives deoxygenated blood from the body through …….

a) Pulmonary vein b) Superior vena cava c) Lungs d) All of them

6): Which of the following atrium receives oxygenated blood from the lungs through pulmonary vein? a) Left atrium b) Right atrium c) Right ventricle d) None of them

7): ……. Valve controls the opening between right atrium and ventricle.

a) Mitral valve b) Left atrium c) Tricuspid valve d) Left ventricular

8): The SA node of the heart is also called as …….

a) Nerve maker b) Cardiac node c) Pace maker d) Sinus node

9): To which of the following organs do the pulmonary arteries supply blood?

a) Brain b) Lungs c) Liver d) Kidney

10): The rate of heart that conducts electrical impulses is called as ……..

a) Cardiac conduction b) Cardiovascular system c) Coronary circulation

d) Bundle branches

ANSWERS

1. B
2. A
3. B
4. B
5. B
6. A
7. C
8. D
9. B
10. A

Appendix B

Post-Test Students Science Achievements Tests (POSSAT)

Age…….. **Class……..……** **Sex. M [ ] F. [ ]**

CIRCLE THE CORRECT ANSWER **Time: 15 minutes**

1): Which of the following is carried by the heart to all organs of the body through arteries, capillaries and arterioles?

a) Cytoplasm b) Blood c) Bone marrow d) fluid

2): The heart is located in the …….. cavity.

a) Thoracic cavity b) Abdominal cavity c) Pelvic region d) Head cavity

3): The largest artery that carries blood to all parts of the body is called…….

a.) vena cava b). aorta c.) lungs d.) heart

4):…… is the innermost layer of the heart and it is smooth thin lining to reduce friction of blood flow through the chambers.

a) Pericardium b) Endocardium c) Neurocardium d) Mayocardium

5): The right atrium receives deoxygenated blood from the body through …….

a) Pulmonary vein b) Superior vena cava c) Lungs d) All of them

6): Which of the following atrium receives oxygenated blood from the lungs through pulmonary vein? a) Left atrium b) Right atrium c) Right ventricle d) None of them

7): ……. Valve controls the opening between right atrium and ventricle.

a) Mitral valve b) Left atrium c) Tricuspid valve d) Left ventricular

8): The SA node of the heart is also called as …….

a) Nerve maker b) Cardiac node c) Pace maker d) Sinus node

9): To which of the following organs do the pulmonary arteries supply blood?

a) Brain b) Lungs c) Liver d) Kidney

10): The rate of heart that conducts electrical impulses is called as ……..

a) Cardiac conduction b) Cardiovascular system c) Coronary circulation

d) Bundle branches

ANSWERS

1. B
2. A
3. B
4. B
5. B
6. A
7. C
8. D
9. B
10. A

Appendix C

MULTIPLE INTELLIGENCE INVENTORY OBSERVATION CHECKLIST

Using the scale below, give each statement a number that best represents your response.

1—Completely disagree 2—Disagree 3—Agree 4—Completely Agree

Add the total for each category and then identify your top five intelligences.

School…….. Age……. Sex M [ ] F [ ]

VERBAL/LINGUISTIC INTELLIGENCE	
1. I like puns and other wordplay.	
2. I feel comfortable and get positive reinforcement when dealing with language and words.	
3. I enjoy completing crosswords and other word games	
4. I remember things exactly as they are said to me.	
5. I like to take part in debates and/or discussions	
6. I prefer writing long- and short-answer responses rather than multiple choice responses.	
7. I enjoy keeping a written journal, and/or writing stories and articles.	
8. I like to read a lot	
MY VERBAL/LINGUISTIC TOTAL	
LOGICAL/MATHEMATICAL INTELLIGENCE	
1. I work best in an organized work area.	
2. I enjoy math and/or science.	
3. I keep a “things to do” list.	
4. I enjoy playing brainteasers and games that involve logical thinking.	
5. I like to ask “why” questions and seek clarification of issues and concerns.	
6. I work best when I have a day planner or timetable.	
7. I quickly grasp cause-and-effect relationships.	
8. I am good at estimating.	

