2019-09-03

The Effectiveness of 5e Instructional Model of Constructivist Approach on Grade Seven Students Conceptual Understanding of Muscular and Skeletal System at Ewket Fana Primary School

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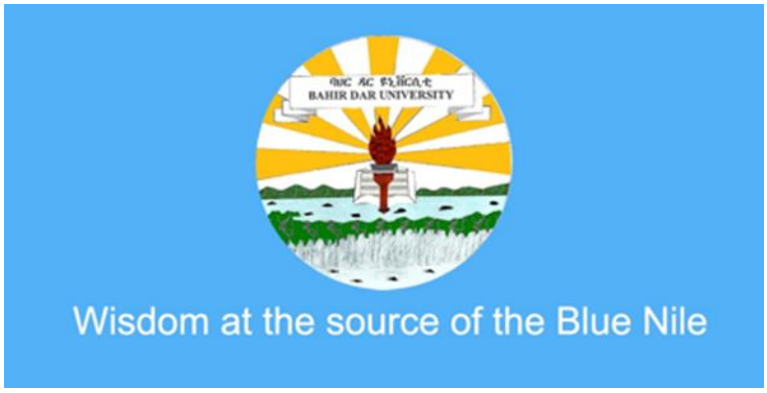

THE EFFECTIVENESS OF 5E INSTRUCTIONAL MODEL OF CONSTRUCTIVIST APPROACH ON GRADE SEVEN STUDENTS CONCEPTUAL UNDERSTANDING OF MUSCULAR AND SKELETAL SYSTEM AT EWKET FANA PRIMARY SCHOOL

By

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A Thesis Presented in Partial Fulfillment of the Requirements for the

Degree of Master of Education in Teaching Science Subjects

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June, 2019

Bahir Dar, Ethiopia

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DECLARATION

I declare that, this thesis entitled "The effectiveness of 5E instructional model of constructivist approach on grade seven students conceptual understanding of muscular and skeletal system concepts at Ewket Fana primary school, Bahir Dar" is my original work prepared under the guidance of Dr. Meskerem Lechissa and I have fully cited and referenced all materials that are not original to this work.

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Date: July/ 9/ 2019

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Name _____ Signature _____ Date _____

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ACKNOWLEDGMENTS

First, I give thanks to the Holy Trinity and the Mother of Lord, the Virgin Mary, for helping me throughout my work.

I would like to express my deepest gratitude to adviser of my thesis, Dr.Meskerem Lechissa, for her guidance, advice, encouragements, feedbacks and suggestions throughout my study.

I would also like to acknowledge the Norwegian Agency for Development Cooperation (NORAD) for financially supporting my studies at BDU and funding this research work.

I admired Dr. Dawit Asrat, who is the coordinator of NORHED project, for his humbleness and positive reaction for each of my questions during my study time and also I would like to appreciate him for his cooperation and best communication skill.

My sincere appreciation to grade seven students of Ewket Fana primary school who participated in this study and also their biology teacher Mrs. Yeshiwork she gave me permission to apply my instructional design in her classroom. I would also express my sincere appreciation to school administrators and all teachers worked in this school for their acceptance and facilitation during lesson implementation.

Lastly, I am very much thankful to my friends for all the things they did for me.

Abstract

The main purpose of this study was to investigate the effectiveness of 5E instructional model of constructivist approach on grade seven students' conceptual understanding of muscular and skeletal system concepts at Ewket Fana primary school. Quasi-experimental research design was employed. Out of four grade seven sections, two sections (N=122) were selected randomly and assigned as experimental (N=61) and control (N=61) groups. The students in the experimental group were instructed with the 5E instructional model of constructivist approach, and students in the control group were instructed with traditional teaching instruction for three weeks. Muscular and skeletal system concepts test, classroom observation and informal classroom assessment were used as data collection instruments. Pretest and posttest were analyzed quantitatively (descriptive statistics and t-tests) while classroom observation and informal classroom assessment were analyzed qualitatively. The pretest results indicated that there was no significant mean difference between experimental and control group students at $P>0.05$. The posttest comparison of students' in the experimental group exhibited significant changes in conceptual understanding of the concepts compared to control group students at $P<0.05$. Similarly, the post informal classroom assessment comparison of students' in experimental group showed a higher explaining and reasoning ability of the concepts compared to the control group. From the results, it is possible to conclude that the 5E instructional model of constructivist approach was more effective than the traditional teaching instructional in students' conceptual understanding. Based on the finding the researcher suggested that curriculum developers should incorporate constructivist strategy of 5E learning cycle model into the biology curriculum as an instructional model for teaching biology.

Keywords: 5E instructional model, Traditional teaching, Conceptual understanding, Muscular and skeletal system

LIST OF ABBREVIATIONS

df: Degrees of freedom

N: Number of Students

P: Significance level

SPSS: Statistical Package for Social Sciences

5E: E1: Engagement, E2: Exploration, E3: Explanation, E4: Elaboration, E5: Evaluation

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CHAPTER ONE

1. INTRODUCTION

1.1. Background of the study

In an attempt to promote meaningful learning in science, a substantial body of research has been accumulated in the last few decades. Researchers have examined the effectiveness of different teaching strategies on students' understanding of variety of science concepts (Mer, 2007). One of the teaching strategies based on constructivist approach with a long history in science education is the 5E instructional model (Bybee, Powell, & Trowbridge, 2000). 5E instructional model of learning cycle is a hands-on, minds-on teaching strategy derived from Piaget's mental functioning model that makes students aware of their own reasoning by helping students reflect on their activities (Sharmann,1991). The 5E instructional model of constructive approach allows students to become active participants in the process of science as they construct understanding of scientific concepts. In addition, it provides opportunities for student interaction and dialogue through systematic instruction, learning experiences and activities in each of well-known phases like, Engagement, Exploration, Explanation, Elaboration and Evaluation (Mer, 2007; Barman, 2018).

The contributions of science of biology towards the quality of human life cannot be overemphasized. However, despite the relevance of Biology, in developing countries research report is replete on high level of failure in the subject at the school level. The failure rate is more obvious in the areas often labeled as difficult in biology (Ihejiamaizu, Ukor, & Neji, 2018). Studies have also showed that students have problems in understanding of biology topics such as internal organs and organ system particularly in muscular and skeletal system is one of the difficult concepts as determined by teachers (Tekkaya & Ozkan 2001). Certain concepts, such as

axial and appendicular skeleton, types of bone and joints, types muscles, structure and functions of muscle, muscles and skeletal health are perceived as difficult to teach and the subject teachers have a tendency of avoiding teaching those concepts (María & Molina, 2016). Those concepts are very difficult for the teachers teaching and students learning because it is complex (María & Molina, 2016). This means that, students lack understanding of such concept, avoid answering questions from such topic in the examination paper and as a consequence record high rate of failure time over. There are many reasons why students have difficulties in learning biological concepts (Tekkaya & Ozkan 2001). The nature of science itself and its teaching methods are among the reasons for the difficulties in learning science, while according to Çimer (2012), the biological level of organization and the abstract level of the concepts make learning biology difficult and hard for students understanding . Among other reasons, poor pedagogical approach which the teachers utilize in teaching biology concepts has been attributed to these problems (Eshiet & Sheng, 2011).

Traditional learning instructions describe the teacher as information provider and the students as passive learners. The major components of traditional instructions include lectures, demonstrations, and use of only textbooks and strategies depending upon the explanation of teacher without taking into consideration the alternative learning preferences of learners. Furthermore, traditional learning environment makes students passive learners that only give them a chance to retain and grasp information (Naqeeb, Khalil, & Kayani, 2015). So teacher-centered traditional instruction approaches have persisted in biology classrooms. These traditional approaches are predominantly trans-missive, make the learning of biological concepts irrelevant and relatively difficult for the students' conceptual understanding (Arokoyu, 2017).

In view of this trend, a number of innovative approaches to science teaching have been introduced in primary schools with the curriculum revised to give meaningful biology education to students. One signal of the paradigm shift from teacher-centered instruction to student-centered instruction approach to biology teaching is constructivism (Jia, 2010). Constructivist theory is one of the contemporary learning theories that emerged from the philosophical basis that the teacher's role should be trainer, facilitator of learning processes and creator of educational environment. This is for the students to build their knowledge by themselves through direct interaction with the learning and the use of all their accumulated concepts and previous experiences (Kaynar & Tekkaya, 2009). Constructivism is a theory that gives hope to the development of the deep understanding of the science concepts. In constructivist approach students construct their knowledge by making link between their ideas and new concepts through experience they acquire in school or daily life (Singh & Yaduvanshi, 2015).

Constructivist-based models have proven in its different stages successful, resulting in proper conceptual understanding of the cognitive structure. One of the teaching strategies based on constructivist epistemology with a long history in science education is 5E learning cycle model. This emerging model from constructivist theory is successful strategy for teaching any topic, and they all focus on the active and effective students role, emphasizing that students are the producers of their knowledge(Singh & Yaduvanshi, 2015). The 5E learning cycle or 5E instructional model has been shown to be an extremely effective approach to learning. This 5E instructional model developed by Bybee *et al*. (2006) derives its name from the number of its phases and the initials. The five phases are Engage, Explore, Explain, Elaborate and Evaluate. As a constructivist-based teaching and learning model, 5E model consists of active inquiry skills

that are necessary for knowledge construction and comprehension, and also hands- on, minds-on teaching strategy (Pommerville, 2018).

Therefore, the study of the 5E instructional model covers multiple aspects of educational practice. Studies have shown that compared with traditional teaching instructions, the 5E instructional model results in greater benefits in terms of stronger student interest in learning and greater ability for scientific inquiry. Thus, the 5E instructional model has been found to have a positive impact on student conceptual understanding of muscular and skeletal system (Hu, Gao, & Liu, 2017).

1.2. Statement of the problem

Biology is one of the science subjects. So it needs effective teaching is crucial, in order for students to reach educational success in and outside the classroom setting. In most African countries including Ethiopian primary school students have been learning Biology through predominant use of lecture method instructions (Ugwuadu, 2010). According to Ugwuadu (2010), lecture method is not effective because it involves verbal presentation of pre-planned lesson to the students which requires little or no instructional aid and does not promote students' conceptual understanding. In this case several studies revealed that they have been performing poorly at the end of their final results (Stavreva, Koleva, & Djokic, 2011). This makes students hate the topic and the situation leads to poor conceptual understanding of students in Biology particularly in muscular and skeletal system, especially at upper primary school level (Tambaya, 2017).

In elementary school level students have misunderstanding about the internal body structure particularly, part of muscular and skeletal system function and location. At lower grade level students considered as, axial & appendicular skeleton are the same, there are fixed joint in

our body, cartilage is the same as bone, ligament is the same function as tendon, and all muscles are the same position and function thus, misunderstandings are widespread in these topics (Aydin & Balima, 2009). According to Trefil, Rita and Cutler (2005), students have common misconception on bones are not living tissues because of their solid, strong and rock-like appearance (when, in fact, bones are living they contain cells, blood vessels, and marrow); and muscles push on bones (when, in fact, muscles don't move bones directly they contract, pulling on tendons, which attach muscles to bones, and the bones move). Generally from different literatures and my experience students have difficulty in internal human body systems, including muscular and skeletal systems concepts.

Hence, this problem leads to an upsurge of research into innovative approaches that can alleviate this situation. One such emerging approach advocated here is the use of 5E instructional model of constructivist approach (Bybee et al., 2006). Based on the students' misunderstanding, 5E instructional model emerge as an important model for the minimizing of students misunderstanding about muscular and skeletal system concepts because it allows to determine the misunderstandings, minimizing them through five stage of instructional model, Engaging the students by asking prior understanding and identify misconceptions before proceeding the learning process, allow students to Explore the concept being introduce and discovery, Explain for the concept they are learning, Elaborate on what learned by applying their knowledge the new situation and multiple opportunity for Evaluation of students understanding.

Its efficacy in enhancing students' conceptual understanding in Biology especially in muscular and skeletal system concepts when compared with that of the traditional lecture method instruction is the attention of this study. Therefore, this research work to explore the constructivist teaching strategy, specifically 5E instructional model of constructivist approach to

investigate its effectiveness on grade seven students' conceptual understanding of muscular and skeletal system concepts in Ewket Fana primary school, Bahir Dar.

1.3. Theoretical and Conceptual frame work

1.3.1. Theoretical frame work

This study is grounded on Piaget's theory of cognitive functioning development and Vygotsky's activity theory of learning. The major principle in Piaget's constructivist theory of cognitive functioning is that learning is attained through construction (Piaget, 1970). This theory suggests that human knowledge is innate and that human knowledge is directly shaped by experience. This theory realizes that learning as occurring based on the interaction between what the learner already knows and the physical environment. The basic principle of this theory, which is creating knowledge through interaction between the learner and the environment perfectly, agrees with the fundamental structures of 5E learning cycle. Vygotsky's Activity theory of learning sees learning as appropriation which resides within the learner. Students' learning development is facilitated by social interaction with more sophisticated individuals who provide guidance during the learning process (Vygotsky, 1978). The structure of this theory also agrees with the principle of 5E learning cycle, particularly in the area of skillful intervention of the science teacher to raise students' thinking, learning and the existence of social interaction among peers and between teachers and students.

Therefore, 5E learning cycle is a constructivist model, every E represent a part of process helping students sequential learning to bridge prior knowledge and new concept and also is a promising model of students understanding in science learning (Turk & Calik, 2008). This is evident previous studies reveal that the constructivist 5E instructional model is successful in facilitating conceptual understanding of students' in variety science topics including biology

(Aydede, Kesercioglu & Arabacıoglu, 2010). These models suggest creating dissatisfaction in the students with their alternative conceptions followed by strengthening the status of the preferred scientific conception. In particular, studies suggest that four conditions of conceptual change; the learners must become dissatisfied with their existing concepts, the new conception must be understandable, the new conception must be plausible for it to be accommodated and the new conception must be fruitful (Artun & Costu, 2013).

1.3.2. Conceptual frame work

The conceptual frame work was the researcher understanding of how the particular variables in the study connect with each other. It was the researcher map in following investigation. Therefore the conceptual framework of this study showed that the relationships between variables. The independent variables were 5E instructional model and traditional teaching instruction approaches affected the dependent variable that is the students' conceptual understanding in muscular and skeletal system concepts as shown in Figure 1. In this study the implementation of 5E instructional model of constructivist approach in biology classroom with teaching muscular and skeletal system can improve students' conceptual understanding is one of the basic abilities in science learning. This study expected that 5E instructional model has significantly importance to improve students' conceptual understanding than traditional teaching instruction because traditional teaching instruction describe all concepts by the teacher; it does not easily understand the concepts. However, 5E instructional model of constructivist approach is hand-on and mind-on teaching approach through each well-known phases (Bybee et al., 2006).

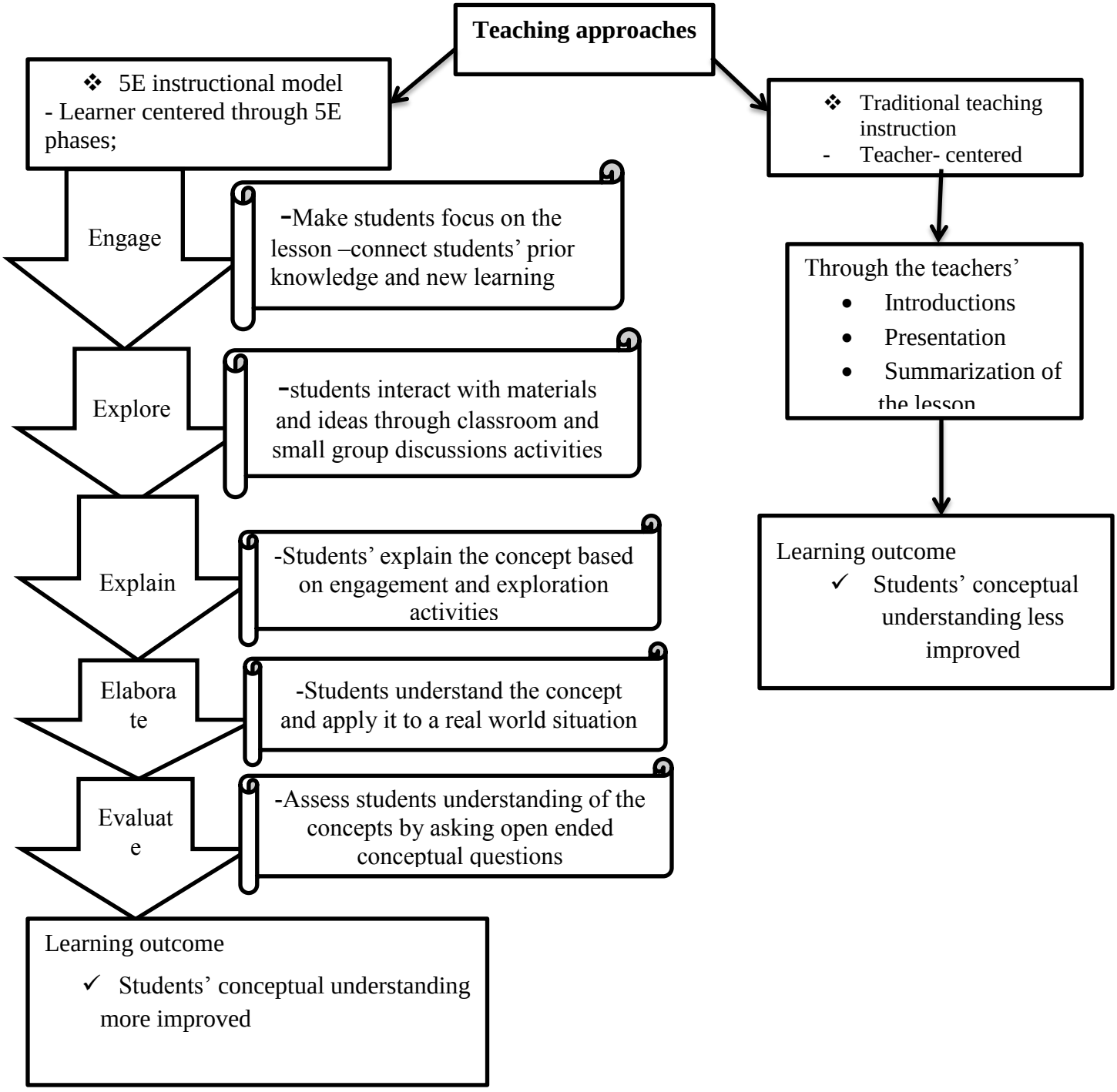

Figure 1: Conceptual frame work

1.4. Objectives of the study

1.4.1. General objective

The main objective of this study was:

- ✓ To investigate the effectiveness of 5E instructional model of constructivist approach on grade seven students' conceptual understanding of muscular and skeletal system concepts at Ewket Fana primary school in Bahir Dar.

1.4.2. Specific objectives

The specific objectives of this study were:

- ✓ To compare the effectiveness of instructions, based on 5E instructional model of constructivist approach and traditionally designed biology instruction on grade seven students' conceptual understanding.
- ✓ To improve students' conceptual understanding of muscular and skeletal system concept by using 5E instructional model of constructivist approach.
- ✓ To observe the students' reaction towards the new methodology.

1.5. Research questions

This study mainly focuses on the effectiveness of 5E instructional model of constructivist approach in muscular and skeletal system concepts. Therefore, this study was attempted to answer the following research questions;

1. Is there a significant difference in the test score of students' taught with 5E instructional model of constructivist approach and those taught with traditionally designed instruction?
2. Do students' have better conceptual understanding of muscular and skeletal system when they are taught through 5E instructional model of constructivist approach?
3. What is the students' reaction towards the new methodology?

1.6. Significance of the study

The old instructional methods used in science curriculum do not develop students' interest in the subject matter. It does not empower students to become deep thinkers who are capable of making new discoveries and solving complex problems. Science courses must be designed with the consideration that learning consists of repeating interactions that take place between students' existing conceptions and their new experiences. In this respect, the present study may lead to various implications for curriculum developers; give feedbacks about the curricular implementations, educational researchers, and science teachers in terms of effectiveness of learning environments through 5E learning cycle instruction. Thus, using 5E instructional model of constructivist approach enables the students to learn more, retain more and apply what is learned by engaging and constructing new knowledge.

Therefore, this study provides hope for students to achieve better and to increase their conceptual understanding in science lesson, particularly in biology. This study also helps to bring some empirical data about the effectiveness of 5E teaching model in science class. And the finding of this study is pave way for further research and the educational stakeholders who may use it as an input in curriculum development in science lesson design. The results help teachers to know the direct application of constructivist teaching approach in actual classrooms.

1.7. Delimitation of the study

This study would be confined in its scope to Ewket Fana primary school of Bahir Dar town. The researcher selects this school so as to make the study manageable in terms of distance and financial constraints. The study is also delimited only to investigate the effectiveness of 5E instructional model of constructivist approach on students' conceptual understanding of muscular and skeletal system concepts on grade seven students as a population of the study.

1.8. Limitations of the study

To investigate this study, the following limitations are faced during the process of the study;

- ✓ Lack of time; shortage of time is one of the limitation for the implementation 5E instructional model of constructivist approach in muscular and skeletal system lesson because each phase of the 5E learning cycle needs more time but in primary school level the time allocated is 40 minute in one period in this case it is difficult to applied all activities in a given time.
- ✓ Lack of available resources; lack of resource is one of the limitations during the implementation of muscular and skeletal system topics; resources like, teaching materials related to these topics and laboratory rooms were limited.
- ✓ Large number of students in the classroom; in one classroom the number of students is above 61, so it was difficult to manage and accomplished the task at a given time.

1.9. Operational definition of key terms

5E instructional model: It is a design in constructivist learning approach or it is constructivist instructional strategy that process through five phases these are; Engage, explore, explain, Elaborate and evaluate. Each phases cover hands-on and minds-on activities.

Constructivist teaching approach: Constructivist teaching is based on the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information.

Conceptual understanding: refers to the pupils' knowledge of the biological and physical aspect of the world. Students' comprehensions toward science concepts, in the current study the concerned science concepts muscular and skeletal systems.

Muscular and skeletal system: is an organ system that gives humans the ability to move.

CHAPTER TWO

2. LITERATURE REVIEW

This section explores the literature related to the study. The purpose of this section is to establish the foundation for the study and exploring what others have done in the related field of the study; this is used to strengthen the findings of the study. Therefore, related literature of this study is presented in the following headings; students' misconception on muscular and skeletal system, constructivist teaching approach in science, traditional teaching approach in science, 5E instructional model, effectiveness of 5E instructional model, students' understanding on muscular and skeletal systems concepts.