MY LOGICAL/MATHEMATICAL TOTAL	
VISUAL/SPATIAL INTELLIGENCE	
1. I understand colour combinations and what colours work well together.	
2. I enjoy solving jigsaw, maze, and/or other visual puzzles.	
3. I read charts and maps easily.	
4. I have a good sense of direction.	
5. I like to watch the scenes and activities in movies.	
6. I have vivid dreams when sleeping.	
7. I can anticipate the moves and consequences in a game plan (i.e., hockey sense, chess sense).	
8. I remember things best by seeing them.	
MY VISUAL/SPATIAL TOTAL	
INTERPERSONAL INTELLIGENCE	
1. I work best through interaction with people.	
2. I enjoy team sports rather than individual sports.	
3. Being around people energizes me.	
4. I prefer group activities rather than ones I do alone.	
5. I enjoy learning about different cultures	
6. I usually talk over my personal problems with a friend.	
7. I enjoy sharing my ideas and feelings with others	
8. I work best in cooperative groups where I can discuss issues with others.	
MY INTERPERSONAL INTELLIGENCE TOTAL	
INTRAPERSONAL INTELLIGENCE.	
1. I am a private person, and I like my private inner world.	
2. I have a few close friends.	
3. I have strong opinions about controversial issues.	
4. I work best when activity is self-paced.	
5. I am not easily influenced by other people.	
6. I have a good understanding of my feelings and how I will react to situations	
7. I often raise questions concerning values and beliefs.	
8. I understand that I am responsible for my own behaviour.	

MY INTRAPERSONAL INTELLIGENCE TOTAL	
BODY/KINESTHETIC INTELIGENCE	
1. I like to move, tap, or fidget when sitting.	
2. I participate in extreme sports (i.e., sea kayaking, snowboarding, mountain biking).	
3. I am curious as to how things feel and I tend to touch objects to examine the texture.	
4. I am well coordinated.	
5. I like working with my hands.	
6. I prefer to be physically involved rather than sitting and watching.	
7. I understand best by doing (touching, moving, and interacting).	
8. I enjoy creating things with my hands.	
MY BODY/KINESTHETIC TOTAL	
MUSICAL INTELLIGENCE	
1. I play music in my head.	
2. I make up a rhyme to remember something.	
3. It is easy for me to follow the beat of music.	
4. I like setting songs and poems to music.	
5. I keep time when music is playing.	
6. I can hear an off-key note.	
7. I find it easy to engage in musical activities.	
8. I feel proud of my musical accomplishments.	
MY MUSICAL INTELLIGENCE TOTAL	
NATURALISTIC INTELLIGENCE	
1. I have a collection (i.e., shells, mugs, rocks, hockey cards).	
2. I notice similarities and differences in trees, flowers, and other things in nature.	
3. I am actively involved in protecting the environment.	
4. I enjoy digging for and discovering artifacts and unusual items.	
5. I prefer to be outdoors rather than indoors	
6. I like planting and caring for a garden.	
7. I enjoy fishing and tracking.	
8. I learn best when I can go on field trips to explore and observe nature exhibits, museums, or the outdoors.	
MY NATURALISTIC TOTAL	

My Top Five Multiple Intelligences

1. _____
2. _____
3. _____
4. _____
5. _____

APPENDIX D

QUESTIONNAIRE

Student Perception on Multiple Intelligence Approach in the Classroom

Dear Student,

This questionnaire is designed to obtain information for the purpose of thesis writing at the University of Education, Winneba. The information you will provide will be treated as confidential and your anonymity is highly assured.

NOTE: This survey aims to gather your thoughts and opinions regarding the application of the Multiple Intelligence approach in your classroom. Your feedback is valuable and will help us understand how this approach impacts your learning experience. The information provided will be strictly used only for this study. Please answer the following questions honestly and to the best of your ability.

Class…….. Year…….. Age…… Gender: M [ ] F [ ]

a. In your opinion, how often is the Multiple Intelligence approach used in your classroom? a. Very Often b. Often c. Rarely c. Never

1. How do you feel when your teacher uses a variety of teaching methods that cater for different intelligences in the classroom?

   a. Engaged and excited b. Interested and motivated

   c. Confused or unsure d. Uninterested or bored

2. Do you think that the Multiple Intelligence approach helps you better understand and remember the subject matter? a. Yes b. No

   c. Somewhat

3. Have you noticed any improvements in your learning experience or academic performance since the application of the Multiple Intelligence approach?

   a. Yes b. No c. Not sure

4. Has the application of the Multiple Intelligence approach made your classroom experience more enjoyable? a. Yes b. No c. Neutral
5. Do you believe that the use of the Multiple Intelligence approach has given you a better understanding of your own strengths and areas for improvement?
   a. Yes b. No c. Unsure
6. How does the application of Multiple Intelligence approach affect your interaction with your classmates? a. It encourages collaboration and teamwork
   b. It doesn't have a significant impact c. I prefer to work independently
7. Overall, how satisfied are you with the application of the Multiple Intelligence approach in your classroom? a. Very Satisfied b. Satisfied
   c. Dissatisfied d. Very Dissatisfied

APPENDIX E

Raw Scores for Experimental and Control Groups During Pre-Test and Post-test

PRETEST		POSTTEST	
Control	**Experimental**	**Control**	**Experimental**
1	3	7	9
5	3	6	8
4	4	7	7
4	4	5	9
5	5	8	8
8	4	6	9
5	3	7	10
5	3	6	7
3	3	6	7
0	3	4	7
5	2	8	8
8	3	9	9
4	3	7	8
6	8	6	9
3	6	5	7
4	6	5	7
1	8	5	10
5	3	7	8
4	5	8	9
8	8	9	10
3	7	7	10
4	4	7	7
5	3	6	4
4	1	6	4
5	4	8	9
3	5	6	9
3	4	8	8
6	3	6	7
0	1	4	4
1	6	8	8
3	3	7	4
5	5	7	9
3	3	7	10
5	4	6	8
3	3	6	10
3	2	6	6
6	4	6	5
2	5	7	6
4	4	6	10
3	1	7	10
5	4	6	9
4	1	8	8

4	2	6	9
4	2	7	9
6	5	7	8
2	3	6	10
6	3	6	7
2	1	6	10
4	4	8	9
4	6	7	10
1	4	6	4
4	1	6	9
4	2	8	7
4	3	8	9
8	4	8	8
3	4	7	7
1	2	4	4
2	4	6	8
2	3	6	8
4	4	5	9

APPENDIX F

Summary Statistics for Pre-test Analysis

	Control	Experimental
Mean	3.88	3.68
Standard Error	0.239	0.218
Standard Deviation	1.851	1.692

APPENDIX G

Summary Statistics for Post-test Analysis

	Control	Experimental
Mean	6.55	7.93
Standard Error	0.147	0.228
Standard Deviation	1.141	1.765

APPENDIX H

Summary Statistics of Paired Sample T-test

	Control pre-test – control post-test	Experimental pre-test – experimental post-test
t	-12.193	-15.705
Df	59	59
P-Value	0.0001	0.0001
	Paired difference	
Mean	-2.667	-4.250
Standard Deviation	1.694	2.096
Standard Error Mean	0.219	0. .271

APPENDIX I

Summary of Independent Sample T-test

	Control pre-test – Experimental pre-test	Control post-test – experimental post-test
t	0.672	-6.032
Df	59	59
P-Value	0.504	0.0001
	Paired difference	
Mean	0.200	-1.383
Standard Deviation	2.305	1.776
Standard Error Mean	0.298	0.229

APPENDIX J

The lesson plans for the teaching and learning process

LESSON ONE

Week ending: 04/08/2023	**Duration:** 120 minutes	**Subject**: Integrated Science
Day: Wednesday 02/08/2023	**Class:** SHS 2	**Topic**: The Circulatory System
Time: 9:15-11:15	**Class size**: 60	**Sub-topic**: Structure and functions of the circulatory system of humans
Reference: Kusi-Aidoo, P. A. (2019). *Integrated Science Revision Guide for Senior High Schools, Supporting Free SHS*. Kumasi: Elite Publishing Company. Ministry of Education (2010). *Teaching Syllabus for Integrated Science (Senior High School).* Accra. Oddoye, E. O., Taale, K. D., Ngman-Wara, E., Samlafo, V., & Ofori, D. O. (2011). *Integrated Science for Senior High Schools, Student's Book*.		