2.1. Students' misunderstanding on muscular and skeletal system

The studies have shown that students do not fully understanding the major concepts of internal human body systems, especially muscular and skeletal systems and have misunderstanding, knowledge deficiencies and difficulty to interpret the subject (Tekkaya & Ozkan 2001). The reasons behind these problems are the abstract, complex and micro structured nature of concepts as well as the obstacles in students' priory constructed knowledge. Students construct knowledge through their experiences not only in school but also in real life. These existing knowledge structures influence their understanding of introduced concepts since learning consists of not only gaining of new knowledge but also iterative interactions between new knowledge and students' existing conceptions. These existing conceptions may facilitate or hinder learning. The influence of this existing conceptual knowledge on the learners' conceptual development was empirically supported (Duschl & Gitomer, 1991). Concerning the human body including muscular and skeletal system, a body of research has explored and listed the students'

misconceptions and difficulties in understanding(Aydin & Balima, 2009; Kesercioglu & Gucluer ,2011; Ozsevgec, 2007; Caravita & Falchetti, 2005; Reiss et al., 2002).

Bearing in mind the skeletal system concept, the study conducted by Caravita and Falchetti (2005), understood the perception of students regarding the bones; if the bones of a living organism is also living or nonliving. The data were collected from 189 students ranged in age from 7 to 12 years who visited the civic zoological museum. Each student was interviewed with the following questions: Are bones alive when they are inside the living body? What evidence do you have to this effect? What are bones made of? Can bones grow? How do they grow? Do children or newborn animals have the same bones as adults? The answers of students especially in secondary school level indicated a large frequency of then nonliving statement towards bones. Moreover, students who stated bones as alive mostly failed to express acceptable criteria to justify their answers. Rather, they argued the movement of bones or presence of bone components like marrow as criterion. These justification criteria were also observed student who state the bones as not alive, but in opposite way. They explained, for example, bones are not alive because they cannot move themselves. Despite this, most of the students agreed that the bones grow and denied that babies and adults have the same bones. The authors argued that students tried to justify their ideas through function rather than structure of the organs. In this manner, they suggested to focus on the interrelationships among the structure and function as a priority in task developments in science.

Ozsevgec (2007) investigated sixth and eighth grade students understanding of their internal structure. The participants of study were 112 students attending two junior high schools. The students were requested to draw the organs existing in their body on a given body map. They were also asked to write the function of organs which they draw. The results of the study

indicated students are aware of a wide variety of organs. However, they failed in locating the organs accurately, explaining the correct function of the organs, and relating the organs with a body system. Students tend to draw individual organs without connecting them with other related structures. The mostly drawn organs were the heart and lungs. However, none of the students were able to draw a correct shape of heart. Moreover, they appeared to have confusions related to the function of heart. Most of the explanations directed by students were wrong such as cleans blood, collects the clean blood, and separates the clean and dirty blood. The rate of incorrect responses for the function of lungs was half of the explanations for example lungs help the inhaling and exhaling, circulate the blood, and provide fresh air. The drawing about skeletal system was muscles which have drawn only in the elbow. Students also reflected unscientific terminology like clean or dirty blood to refer oxygenated or deoxygenated blood. The study results revealed that both grades students knew the names of the organs, but they had problems about their location, shape and function. It was also found that students did not have sufficient understanding about the connections between the organs in a single body system.

Study conducted by Aydin and Balima (2009) to identifying grade 6^{th} students' misconceptions on the unit systems in our body, the skeletal system, the circulatory system, and the respiratory system. This research was carried out with 62 students in three 6^{th} grade classes at a primary school in Izmir. Two of the three classes were chosen as the experimental groups. The first experimental group was taught with technologically supported mind-mapping technique. The second experimental group was taught with technologically-supported concept-mapping and the control group was taught with the activities based on the Science and technology curriculum. After the experimental implementation, students were given a conceptual understanding test to find out their misconceptions regarding the unit systems in our body. Based on the problem of

the study was formulated as what are the misconceptions of students in each group on subjects of the unit 'systems in our body' based on this problem the qualitative analysis of the answers showed that some students had misconceptions on the unit systems in our body. Misconceptions like, there are fixed joints in our necks, there are fixed joints in our waists. Tonsils are in the throat, and Tonsils are a part of the digestive system. The authors conclude that, the qualitative analysis of the result shows that students' answers were made and their misconceptions about the body system were determined.

Similarly, Kesercioglu and Gucluer (2011) to determine the 7^{th} grade students' misconceptions about the unit of Systems of our body. For this purpose, open questions and interviews were directed at 42 students. As a result of the analysis of data obtained, it was determined that the primary school students have various misconceptions about systems organs and hormones. Some of the misconceptions; anus is a digestive system organ, driving bicycle is not reflex, insulin increases blood sugar and diabetes causes from eating too much sugar. The authors conclude that, students have some understanding difficulties and develop some alternative conceptions at the unit of systems of our body which is one of the difficult units in science lessons. Consequently it was seen that students have important misconceptions about the jobs of the organs, the shape and place of the organs and the health of the organs.

Results from an international study Reiss et al. (2002), about 15 year-olds students' from 11 different countries understanding of different organ systems show that the generally best known organs belong to the digestive system, the gaseous exchange system and the skeletal system. Student had knowledge of their internal organs, most of them revealed little understanding of their organ system.

2.2. Teaching approaches

2.2.1. Constructivist teaching approach in science

Among the theories of learning, constructivism has become the most investigated over the recent research in science education (Matthews,2002). The curriculum and teaching in science education were impressed by the perspectives of constructivism in last decades (James et al., 2013). In this theory, understanding of knowledge is an active construction process in the mind of the learner instead of being the acquisition from outsiders in an already organized form (Rowlands & Carson, 2000).

Constructivism is a theory about knowing and learning, asserting that knowledge cannot be directly transmitted but must be actively constructed by learners (Bodner, 1986). This view of learning also emphasizes the significance of each individual learner's previous knowledge in subsequent learning (Wu & Tsai, 2010). There is no doubt that the perspectives of constructivism in learning and teaching have profound influences on the development of science curriculum and science teaching practice (Matthews, 2002). In the past few decades, meaningful learning has been strongly advocated by science educators (Ivie, 1998). Among biology teachers and educators, there seems to be a growing recognition of the need to refocus on students' learning outcomes derived from meaningful learning and their conceptual understanding of biological ideas (Mintzes *et al*, 2001) . It is also suggested that constructivist-oriented instruction or strategies can promote students' meaningful learning (Taylor & Fraser, 1991). Therefore, many teaching strategies based upon the assertions of constructivism have been adopted in biological education, and many of these teaching strategies have been shown to improve students' performance and conceptual understanding in biological learning, for example, concept mapping

(Kinchin, 2001), cooperative learning strategies (Chatila & Husseiny, 2017) and 5E instructional model of learning cycle (Bybee *et al*., 2006).

5E Learning cycle is a constructivist instructional model; therefore, it begins with the activation of prior knowledge in students about the subject matter (Raine & Collett, 2011). Raine and Collett (2011)stated that prior knowledge is the most important factor in students' learning. Similarly, Odom and Kelly, (2000) suggest that the learner must possess concepts relevant to the new learning to be able to learn meaningfully. In this phase, the teacher has an opportunity to assess students existing concepts, while the students have the opportunity to recall their ideas. Moreover, science educators have also proposed that the integration of multiple teaching strategies could promote students' conceptual learning and knowledge construction in biological classrooms (Bean *et al.,* 2018). The effects of the constructivist-oriented teaching strategies on high school or college students' learning outcomes have been widely evaluated (Odom & Kelly, 2000; Tastan, 2008) but few studies on elementary school students were conducted (Wu & Tsai, 2010).

Adula and Kassahun (2010) observed that the implementation of innovative approach that is student-centered constructivists teaching of Mathematics and Natural Science subjects in three selected schools in Jimma Zone. Classroom observation method was utilized. In 40 lessons of 24 teachers were observed. They were also active in making question rich learning environment and utilization of learning materials and activities. The observation result shows that teachers were effectively utilizing prior knowledge of learners in starting their lessons. Constructivists claim that learning takes place when learners are able to use the knowledge and skill they have constructed in unfamiliar context or in real world of work. The authors conclude that constructivist teaching approach has the conception that students learn for understanding of

natural science when they learn using the tools materials that the expertise in the concerned area are using and perform the real activities. Moreover, delivery of materials and activities in learning science for learners helps them to test their ideas or the theoretical part of the lesson

In the study of Hand and Treagust (1997), junior secondary school students' perceptions of implementation of constructivist approach to the teaching of science was investigated. Students were more actively involved, had more discussions, practical work, and more fun. As a result of this, constructivist teaching and learning approaches lead greater understanding of concepts. It was concluded that students were more active in the learning process. Students had opportunity to see and control their thinking and they constructed correct knowledge more confidently and became more confident in their understanding of science. In addition to these, Liang and Gabel (2005), examined the effectiveness of the instruction based on the constructivist approach by focusing on the class teacher- student and student-student interaction within small groups over traditional method of instruction. Lord (1997) compared the effectiveness of constructivist teaching and traditional teaching approach on achievement in biology. Study was conducted on eighty six college students. Sample was divided in two groups. Control group was taught through traditional approach and experimental group was taught through constructivist approach. It was found that the constructivist treated group out-performed than traditionally taught group.

In general constructivist teaching approaches make the science subject effective and interested to learners. These because to improve students' performance and conceptual understanding in science education.

2.2.2. Traditional teaching approach in science

In traditional teaching approach classes are usually driven by teacher talk and depend heavily on textbooks for the structure of the course. Teachers serve as channels and seek to transfer their thoughts and meanings to the passive student. In the context of traditional teaching instruction refers to the usual methods used by educators to teach science subjects, which could involve occasional reference to real-life applications of science (Hackling *et al*., 2011). Studies suggests that the traditional ways of teaching science often fail to sufficiently develop learners understanding of scientific concepts (Taasoobshirazi & Carr, 2008). The opinion of Taasoobshirazi and Carr (2008) 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. According to these authors, traditional way of teaching encourages poor conceptual understanding and limited comprehension of learned in science concepts and ideas.

According to Adunola (2011), teacher-centered methods of traditional teaching does not apply activity based learning to encourage students to learn real life problems based on applied knowledge. Since the teacher controls the transmission and sharing of knowledge, the lecturer may attempt to maximize the delivery of information while minimizing time and effort. As a result, both interest and understanding of students may get lost. Ahmad and Aziz (2009) observe that teacher-centered teaching is the traditional teaching method where teachers are at the center of the class activities: teach, talk and explain all the way. That means in traditional classrooms, students have a definite and fixed perception and idea of their own roles and those of their teachers as custodians of knowledge. Their experiences show that teachers behave in certain ways and have particular roles in the process.

In general Traditional teaching approaches make science subjects appear irrelevant, uninteresting and difficult to learners. These perceptions could reason for the hopelessness, poor performance and poor conceptual understanding in science education.

2.3. 5E learning instructional model

The 5E constructivist instructional model of learning proposed by Bybee *et al*. (2006) was adopted in this study. It is an instructional model of learning, in which the learners build or construct new ideas on top of their prior idea. The 5E instructional model can be used with students of all ages and ability levels (Bybee *et al.*, 2006). The Biological Science Curriculum Study (BSCS), a team whose principal investigator is Bybee (1997) developed an instructional model for constructivism, called the "Five E" .5E teaching cycle is interchangeably called 5E learning cycle, 5E teaching model, 5E instructional model and constructivist-oriented teaching strategy.

Bybee (1997) announces that using this approach, students redefine, reorganize, elaborate, and change their initial concepts through self-reflection and interaction with their peers and their environment. These means learners interpret objects and phenomena and internalize those interpretations in terms of their current conceptual understanding. Science teachers and curriculum developers may integrate or apply the model at several levels. The model can be the organizing pattern of a sequence of daily lessons, individual units, or yearly plans (Bybee, 1997). According to Dwyer (2014) , 5E teaching cycle is an instructional model for designing lessons that are conceptually linked and developmentally sequenced to support the ongoing, progressive refinement in student understanding. 5E teaching cycle as an instructional model based on the constructivist approach to learning which mean that learners build or construct new ideas based on the prior knowledge and it allows students and teachers to

experience common activities, to use and build on prior knowledge and experience, to construct meaning and to continually assess their understanding of a concept (Bybee, 2009). The 5 E-learning cycle model sequences learning experiences so that students have the opportunity to construct their understanding of a concept during the teaching and learning process (Bybee, 2002) .

According to Bybee *et al*.(2006), the model leads students through five phases of learning cycle that are easily described using words that begin with the letter **E, Engage, Explore, Explain, Elaborate and Evaluate** as shown in Figure 2.

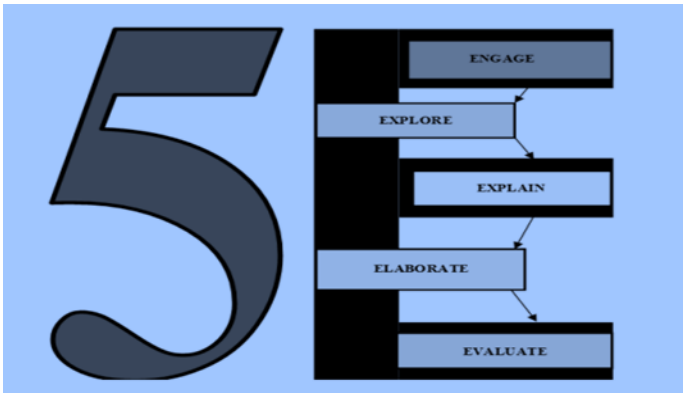

Figure 2: Phases of 5E instructional model by (Bybee *et al*., 2006)

This 5E learning cycle instructional model based on Bybee *et al*. (2006) as shown in the following Summary;

Engage: It is first phase of 5E learning cycle instruction. The learning cycle requires active engagement of students. The motivated strategies that create interest in the topic, captivate students' attention and promote curiosity are implemented in this step. Bybee *et al*. (2006) advised that a discrepant event, questioning, or some other act secures the learners' attention and interest in the topic. The role of this step is not only to make students focus on the lesson but also make them access and uncover their prior knowledge and identify misconceptions before proceeding with the learning process. Students need to recognize their current conceptual

structures to be able to build new knowledge over the existing ones. This step provides short activities seek to connect and organize to students' prior knowledge to prepare students for new learning.

Explore: During the second phase of 5E learning cycle, students have common, concrete experiences upon which they continue building concepts, processes, and skills. In the exploration phase students' interact directly with the material, concepts, and ideas through classroom and small group discussions. This helps the students to acquire a common set of experiences so that they can compare results and ideas with their classmates. Students were aimed to acquire concrete experiences in the subject matter. The teacher, guide students by asking probing questions and provides enough time to students for their exploration about the concept. Exploration experiences provide students with a common base of activities within which current concepts (misconceptions), processes and skills are identified and conceptual change is facilitated (Bybee *et al*., 2006) .

Explain: The definition of the explanation phase stated by Bybee *et al*. (2006) is to present ideas, processes and skills briefly, clearly and directly. This explanation phase focuses students' attention on a particular aspect of their engagement and exploration experiences and provides opportunities to demonstrate their conceptual understanding, process skills, or behaviors. This phase also provides opportunities for teachers to directly introduce a concept, process, or skill. Learners explain their understanding of the concept because of reflective activities. An explanation from the teacher or the curriculum may guide them toward a deeper understanding, which is a critical part of this phase.

Elaborate: The elaboration phase of the 5E model allows students to apply knowledge they have gained to new situations so they can expand their understanding **(**concept application

takes place in this phase). Teachers challenge, extend students' conceptual understanding and skills. Through new experiences, the students develop deeper and broader understanding, more information, and adequate skills. Students apply their understanding of the concept by conducting additional activities (Bybee *et al*., 2006) .

Evaluate: The evaluation phase encourages students to assess their understanding and abilities and provides opportunities for teachers to evaluate student progress toward achieving the educational objective. Evaluate students' understanding of concepts and their proficiency with various skills and use a variety of formal and informal procedures to assess conceptual understanding and progress toward learning outcomes. In the 5E learning cycle model, assessment can be gathered through formative and summative assessment procedures (Bybee *et al*., 2006).

In general Bybee *et al*. (2006) using5E learning cycle instructional model is based on a constructivist approach, students redefine, reorganize, elaborate and change their initial concepts through self-reflection and interaction with their peers and their environment.

2.3.1. Effectiveness of 5E instructional model

According to research findings, the effectiveness of 5E instructional model (5E learning cycle instruction) over traditional instruction in promoting conceptual understanding and achievement in biology as well as other science disciplines has been the focus of different studies. Most of these studies reported that 5E learning cycle instruction is an effective way to teach science and it produce better conceptual understanding. Some examples of studies are reviewed below;

Sadi and Cakiroglu (2010) conducted a quasi-experimental study to compare the relative effectiveness of 5E learning cycle and traditional instructions on 11^{th} grade students' human

circulatory system achievement. A total of 60 students (17 years of age) from four classes participated in the study. The class was assigned as experimental groups, treated with 5E learning cycle instruction and other class was assigned as control groups, treated with traditional instruction for three 40 minute lessons per week and the data collection instruments through achievement test and observation checklist. During the treatment, both the control and the experimental groups were observed to identify whether the teachers follow the treatment and students activities. The classes were instructed by two teachers and each teacher had one experimental and one comparison group. The authors developed a human circulatory system achievement test to assess students' achievement in this topic. The test consists of 25 multiple-choice items related to the topic. Students in each group was administered the test twice as pre-test and post-test. The test results indicated significant differences between experimental group and comparison group in terms of students' achievement scores. The students instructed with 5E learning cycle approach performed better on achievement test than the students who received traditional instruction. Therefore, the finding of this study shows that 5E learning cycle instruction increased students' achievement and to provide better understanding in human circulatory system concepts than the traditional instruction. That means 5E learning cycle is an effective strategy to provide better understanding and achievement of students' in human circulatory system concepts.

Similar study was conducted by Cardak, Dikmenli, and Saritas (2008), to examined the effect of the 5E instructional model on primary (sixth grade) student success during the circulatory system unit. This study was conducted with 38 students in two different classes by the same researcher in 2006-2007. One of the classes was assigned as the control group and the other as the experimental group. Appropriate activities using the 5E instructional model were

used in the experimental group, while a traditional teaching method was applied with the control groups for 4 weeks in 4 class hours (40 minute). The data collecting instrument was achievement test. The test consisted of 15 multiple choice items related to the topic, the achievement test was given to both groups as pre-test and post-test. After the data analysis, the result show that, positive changes from the experimental group of students receiving the 5E instructional model activities based on the constructivist approach have an effect of increasing success when learning about the circulatory system. Generally in this study indicated that the experimental groups had much greater understanding about circulatory system topic than traditional methods of instructions.

Balci, Cakiroglu and Tekkaya (2006) to compared the effectiveness of the 5E learning cycle instruction, conceptual change texts and traditional instructions on elementary school students' understanding of photosynthesis and respiration in plants. 101 eight grade students consisted of the subjects of the study from the same school located in an urban area. Teaching methods were randomly assigned to three groups and treatment period took 3 weeks (40 minute per week). The instrument were used to collect data in this study was concept tests. Students in the first experimental group received 5E learning cycle instruction, students in the second experimental group received conceptual change text instruction, and students in the control group received traditional instruction. The researcher observed all groups during the whole implementation period. All groups were instructed on photosynthesis and respiration in plant concepts and were administered a diagnosing test on these concepts before and after teaching. In this study quasi-experimental research design was utilized. After the analysis the data, the results showed that students in both learning cycle and conceptual change texts groups

understand the scientific conceptions related to photosynthesis and respiration in plant significantly better than students in traditional groups.

Kaynar and Tekkaya (2009) has done a study that to compared effectiveness of 5E learning cycle against the lecture based instruction in the development of epistemological beliefs besides the conceptual understanding in the unit of cell. A sample of 153 students from 4 intact classes in grade six was selected for the study. The classes were instructed by the same teacher and randomly assigned as experimental and comparison groups as treated with 5E learning cycle instruction and traditional lecture based instruction, respectively. The implementation process lasted 3 weeks. Students in both groups were tested through cell concept tested at the beginning and at the end of the treatments. The result of the study show that experimental group substantially outperformed over comparison group in terms of cell concept achievement. Moreover, learning cycle instruction significantly improved their conceptual understanding of students in comparison with traditional instruction. The authors argued that the instructional strategies utilized in experimental group supported change in elementary science students from passively receiving knowledge to actively examining their own conception.

Haribhai (2012) compared the effectiveness of 5 E Instructional model and lecture method with respect to achievement and retention in science. Researchers decided to study its effectiveness having the area as a moderator variable. Keeping in mind these objectives, control and experimental groups are selected randomly from urban and rural schools, only post-test experimental research design was used on two randomly selected groups. One experiment was conducted in urban school and one in rural school of Patan Taluka. The program was implemented for five days in each school and the test was applied on the sixth day. Thus collected data was analyzed through t-test. The results of this study provide research-based

evidence in support of effectiveness of constructivist 5E model compared to Lecture method with reference to achievement and retention of learning science. So, it could be concluded that constructivist 5E model was effective both in urban and rural area with reference to achievement and retention. And also the constructivist 5 E model were effective both in urban and rural area, this suggests that this model is culture-free.

Hagerman (2012) the use of the 5E instructional model in a sophomore and junior level biology course would increase student understanding of science concepts and processes, fostering application to real-life situations and students' scientific literacy skills. Three units, cellular structure, genetics and evolution, were taught in four biology classes composed of 42 students by using 5E learning cycle instruction for the period of eight months. Multiple data collection through surveys, interviews, inquiry process analysis, lab assessments, team performance assessments, journals, scientific papers was performed during the whole implementation period. At the end, researcher reported that provides evidence of the 5E learning cycle is an effective method for developing scientific literacy in students and increase student understanding of science concepts.

Sutuma (2018) conducted a quasi-experimental study to identify the variable of lesson delivery for adapting 5E model cycle and normal teaching method on 40 diploma graduating students of teaching biology from four college of teacher education in Ethiopia. The efficacy of using both mode of lesson delivery was evaluated comparatively through properly set of performance checklists. As result, the overall average teaching effective ness of adapting the 5E model cycle was more in comparison with the learning gained through the use of the normal teaching methods. The authors conclude that, adapting the 5E model cycle had solved the problem teaching biology and that much improved the quality of teaching biology. Moreover

adapting the 5E model cycle in the daily lesson and use for teaching biology had significant role both in conceptual change and constructivist view of learning while use of the components in classroom discussion facilitated for more self-preparedness in teaching to suit with the quality and serve.

Aligarh (2016) investigated the Effectiveness of 5E Instructional model of Constructivist approach on Ninth-Grade Students' conceptual understanding of Solutions. In this study, a pretest-posttest control group quasi-experimental design was used. The participants included 60 students, who were enrolled in ninth grade and belonged to two different sections during the session 2014-15, in a secondary school in Kisangani, Bihar, India. These two sections were randomly assigned to traditional instruction and 5E Instructional model of constructivist approach respectively. One section, subjected to traditional instruction, was considered as control group and the other section, subjected to 5E Instructional model of constructivist approach, was considered as experimental group. Both the groups were subjected to their respective instructional method for one week. They attended six periods per week. Each period was of 35 minutes duration. These groups followed the same instructional sequence and had the same learning objectives. The data gathering instrument of this study was achievement test. After the analysis the data, the results showed that 5E Instructional model of constructivist approach is a good supplementary method for traditional instruction in Chemistry at secondary school level.