Objectives/RPK	Teacher Learner Activity	Teacher Learner Resources	Core Points	Evaluation/ Remarks
Objectives By the end of the lesson, the student will be able to;	**Introduction:** Review students‟ RPK by questions and answers **Teacher:** What have you heard about the circulatory system? **Student 1:** it includes the heart, blood vessels, and blood. **Student 2:** The heart pumps blood, and the blood vessels carry it all around our body	Whiteboard, markers,		

I. define blood circulation	**Student3:** there are different types of blood vessels: arteries, veins, and capillaries. With the help of a marker students responses are written on the white board **ACTIVITIES** **1.** Put students into groups of ten, each group has six members. 2. Guide students to brainstorms and come out with the meaning of blood circulation. 3. Provides a rich array of learning resources (articles, books, videos) for each group to explore blood circulation at their own pace.	laptop, projector, textbooks, video of blood circulation chart on the human heart,	**Blood circulation** It is the continuous movement or flow of blood within the system of a mammal involving the heart (pump) and the blood vessels (route). The system consist of Heart, Blood and Blood vessels (veins, arteries, capillaries). **Importance of blood circulation** 1. Transportation of Nutrients and Oxygen to body cells 2. Removal of Waste Products from the body 3. Regulation of Body Temperature.	1. Define the term blood circulation 2. Explain four importance of blood circulation to the human body.

Ii. explain the importance of blood circulation **RPK** Students have basic knowledge about the circulatory system	4. Allow students to select a resource of their choice and circulate around the classroom to offer guidance and support as needed. 5. Introduce creative avenues (report writing, presentation, forming of poem, recitals, songs etc) for students to express their understanding of the importance of blood circulation. 6. Observe students' progress informally, assessing their grasp of blood circulation. 7. Teacher conducts a whole-class discussion where each group presents their final projects, answer questions, and receive feedback. **Closure** Teacher ends the lesson by summarizing the core points, reinforcing the key takeaways and assigns students with exercise		4. The circulatory system transports substances like bicarbonate ions and electrolytes to regulate pH and electrolyte balance throughout the body. 5. Blood circulation is critical for wound healing and tissue repair processes. **Application** Students can apply their understanding of blood circulation to various situations, such as understanding the importance of exercise and the need to eat balanced diet to keep their circulatory system healthy.	**Remarks** Lesson was successfully taught

LESSON TWO

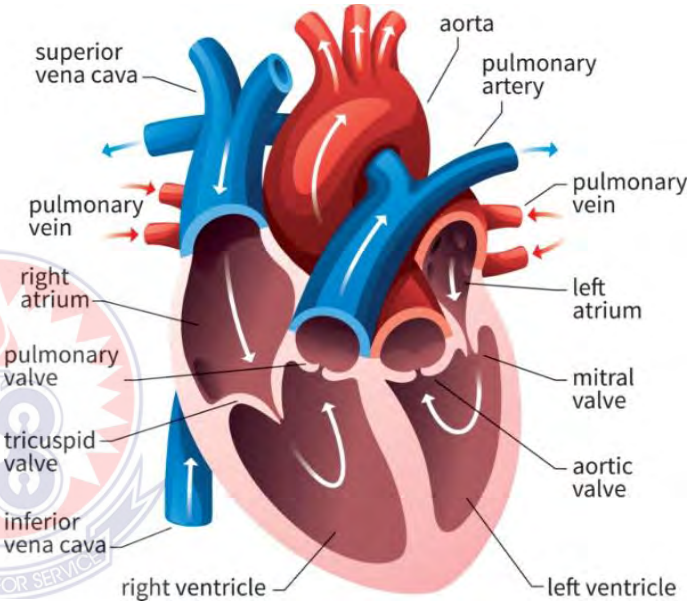
Week ending: 11/08/2023	**Duration:** 120 minutes	**Subject**: Integrated Science
Day: Wednesday 09/08/2023	**Class:** SHS 2	**Topic**: The Circulatory System
Time: 9:15-11:15	**Class size**: 60	**Sub-topic**: Structure and functions of the parts of the heart

Reference: Kusi-Aidoo, P. A. (2019). *Integrated Science Revision Guide for Senior High Schools, Supporting Free SHS*. Kumasi: Elite Publishing Company. Ministry of Education (2010). *Teaching Syllabus for Integrated Science (Senior High School).* Accra.

Oddoye, E. O., Taale, K. D., Ngman-Wara, E., Samlafo, V., & Ofori, D. O. (2011). *Integrated Science for Senior High Schools, Student's Book*.