Similar study was conducted by Akar (2005) in this study to find out the effectiveness of 5E learning cycle instruction over traditional instruction on 56 tenth grade students' understanding of acid-base concepts. The groups were randomly assigned and the same teacher taught these groups. Achievement Test was administered to both groups as a pretest and posttest in order to assess their understanding of concepts related to acid-base. After analyzed statically,

the result shows that 5E learning cycle instruction caused a significantly better understanding of acid-base concepts than the traditional instruction.

Campbell (2006) explored the effects of the 5E learning cycle model on the fifth grade students' understanding of force and motion concepts. In this study the fifth grade students' understanding of force and motion concepts as they engaged in inquiry-based science investigations through the use of the 5E learning cycle. The initial data were provided by a pretest indicating students' understanding of force and motion concepts. During 14 weeks implementation period, students participated in investigations related to force and motion concepts. Their subsequent understanding of these concepts and their ability to generalize their understandings was evaluated via a posttest. After analysis of the test, the result shows that students learn through 5E instructional model have better knowledge and understanding of force and motion concepts than textbook-based traditional instruction. Generally in inquiry-based science investigations through the use of the 5E Learning Cycle is better for primary students' science understanding than traditional instruction.

In general most of the results of the above studies confirms that compared to traditional lecture based instructions, on the effectiveness of the 5E instructional model (5E learning cycle instruction) indicated that, 5E instructional model (5E learning cycle instruction) is more effective to improve students' conceptual understanding in science concepts (Balci, Cakiroglu, & Tekkaya, 2006; Cardak, Dikmenli & Saritas, 2008; Hagerman, 2012; Aligarh ,2016; Akar ,2005; Campbell ,2006), to develop students epistemological beliefs besides the conceptual understanding (Kaynar & Tekkaya, 2009) and to produce greater achievement in science subject matter(Sadi & Cakiroglu, 2010; Haribhai, 2012).

2.4. Students' understanding on muscular and skeletal systems concepts

The human body system is a complex organism, the gross mechanical properties of which are enabled by an interconnected of muscular and skeletal network. The nature of muscular and skeletal system interconnection facilitates stability, voluntary movement, protection of internal organ, storage of mineral and fat and strength to injury (Murphy et al., 2018). The combination of muscular system and skeletal system are known as the musculoskeletal system. This Human musculoskeletal system composed of bones and muscles (Esteve et al., 2015). In the whole-body musculoskeletal network, single muscles connect to multiple bones through both origin and insertion points (Murphy *et al*., 2018).

Studies empirically demonstrating the influence of instructional strategies employed in the classrooms on students' understanding of human body systems including muscle and skeleton (Aydin 2013 ; Alkhawaldeh, 2012; Reiss & Tunnicliffe, 2001 ; Sarihavu & Keinonen, 2010). In these studies different methods have been used to examine students' understandings and to detect alternative conceptions in human body system such as multiple-choice questions, drawings and open-ended questions and interview were utilized in order to get an idea about students' understanding on related topics.

The effectiveness of conceptual change text on students' understanding of circulatory system concepts, Alkhawaldeh (2012) studied with 74 ninth grade students from two classes. The classes were randomly assigned as experimental group and control group. The experimental group to receive conceptual change text instruction and the control group taught with traditional instruction. In order to determine students' conceptual understanding the researcher developed a concept test that covers 14 multiple-choice items. Each item of the test had one correct answer and three distracters which reflected students' misconceptions related to the human circulatory

system. The distracters of each item of the test comprise students' general conceptual difficulties and misconceptions derived from the related literature and interviews conducted by the researcher. Students in both experimental and control group were administered the concept test at the beginning of the instruction, at the end of the instruction and after one month period to determine their understanding of concepts. The researcher found significant mean differences between groups in terms of post-test. The results showed that the experimental group students outperformed than control group in terms of conceptual understanding. The researcher argued that instructing the concepts through methods explicitly dealing with the misconceptions of students is more effective for acquisition of scientific conceptions and elimination of misconceptions related with the concept.

Aydin (2013), in their quasi-experimental research design to compare the effectiveness of three instructional techniques namely, technologically-supported mind-mapping technique combined in 5E learning cycle constructivist approach, technologically-supported concept-mapping combined in 5E learning cycle constructivist approach, and curriculum driven instruction on students' understanding of body systems. The sample of the study consisted of 62 6th grade students in three intact classes. Two of the classes were randomly assigned to experimental groups to be taught the concepts through 5E learning cycle instruction. Particularly, students in each experimental group prepared either mind map or concept-map on subjects related with skeletal, muscular, and circulatory and respiratory systems in computer environment. One of the classes assigned as comparison group in which the instruction was carried out based on the activities suggested by curriculum. Students understanding of human body systems concepts were identified using a conceptual understanding test including 13 open-ended questions and interview. The test was implemented pretest at the beginning and posttest at

the end of the instruction. The analysis of the students' responses revealed a meaningful difference in favor of the experimental group which prepared mind-maps. That is, the frequency of correct answers on almost all of the items was higher for students employing technologically-supported mind mapping technique than that of the students in other groups. The study also recognized students' existing misconceptions regarding systems in our body like, skeletal, muscular, and circulatory and respiratory systems. The authors indicated that activities that provide the linkage among the concepts enhance the meaningful learning and contribute to students opinions about understanding science concepts better.

Reiss and Tunnicliffe (2001) explored what the students' understandings of their internal structure through drawings. 158 students in various grades ranging from primary school to college were participated in the study. All students were given a blank page to draw their ideas about what they think exists inside their body. Among the organ systems, digestive system was the one which was the mostly drawn while the muscular system was the least one. The drawings revealed that students' knowledge about the organs and systems increases with the age but there was a general tendency in each grade to reflect independent organs that not connected in a whole system of the body. In other words, the drawings indicated that students observe organ systems as functioning in an isolated manner and they had difficulties in drawing an organ system with its all parts. In this study the result indicated that students' have understanding of their own internal structures.

Sarihavu and Keinonen (2010) explored the changes in 12 year old pupils' conceptions of the organs and systems of the human body. The research was conducted as an intervention study in one Finnish primary school. The instruction was carried out by using the science, technology and society based teaching approach which aims at linking the studying contents to everyday life

contexts. The drawing method was used to catch pupils' conceptions of organs and parts of the body, before and after the teaching period. In addition, nine pupils were interviewed. Results indicate that before teaching, pupils were able to name several organs of the human body, but they had no understanding of how they function and what is their relation with each other. After the teaching period the pupils were able to name more of the organs and explain more clearly their function and meaning**.** The author concludes that, the pupils' conceptual understanding of the human body changed during the study. Although the pupils had quite a lot of information about the organs of the human body, the pupils drew and explained organ systems more accurately after the studying project.

In general students' conceptual understanding of human body system including muscle and skeleton concepts appeared to better when the classroom provides students with opportunities to actively engage in activities that help them recall prior knowledge and identify the associations between the concepts. Additionally, classroom environments promote social interaction with teacher and peers, encourage students to generate questions and seeking solutions, and require teachers act as to encourage and challenge students to construct their own knowledge are likely to causes better gaining of scientific concepts (Alparslan, Tekkaya, & Geban, 2003).

CHAPTER THREE

3. METHODOLOGY

This chapter presents the methodologies which were employed in the study. Hence these common elements such as; research design, study site, population of the study, sampling techniques, intervention plan, sources of data, data gathering instrument, data collection procedures, study variables, data analysis techniques and Ethical considerations of the research were presented.

3.1. Design of the study

In order to investigate the effectiveness of 5E instructional model of constructivist approach on students' conceptual understanding of muscular and skeletal system concepts, the researcher conducted a design-based research process. Design-based research is a systematic study of designing, developing, implementing and evaluating educational interventions. In this study quasi- experimental research design was employed because the study used pre-test and post-test with in experimental and control groups.

3.2. Source of data

The main source of data for this study was grade seven students from Ewket Fana primary school.

3.3. Population of the study

The target population of this study was all grade seven students who learn at Ewket Fana primary school in Bahir Dar during 2011 E.C academic year. According to the information obtained from Ewket Fana primary school record office (2011E.C), there are four sections in each section (A; male=33,female=29, B; male=28, female=38, C; male= 29, female=39, D;

male=27,female=42) and the total number of students for each sections are 265 (male = 117 and female =148).

3.4. Sample size and sampling technique

From the total population**,** the sample of the study consisted of 122 students from grade seven (male = 60 and female = 62) who were in two classes of Ewket Fana primary school during 2011 E.C academic year. Random sampling technique was employed in this study because students are the same grade level. The two different instructional methods used in the study were assigned for the two classes, as experimental and control groups.

Table 1: Sample size used for the study

	Number of students during pre and post test		
Group	Male	Female	Total
Experimental	33	28	61
Control	27	34	61
Total	60	62	122

3.5. Intervention plan

The intervention program of this study was continued for 3 weeks in each week include 3 periods (3 periods per a week) and in each period contain 40 minute. Multiple choice Pre-test was administered before carry out any intervention of instructional design, during intervention; six different sessions were implemented by two different instructional designs, that means intervention program for 5E model instruction was applied on experimental group and traditional instruction also applied on control group and post-test after intervention for both groups . The classroom interventions for all groups were given by the researcher. In general the intervention design was prepared on six subtitles of muscular and skeletal system topics according to the two instructional approaches and also includes the pretest before intervention and posttest after

intervention were given for both control and experimental groups (Intervention plan see in Appendix C).

3.5.1. Teaching approach used for the experimental group

Students in the experimental group received 5E learning cycle instruction for muscular and skeletal system concepts. Six separate 5E learning cycle lessons, first for part of human skeleton (axial and appendicular skeletal), second for type of bones , third for types of joints, fourth for structure and function of muscle ,fifth for type of muscles and the last for muscles and skeletal health were designed. During the implementation of these topics the researcher used 5E learning cycle instruction it consists of five phases, in the first, Engagement phase, students' interest and motivation, to make students focus on the lesson and identify misunderstandings by showing model of human skeleton and asked conceptual questions; identify axial and appendicular skeleton? In the second, Exploration phase, students observed the model of human skeleton and discuss on the questions, in the third Explanation phase, permit students to make sense of their explorations students explain the concept, in the fourth Elaboration phase, gave the students the opportunity to extend their knowledge of concepts to other contexts and finally in Evaluation phase, in which students' understanding were assessed by asking several open ended conceptual questions about muscular and skeletal system. Based on this lesson plan the researcher implemented the lesson about muscular and skeletal system concepts for 3 weeks (Detail 5E learning cycle lesson plan see in Appendix D).

3.5.2 Teaching approach used for the control group

Students in the control group received traditional instructions (lecture methods) which include introduction of the lesson, presentation, summarization and evaluation of the lesson by the teacher researcher. In this teaching approach all activities of the lessons were explained by

the teacher. The content of the lesson includes, first for part of human skeleton (axial and appendicular skeletal), second for type of bones, third for type of joints, fourth for structure and function of muscle, fifth for type of muscles and the last for muscles and skeletal health were designed in traditional way. Based on this lesson plan the researcher implemented the lesson about muscular and skeletal system concepts for 3 weeks (Traditional lesson plan see in Appendix E).