Objectives/RPK	Teacher Learner Activity	Teacher Learner Resources	Core Points	Evaluation/ Remarks
Objectives By the end of the lesson, the student will be able to;	**Introduction:** Review students‟ RPK by questions and answers **Teacher:** explain why the circulatory system is important? **Student 1:** it Transports nutrients and oxygen to body cells **Student 2:** Removes of Waste Products from the body **Student3:** Regulates Body	Whiteboard, markers,		

I. draw and label the parts of the mammalian heart correctly	Temperature **Student 4:** Blood circulation helps in wound healing. **ACTIVITIES** **1.** Divide the class into small groups and assign each group to a station based on a different intelligence: **2.** Provides a rich array of learning resources (articles, textbooks, videos and pictures of the structure of the heart,) for students to explore at their own pace about the heart's structure and write a summary about it.	laptop, projector, textbooks, articles,	**The mammalian heart** The heart is a hollow muscular organ which pumps blood around the circulatory system, to enhance the transfer of materials to all parts of the body. The heart lies in the chest or thoracic cavity (to the left side) between the two lungs, surrounded by a thin membrane called **pericardium.** It is protected by the muscles of chest walls, the ribs, the sternum and the diaphragm. The walls of the heart are made of special muscles called **cardiac muscles**. The longitudinal section of the heart reveals four muscular chambers namely; **right atrium, left atrium, right ventricle and left ventricle** The wall which divides the heart into two equal parts is called **septum (cardiovascular wall).** Separating the left atrium (auricle) and left ventricle is **bicuspid valve**. On the other hand; the **tricuspid valve** separates the right atrium (auricle) and the right ventricle.	1.. write the functions of the following parts of the heart. i. aorta ii. vena cava iii. pulmonary artery iv. bicuspid valve v. right ventricle

Ii. State the functions of the parts of the mammalian heart	**3.** Provide each student with drawing paper, coloured pencils etc. **4.** Guide students to draw a diagram of the human heart and label its different parts using the materials giving. **5.** Circulate around the classroom to provide assistance and ensure that each group accurately represents the heart's structure. **6.** Through discussion, students use lyrics, etc. to form songs about the functions of the various parts of the heart with their peers. **7.** Assist students to use stop clock to measure the rate of their heart beat when at rest and	video of anatomy of the heart, chart on the human heart, coloured pencils, drawing sheets, stop clock	**Structure of the mammalian heart**  **Parts of the Heart and their functions** **Aorta:** This is the largest artery that carries oxygenated blood from the heart to all parts of the body. **Vena Cava:** This is the largest vein that carries deoxygenated blood from the whole body to the heart. **Pulmonary Vein:** Transports oxygenated blood from	

	when they do a little exercise **8.** Allow students to present their diagrams to the class, explaining each labelled part and its function. **9.** Encourage questions and discussions among peers. **10.** Reflecting on personal experiences related to heart health and writing a journal entry. 11. Rotate the groups through each station, ensuring that every student engages with different activities. **Closure** Teacher ends the lesson by summarizing the core points, reinforcing the key takeaways and assigns students with exercise.		the lungs to the heart. **Pulmonary Artery:** Transports deoxygenated blood from the heart to the lungs. **Right Atrium (Auricles):** Relaxes and expands to receive blood from the vena cava. Contracts to pump blood under pressure into the right ventricle. **Right Ventricles:** Relaxes and expand, to receive blood from the right atrium (auricles). It contracts and pumps the blood under pressure in the lungs through the pulmonary artery to be oxygenated. **Left Atrium (Auricle):** Relaxes and expands to receive oxygenated blood from the lungs through the pulmonary vein. **Left Ventricle:** Relaxes and expands to receive blood from the left atrium (auricle). It contacts to pump oxygenated blood under pressure to all parts of the body through the aorta (main artery). **Bicuspid Valve:** Prevents the back flow of blood from the left ventricle into the left atrium (auricle). **Tricuspid Valve:** Prevents back flow of blood from the ventricle to right atrium. **Application** Students can apply their understanding of blood circulation to various situations, such as understanding the importance of exercise and the need to eat balanced diet to keep their circulatory system healthy.	
RPK Students have knowledge about the importance of the circulatory system.				**Remarks** Lesson was successfully taught

LESSON THREE

Week ending: 25/08/2023	**Duration:** 120 minutes	**Subject**: Integrated Science
Day: Wednesday 23/08/2023	**Class:** SHS 2	**Topic**: The Circulatory System
Time: 9:15-11:15	**Class size**: 60	**Sub-topic**: composition and functions of blood

Reference: Kusi-Aidoo, P. A. (2019). *Integrated Science Revision Guide for Senior High Schools, Supporting Free SHS*. Kumasi: Elite Publishing Company. Ministry of Education (2010). *Teaching Syllabus for Integrated Science (Senior High School).* Accra.