3.6. Data gathering instruments

In this study, muscular and skeletal system conceptual understanding test, classroom observation and informal classroom assessment were used as data collection instruments. The test was applied to both experimental and control group students before and after the treatment application.

3.6.1. Muscular and skeletal system conceptual understanding test

Muscular and skeletal system concepts test is a quantitative method of data gathering instrument. The aim of muscular and skeletal system concepts test was used to measure students' conceptual understanding in muscular and skeletal system concepts' before and after the treatment implementation. This test was developed by the researcher. The test assessed mainly students' conceptual understanding of basic concepts in muscular and skeletal system; axial and appendicular skeleton, structure and function of skeleton, types of bones, types of joints, structure and functions of muscle, types of muscle and muscle and skeleton health. Pretest and posttest are the same questions from muscular and skeletal system topics and the test was administered for both experimental and control groups. The test was consisted of 15 multiple-choice questions. Each questions of the test had one correct answer and three distracters which reflected students' misunderstandings related to muscular and skeletal system concepts. The

clarity of each question in the test was evaluated by classroom biology teacher (List of test questions see in Appendix A).

3.6.2. Observation

The aim of this instrument was to observe the students' activities or reactions towards 5E instructional model for the experimental group and traditional teaching instruction for control group during the treatment and also the researcher used informal classroom assessment at the beginning and end of the lesson implementation. The observations serve to capture complete image of 5E instructional model classroom and traditional classroom. The observation type was semi structured observation, in which it has guidelines to guide the observation process throughout the intervention periods (List of observation check list see in Appendix B).

3.7. Data gathering procedures

The data for this study was gathered three times-before intervention, during intervention and after intervention. Before the researcher intervene of 5E instructional model of constructivist approach and traditional way of teaching instructions, researcher gave pretest about muscular and skeletal system concepts for both control and experimental groups. This pre-test was used to determine the prior understanding of students' about muscular and skeletal system concepts. During intervention, the students were taught using 5E instructional model of constructivist approach and traditional way of teaching instructions, the researcher observed the classroom behavior; students' engagement, materials used in presentation that integrate to muscular and skeletal system concepts from real world and students' participations and also used informal classroom assessment at the beginning and end of the lessons. After intervention, muscular and skeletal system concepts post-test was given for both control and experimental groups. This

posttest was used to measure the conceptual understanding change of students' in muscular and skeletal system concepts.

3.8. Variables

3.8.1. Independent variables

In this research, the independent variables were two different types of treatments; instruction based on 5E instructional model of constructivist approach (5E learning cycle model) and traditionally designed Biology instruction (traditional classroom instruction) were the independent variables.

1.8.2. Dependent variable

The dependent variable was students' conceptual understanding of muscular and skeletal system concepts.

3.9. Data analysis techniques

In order to investigate the effectiveness of 5E instructional model of constructivist approach on students' conceptual understanding of muscular and skeletal system concepts, pre-test and post-test scores were analyzed quantitatively. To check the difference between the two approaches of teaching on students' conceptual understanding, pre-test and post-test mean values were compared, whereas to calculate whether there is a significant difference or not on the 5E instructional model of constructivist approach and traditional teaching instructions on the students' conceptual understanding, descriptive statistics, paired sample t-test and independent sample t-test were employed. The results were compared at "0.05" level of significance (α = 0.05) and 95% of confidence interval by using SPSS program version 21. The information obtained from classroom observation and pre-post informal classroom assessments were

analyzed qualitatively through narration. Therefore, in this study both quantitative and qualitative data analysis techniques were employed.

3.10. Ethical considerations of the research

During conducting the research, the researcher announced that the study never harmed the participants' academic program as it was never for other purpose. It is clear that without the student permission, no data disposed for other party. Additionally, the researcher asked and got permission to conduct this study under the stated area from a responsible body of the school director.

CHAPTER FOUR

4. RESULTS

The results of this study were reported under the titles; statistical analysis of pre-test and post-test results, result from informal classroom assessment and classroom observation with regard to the research questions.

Therefore, this study aims to investigate three main research questions. The first research question, which addresses the instructions effectiveness, between-group differences; (Is there a significant difference in the test score of students' taught with 5E instructional model of constructivist approach and those taught with traditionally designed instruction?) to answer this research question the data obtained from pre and post muscular and skeletal system understanding test.

The second research question, which also address the effectiveness of treatment on the variable; (Do students' have better conceptual understanding of muscular and skeletal system when they are taught through 5E instructional model of constructivist approach?) to answer this research question the data also obtained from pre and post muscular and skeletal system understanding test and informal classroom assessment or classroom conversation, the third research question, which address the overall students' activities in the classroom (What is the students' reaction towards the new methodology?) to answer this research question data obtained from classroom observation..

4.1. Statistical analysis of pretest and posttest results

4.1.1. Descriptive statistics analysis of pre and post test results for both groups

The mean, standard deviation, minimum and maximum of pre-test and post-test for both experimental and control groups of muscular and skeletal system understanding test scores were

presented in Table 2. Both experimental and control group students pretest and post test results out of 15% presented in appendix part (See in Appendix F).

Table 2: Descriptive statistics of pretest and posttest results for both experimental and control groups

Test	Group	N	Mean	Standard deviation	Minimum	Maximum
Pre-test	Experimental	61	3.623	1.7143	0.0	7.0
	Control	61	3.918	1.4177	0.0	7.0
Posttest	Experimental	61	10.311	2.4395	6.0	15.0
	Control	61	6.934	1.4361	3.0	10.0

As presented in table 2, before intervention, the pretest result of experimental group (Mean= 3.623, Standard deviation = 1.7143, Minimum score = 0 and Maximum score = 7), and control group was at the Mean = 3.918, Standard deviation = 1.4177 and the same range of Minimum and Maximum score from experimental group. In both groups, the Maximum value of pretest score is 7, it appeared to be under the midpoint of the test result.

After intervention, the students in the experimental groups who were engaged in 5E instructional model of constructivist approach oriented instruction demonstrated better understanding (Mean=10.311, Standard deviation=2.4395, Minimum= 6.0 and Maximum= 15.0) over the control group students who were engaged in traditional teaching instruction (Mean= 6.934, standard deviation = 1.4361, Minimum = 3.0 and Maximum = 10.0). Therefore, the result showed that before intervention in both group students had low level of prior understanding on the concepts however, after intervention experimental group students had better understanding on muscular and skeletal system concepts that compared with control group students.

4.1.2. Inferential statistics analysis of data from pre and post test score

4.1.2.1. Paired sample t- test analysis of pre and post test scores

Paired sample t-test is repeated measures test within-subjects design commonly used comparing a mean of difference scores before and after designs intervention. To compare the effectiveness of instructions on experimental and control groups by conducting paired sample t-test for pre and post test scores of each group as shown in Table 3.

Table 3: Paired sample t-test for both experimental and control groups pre-post test results

Group	Paired samples statistics			Paired differences				t	df	Sig(2-tailed) (p value)
Experimental group	N	Mean	Std. deviation	Mean difference	Std. deviation	95%of confidence interval of the difference				
						Lower	Upper			
Pretest	61	3.623	1.7143	6.688	2.4395	6.0637	7.3133	21.413	60	0.000
Post test	61	10.311	2.4395							
Control group										
Pre test	61	3.918	1.4177	3.016	1.8119	2.5523	3.4804	13.002	60	0.000
Post test	61	6.934	1.4361							

P value is significant at P< 0.05

As shown in Table 3, the experimental group showed mean increase ranging from 3.623 to 10.311 in their level of muscular and skeletal system understanding from the pretest to posttest scores. In this group t (60) =21.413, p=0.000; ($P<\alpha$) this means 0.000<0.05 at α=0.05. However, the control group showed a mean increase ranging from 3.918 to 6.934 in their level of muscular and skeletal system understanding from the pretest to posttest score and t (60) =13.002, p=0.000; ($P<\alpha$) this means 0.000<0.05 at α=0.05. Therefore, experimental group shows a mean

difference of 6.688 whereas the change in control group is 3.016 points on the muscular and skeletal system understanding test score. Even there was an increase in understanding level of both groups, the control group students could not gain as many score as the experimental group mean score on pre-posttest compared. Experimental group reflects a stronger mean significant effectiveness of 5E instructional model of constructivist approach on students' understanding comparing with the effectiveness of traditional teaching approach. Therefore, the result of this study showed that the experimental group students gained more muscular and skeletal system concepts understanding than the control group students**.** The pre- posttest comparison of students in experimental group use of 5E instructional model of constructivist approach to learn muscular and skeletal system concepts to indicate that higher mean differences between pre-test and post-test results were observed in favor of post-test. This implies that, students in experimental group shown significant changes in minimizing of misunderstanding in muscular and skeletal system concepts.

4.1.2.2. Independent sample t- test analysis of pre and post test scores

4.1.2.2.1. Analysis of pre-test score for experimental and control groups

Pre-test score of students in the experimental and control group independent sample t-test was used to determine whether there is a statistically significant difference between experimental and control group students' score in the understanding test for muscular and skeletal system used as pre-test as seen in Table 4.

Table 4: Independent sample t-test of pre-test result of both experimental and control groups

Group	**t-test for equality of means**					
Experimental and control	t	df	Sig.(2-tailed) (P-value)	Mean difference	95% of confidence interval of the difference	
					Lower	Upper
	1.036	120	0.302	0.295	-0.26885	0.85902

P value is not significant at P>0.05

As seen in Table 4, there is no significant difference between control group and experimental group based on their pre muscular and skeletal system understanding tests score at t (120) =1.036, (P>α) this means 0.302 >0.05 at α=0.05 and Sig (2-tailed) means p value=0.302, there was zero at the lower and upper boundary at 95% of confidence interval because negative at lower boundary and positive at upper boundary, and the mean difference between them was 0.295. The mean difference score of the control and experimental groups were very close to each other, as the result, before intervention these two groups were considered as equal understanding for muscular and skeletal system concepts. When the result of pretest muscular and skeletal system test examined it can be conclude that there was no significant mean difference score. Since the mean score of the control and experimental groups were very close to each other, it can be said that these students had nearly similar level of prior understanding on muscular and skeletal system concepts before lesson implementation (intervention).

4.1.2.2.2. Analysis of post- test score for experimental and control groups

During the comparison of post-test score independent sample t-test was used to determine whether there is a statistically significant difference between experimental and control group as presented in Table 5. Students in the experimental group, where the 5E learning cycle model based on the constructivist approach was used, and students in the control group, where

the traditional teaching instruction was used in understanding test about muscular and skeletal system concepts.

Table 5: Independent sample t-test of post-test result of both experimental and control groups

Group	**t-test for equality of means**					
Experimental and control	t	df	Sig.(2-tailed) (P-value)	Mean difference	95% of confidence interval of the difference	
					Lower	Upper
	9.317	97.125	0.000	3.377	2.65769	4.09640

P value is significant at P< 0.05

According to Table 5, the result showed that there is a significant difference between the posttest of the students' taught by 5E instructional model of constructivist approach and those taught by traditional teaching instruction with respect to human muscular and skeletal system concepts. Based on their post muscular and skeletal system understanding tests score at t (97.125) = 9.317, ($P<\alpha$) this means 0.000<0.05 at α=0.05 and Sig (2-tailed) means p value=0.000, there was no zero between the lower and upper boundary at 95% of confidence interval because positive value at both lower and upper boundary, the mean difference between experimental and control groups were 3.377. Students' in the experimental group who were engaged in the 5E instructional model of constructivist approach oriented instruction demonstrated better understanding on muscular and skeletal system concepts over the control group students. As the result, after intervention these two groups cannot be considered as equal understanding for muscular and skeletal system concepts. So the researcher conclude that instruction based on the 5E instructional model of constructivist approach group students understood the muscular and skeletal system concepts significantly better than the group taught by traditionally designed biology instruction. Therefore, the 5E instructional model based on the constructivist approach used in the experimental group is more effective in teaching muscular and skeletal system

concepts for students' misconception eliminated than that of the traditional teaching method used in the control group.

4.2. Result obtained from informal classroom assessment

In addition to pretest and posttest, the researcher also conducted open-ended informal assessment questions for both experimental and control groups at the beginning and at the end of the implementation period used as pre and post classroom conversation on muscular and skeletal system concepts.

Before lesson design intervention, that means 5E instructional model of constructivist approach for experimental group and traditional teaching instruction for control group, the researcher identified students' misconception on muscular and skeletal system concepts about part of human skeleton (axial and appendicular skeleton) structure and functions, Bones, joints, types of muscles structure and function in our body and the work of muscular and skeletal system together in human body and the health of mussels and skeleton by using open ended pre informal classroom assessment questions.

Before and after lesson implementation period, open ended questions were used as pre and post informal classroom assessment (conversations) were conducted to gain detailed data on students understanding of muscular and skeletal system concepts. Pre informal classroom assessment served as in order to determine what prior understanding students already had on these concepts. The purpose of post informal classroom assessment was to determine the effectiveness of teaching approach on students' conceptual understanding change in the concepts of muscular and skeletal system.

Students' from experimental group and control group were asked the concepts orally and students' answered orally, and by drawing the human skeleton on their notebook and work paper

to the following six questions. Students' were asked: *To draw the structure of human skeleton, label the name of bones in axial and appendicular parts and explain their functions? Explain the structures and role of skeleton in our body? Are bones alive or dead inside the living body? Why? Explain how do muscles work inside human body? We cannot twist our waist as much as we can twist our arm. We cannot move our necks as much as we can move our fingers. What is the reason for this? Explain how the muscular and skeletal systems work together to produce movement?* All these questions were used to expose students' misconception on the topics that related to muscular and skeletal system concepts before lesson implementation as pre informal classroom assessment and what conceptual understanding change occurred after lesson implementation as post informal classroom assessment during classroom conversations.

Pre informal classroom assessment result; Students' answered on muscular and skeletal system concepts before lesson design intervention that is, 5E instructional model of constructivist approach for experimental group and traditional teaching instruction for the control group.

The first question the researcher asked for the students: *To draw the structure of human skeleton, label the name of bones in axial and appendicular parts and explain their functions?* Before implementation period, most of students' in both control and experimental group idea on this question about the general structure of human skeleton; most students' simply drawn the diagram of human picture, the skeletal system was absent in the drawings, did not label the name of skeletal parts and also students' did not explain their functions and some students' responded that, "I don't know the structure of internal body." Therefore, in this question both experimental and control group students had difficulty of understanding in human internal body structure like our skeletal system parts; location and function of bones in our body as shown in figure 3.

Figure 3: Drawing of human skeleton during pre-assessment by both groups

The researcher asked the second question: *Explain the structures and role of skeleton in our body*? Most of experimental group students' idea on this question before learning held misconception is that, "skeleton is a part of bone in our body." "Only one bone found in our body this is skeleton," "the only function of the skeletal system is to support the body." I asked the same question for control group; the common misconception that found in this group is that, "the only function of the skeletal system is to support the body." Therefore, students' in both groups had a common misconception about the structure and function of our skeletal system.

Students' idea on the third question about the general characteristics of bones: *Are bones alive or dead inside the living body? Why?* Most students in experimental group held misconception about bones. Students said that, "bones are not living structures, bones are not alive because they don't need oxygen, food and others, don't contain cells," "bones are solid they don't have spaces, bones are purely hard objects and are not living." Control group students idea about bones; many students held the misconception about bones, bones are not living organ because bones contain nonliving materials like minerals, and also we see those most often in skeletons. The bones in skeletons are not living because it is hard. One student said that "I always understand that bones were solid throughout no hollow," "bones are non-living organ

because it can be controlled by our brain." All these answers were from both control and experimental groups of students, showing that the students held many misunderstanding about bones before learning the topics related to bones.

The researcher asked the fourth question: *Explain how muscles work inside human body?* For both experimental and control groups. Most students answered this question; muscles work inside our body and are only used for voluntary physical actions like walking, running or throwing. "Muscles are only involved by voluntary movement, muscle only found on the humerus of upper arms." To answer this question both group of students reflected a common misconception about the structure and function of muscle in our body that misconception include, muscles are used only for voluntary activities, and muscle only found on the upper arms. Before teaching period, both group students had a misconception on muscle activities and location in human body.

The researcher asked the fifth question, for both experimental and control groups; this question related to joints in our body: *We cannot twist our waist as much as we can twist our arm. We cannot move our necks as much as we can move our fingers. What is the reason for this?* The common misconception that identified from both experimental and control group students' said that "we can twist our arm and fingers because they are thin, little. We cannot twist our waists and necks because they are dense, thick, fat and large structure." This result indicated that both group students' had difficulty about joints in human body.

The researcher asked the last question that is: *Explain how the muscular and skeletal systems work together to produce movement?* Both control and experimental group students' answered, to reflect common misconception that is "muscles push the things around the bones to make them move,'' "muscles are directly attached to bones without connective tissue," "and

joints allow us to move". In this case, students did not understand the connective tissue function in the human body. This result showed that both control and experimental group students' had a common misconception on the movement human body.

Teaching strategy, based on students' misconceptions that obtained from the pre informal classroom assessment questions or students' misconceptions on muscular and skeletal system concepts, the researcher leads to construct conceptual understanding change teaching strategy. So how to eliminate students' misconception on the muscular and skeletal system concepts; part of human skeleton structure and functions, bones, joints, structure and functions of muscles by using the 5E instructional model of constructivist approach for experimental group students that compared to traditional teaching instructions for control group. Therefore, the description of classroom activities for both experimental and control groups as follows;

Experimental group teaching strategy, during the course instruction, experimental group students received the 5E learning cycle instruction which involves hands-on and minds-on activities to recall prior knowledge, increase curiosity, engage students to learn, provide them to explore the concepts and explain their understanding, apply their knowledge in new situations and evaluate students' understanding on the concepts. The instruction followed five phases designed based on the constructivist views in 5E learning cycle model (Engage, Explore, Explain, Elaborate, Evaluate) was used to implement on muscular and skeletal system contents about axial and appendicular part of human skeleton structure and functions, types of bones, types of joints, structure and function of muscles and muscular and skeletal health in our body. The five phase of learning cycle was appropriate guide for used in the lesson design of these concepts implementation. The activities involved in each phases of learning cycle as follows;

Engage phase; in this first phase of learning cycle, the researcher captured the students' interest on the lesson by showing model of human skeleton, arm model, cattle bones and video as shown in figure 4 and asked questions like, what is the frame of our body? How do we stand? How do we move? What is the difference between bone and skeleton? List parts of skeleton draw axial and appendicular skeletons correctly, label the major bones correctly and write functions skeleton on your body, what do protect our vital organs like heart and brain? Are bones a living organ in our body? Why? Are all joints movable in our body? How muscle work in our body? Explain the effect physical exercises, proper diet and rest deficiency in muscle and skeleton system health? To know more about the structure and function of joints and muscles, how they work, then I asked some probing questions like; what would happen if we do not have any joints? Why cannot move neck as much as arms? Why do you think you can control the movement of your arm and but not your heart? These questions aimed to connect the topic with students' daily life activity and elicit students' prior knowledge, students asked themselves: "What do I already know about these topics?" The researcher had opportunity to assess students' prior understanding and identify possible misconceptions on muscular and skeletal system contents. Students were mentioned about the basic terminologies like part of human skeleton, axial and appendicular, types of bones, the parts of bones, marrow, cartilage, types of joints and muscles. Students' also stated about the structure and function of bones, marrow, muscles and joints, as well as how the bones in their body are classified. This student-centered phase should be a motivational period that can create a desire to learn more about these topics. I did not present the correct answers of these questions but I asked more questions to extend their ideas.

Figure 4: Teaching materials used in engage phase

Explore phase; following an engagement phase, Explore phase promote a mental focus students' on the concepts, students' used hands-on activities by using human skeletal model ,arm model, cattle bone and video ,guide students in inquiry, before any formal explanation of terms, definitions of the concepts are discussed or explained by the teacher. The students formed groups to explore the human skeletal model, cattle bones and arm model. I encouraged the students to work together without direct instruction by asking probing questions to redirect the students; question like, describe the function of skull, ribs, skull, vertebral column?, students' were observed the human skeletal model and used their own body and students were allowed to discuss the question in groups by using their previous knowledge related to muscle and skeleton concepts. Students' were examined the model of human skeleton in group identify Axial (skull, ribs, skull, vertebral column) and Appendicular skeleton (shoulder, limb, hip) from the model, Students' classified the bones based on size and shape, students explored the types of movement allowed by each type of joints, students' investigated and developed their practice skills by demonstrate how muscles work using their body movement, encouraged students to think about the joints. In all activities of exploration phase students were encouraged to work in a cooperative learning environment without direct instruction from the teacher, teacher act as facilitator of students' discussion and investigation as shown in Figure 5.

Figure 5: Students investigation in explore phases

Explain phase; the explanation phase is a minds-on activity part of the 5E lesson that follows the exploration phase. Before the teacher explanation, the students had an opportunity to express their own explanations and ideas on muscular and skeletal system concepts. The explanation phase students to describe their understanding and pose questions about the concepts. This is teacher-directed and guided by the students' prior experience during the exploration phase. Thus, the initial part of the explanation phase is a time for the teacher to serve as a facilitator and asked the students to describe and discuss their exploration learning experiences. As seen in Figure 6, students' reflect their observations and ideas such as; bones are hard and strong', the older bone is longer than the younger bone, bones grow as you grow older', and type of bones are long bones, short bones, and flat bones. Students' own classification of bones were varied and some of them confused with the joints since they used terms like

movable, immovable, Joint provides the connectivity between two bones in the human body, if our body had no joints, then it would be similar to a set of unconnected bones it result unable to move because joints are responsible for making the skeleton flexible by connecting the bones together. At this point these students were asked how they decided if the bone is able to move or not, and encouraged to think about the joints. After the students' explanations of the concepts, I introduced scientific information in a direct manner. This phase includes clarification of student misconceptions that may have emerged during the engagement or exploration phases.

Figure 6: Image of the students explaining the concepts

Elaborate phase; in this phase students related the concepts of muscular and skeletal system on their own body parts. The activities in this phase of the learning cycle should encourage students to apply their new understanding of concepts. Students were encouraged to check for understanding with their groups; the goal of this phase is to help develop students understanding of the concepts. In elaboration activities; students' observed the movement of body joints, types of bones, and muscles by using video and applied it on their own body as shown in Figure 7.

Figure 7: Students' activity in elaborate phase

Evaluate; I assessed students understanding by asking open ended questions such as; what is the frame of our body? What is the difference between bone and skeleton? List parts of skeleton draw axial and appendicular skeletons correctly, label the major bones correctly and write functions skeleton on your body, what do protect our vital organs like heart and brain? Do you know a name of bone in your body? Are bones a living organ in our body? Why? Are all joints movable in our body? How muscle work in our body? Explain the effect physical exercises, proper diet and rest deficiency in muscle and skeleton system? Students have answered these question using evidence from previous experiences (from engage, explore explain and elaboration phases) as shown in Figure 8.