Oddoye, E. O., Taale, K. D., Ngman-Wara, E., Samlafo, V., & Ofori, D. O. (2011). *Integrated Science for Senior High Schools, Student's Book.*

Objectives/RPK	Teacher Learner Activity	Teacher Learner Resources	Core Points	Evaluation/ Remarks
Objectives By the end of the lesson, the student will be able to;	**Introduction:** Review students‟ RPK by questions and answers. **Teacher:** what is the function of the following parts of the heart. Vena cava, aorta, pulmonary artery? **Student 1: Aorta:** it is the largest artery that carries oxygenated blood from the heart to all parts of the body. **Student 2: Vena Cava:** it is the largest vein that carries deoxygenated blood from the whole body to the heart. **Student3: Pulmonary Artery:** Transports deoxygenated blood from	Whiteboard, markers,		

I. explain the composition and functions of blood Ii. Explain two types of blood circulation	the heart to the lungs. With the help of a marker students responses are written on the white board **ACTIVITIES** **8.** Put students into small groups. 9. Provides a rich array of learning resources (articles, books,) for each group to explore the components of blood at their own pace. 10. Circulate around the classroom to offer guidance and support as needed. 11. Introduce creative avenues (report writing, presentation, forming of poem, recitals, songs etc) for students to express their understanding of functions of blood and the two types of blood circulation.	laptop, projector, textbooks, video of blood circulation through the heart, laptop, projector, textbooks	**The Blood** The blood consists mainly of liquid called plasma and three kinds of solid particles known as blood cells. **Composition of blood** 1.Blood plasma 2.Red blood cells (erythrocytes) 3.White blood cells (leucocytes) 4.Blood platelets (thrombocytes) **<u>Functions of blood</u>** 1. In respiration, (a) the blood carries oxygen from the lungs to all tissues; (b) carbon dioxide is also carried from the tissues to lungs. 2. In excretion, waste products like urea and CO2 are carried from the tissues to the kidneys. 3. In nutrition, digested foods like glucose, amino acids are carried from	1. State five functions of blood.

	12. Guide students to use lyrics to form songs and poems about how blood circulates in the heart. 13. Guide students to measure their heart pulse using a stop clock before and after doing a small exercise and compare their heart rates. 14. Observe students' progress informally, assessing their understanding in the process. 15. Conduct a whole-class discussion where each group presents their final projects,	laptop, projector, textbooks stop clock	the small intestine to the tissues to be used or stored. 4. The blood circulate white cells, which can destroy invading bacteria and defend the body against diseases. 5. White blood cells produce antibodies, which neutralize poisons produced by germs. 6. It helps in osmoregulation – the regulation of body temperature by distributing heat throughout the body. 7. It helps in the erection of the penis so that sexual intercourse can take place. **<u>Types of blood circulation</u>** **1. The pulmonary circulation (heart – lungs – heart)** This system operates between the heart and the lungs. The vessels involved are the <u>pulmonary artery</u> and the <u>pulmonary vein</u>. Deoxygenated blood (without oxygen) from the vena cava enters the right atrium of the heart and flows through the tricuspid valve into the right ventricle, from which it is pumped through the pulmonary semi-lunar valve into the pulmonary arteries which go to the	

	answer questions, and receive feedback. **Closure** Teacher ends the lesson by summarizing the core points, reinforcing the key takeaways and assigns students with exercise		lungs to get oxygen. The blood which is now oxygenated (with oxygen), is then returned by the pulmonary vein to the left auricle of the heart. **2. The systemic circulation (heart – all body parts – heart)** It is the transportation of oxygenated blood away from the heart, to the rest of the body, and returns deoxygenated blood back to the heart. Here, the blood moves from the left ventricle of the heart to all parts of the body except the lungs, and back to the right auricle of the heart. Systematic circulation is distance-wise, much longer than pulmonary circulation, transporting blood to every part of the body. It involves the arterial system and the nervous system **Application** Students can apply their understanding of blood circulation to various situations, such as understanding the importance of exercise and the need to eat balanced diet to keep their circulatory system healthy.	
RPK Students have knowledge about the functions of the parts of the heart.				**Remarks** Lesson was successfully taught