Figure 8: Students activity in evaluate phase

Control group teaching strategy; during the course instruction, traditional teaching was limited to my control group I started the lesson by introducing, and explaining the topics that were going to taught; muscular and skeletal system contents such as; part human skeleton, types of bone, types of joints, structure and functions of muscles and muscle and skeletal health these all contents activities were explained by the teacher, teaching aids were used explained and demonstrated by the teacher, students' were follow teacher instruction, without allowing time for students to reflect on the material presented, related it to previous knowledge or applied it to real life situations. Students followed teacher explanation and activities suggested in the textbook. Therefore, in traditional teaching approach students were passive involvement in these lessons as shown in Figure 9.

Figure 9: Students' sitting in traditional classroom

Post informal classroom assessment result; after the lessons implemented by the above teaching approach; 5E instructional model of constructivist approach for experimental group and traditional teaching instruction for control group. Post informal classroom assessment questions were asked to both groups of students at end of lesson implementation period in order to measure students' conceptual understanding change on muscular and skeletal system concepts.

Experimental group students' understanding change on the first question about the general structure of human skeleton. After intervention, the researcher asked the students: *To draw the structure of human skeleton, label the name of bones in axial and appendicular parts and explain their functions?* In this question, most of experimental group students' have drawn the appropriate structure of human skeleton, labeled the name of bones and differentiated axial and appendicular parts of bones and explained their functions as shown Figure10.

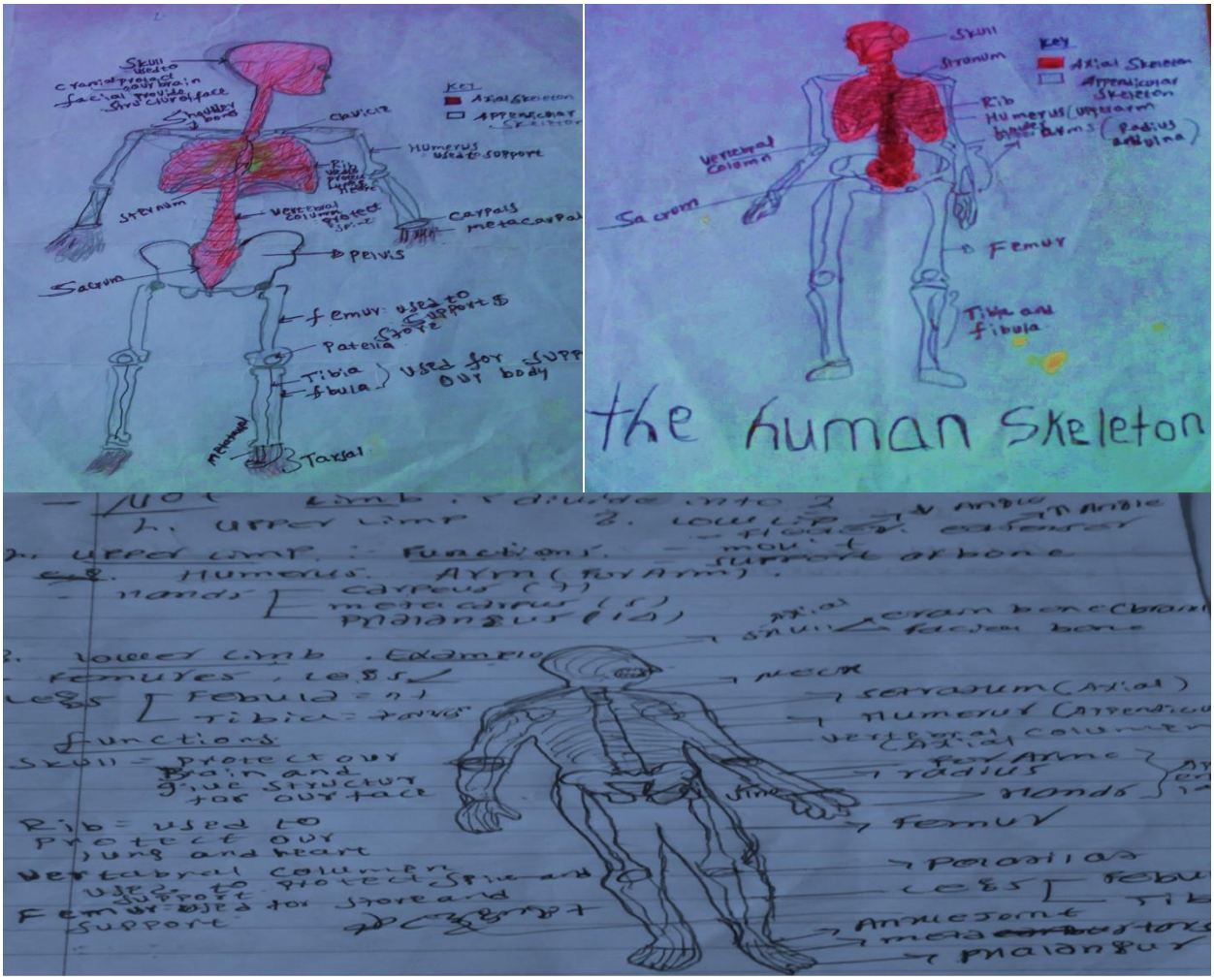

Figure 10: Drawing of human skeleton during post assessment by experimental group

These idea basically developed by using 5E learning cycle phases, during engage phase, the researcher asked questions and showed the model of human skeleton, Explore phase, students' observed the human skeletal model, Explain phase, in this phase students explain the

concept that observed from the hand on activities of exploration phase, in Elaboration phase students related the concept to their own body, at Evaluation phase, I asked the conceptual questions on part of human skeleton lesson. These all student activities in each phase were important to change students' conceptual understanding on the concept of skeleton.

However, most of students in control group to answer this question simply drawn the picture of human skeleton label the name of bones without explanation of the functions and did not differentiated the bones as axial and appendicular parts as shown in Figure 11.

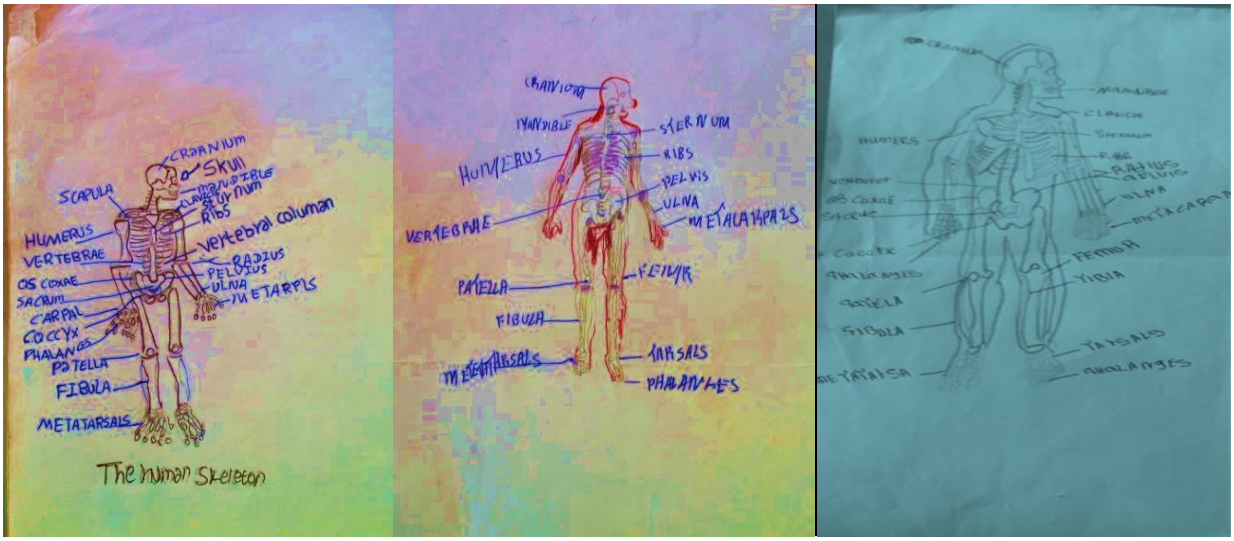

Figure 11: Drawing of human skeleton during post assessment by control group students

These limitation of understanding occurred due to passive participation of students in human skeletal system concepts. The result showed that experimental group students had a better conceptual understanding that compared with students in control group.

The second post informal assessment question: *Explain the structures and role of skeleton in our body?* After the lesson intervention period, most experimental group students' had answered surprising facts about the skeletal system. Students said that, "skeleton is the internal framework of our body that contained 206 bones for adults and new born baby has 350 bones." Why the number of bones new born baby greater than adults? "Because bones in new

born baby over time fuse together then the number decrease," "bone is a single part of skeleton; many bones make up skeleton so bone is like a branch of tree in our body." The role of skeleton in our body, "to provide support and movements of the body for walking, running, the skeleton has protective and storage, blood cell production in bone marrow." It protects the internal organs, including "the brain by cranial bone, spinal cord by vertebral column, heart and lung by ribs and storage of minerals like calcium."

These conceptual understanding changes of experimental group students on the concept of structure and function of skeleton in human body should be developed by using five phase of constructivist instructional model, to engage the students by showing the human skeletal model and asked questions what is the difference between bone and skeleton, students asked themselves: what do I already know about this question? Then explore students' by doing a hand on activities in groups to observe the skeletal model and discussed the questions, I facilitated student discussion after exploration phase students' were reflected their observations and ideas, after the students' explanations of the concepts, I introduced scientific and technical information after explanation phase students were relate the observed mode on to their own body parts identified the structure and function finally I assessed students' understanding by asking different open ended questions. By these sequences of the learning phase students should have a better understanding, to eliminate their misconception on the role and structure of skeleton in human body. But after implementation period two students from this group mentioned that, "the only function of the skeleton is supporting our body and protects the internal organs" but not mentioned other functions and the structures.

Control group students have answered this question partially; there are 206 bones in adults and 350 bones in new born baby, there are four functions of skeleton support, movements,

protective and storage. Most of students' in control group could not be told the reason why baby bones greater than adult and simply told the general term for the function of skeleton. Students in control group answered knowledge questions but did not answer reasoning questions because students' followed the teacher explanation and demonstration of the concepts, without participate the activities of the lesson. Therefore to compere the experimental and control group conceptual understanding change on structure and function of skeleton concepts students learned by the 5E instructional model of constructivist approach most students respond correctly than that of traditional teaching instruction. The result has shown that experimental group students had better conceptual understanding on the concept of skeleton characteristics and role in our body that compared with control group students.

The third question: *Are bones alive or dead inside the living body? Why?* Most of experimental group students' answered this question scientifically correct, students said that "Bones are living organ in our body because; bones contain living cells they form the blood cells in bone marrow, the bone marrow is found the hallow space of our bones" and also "Bones are a living organ because it needs oxygen for blood supply, it needs nutrients and vitamins for repairing, growing and health, it needs minerals like calcium for strength and hardness, bones continue to grow until people are 18-25 years old." These interesting answers make sure they realized that bones consist of living tissues. And also students' classified bones based on size and shape as, long bone, short bone and flat bone and give examples for each and also identified its positions on the given model and their own body.

These conceptual understanding changes of the experimental group students on types of bone lesson should be developed by using five phase of constructivist instructional model, during the Engagement phase, captured the students' interest by shown model of human skeleton and

asked questions, Explore phase promote a mental focus students' on the concepts, students' did hands-on activities by using human skeletal model, cattle bones used for bone classification, students discussed the concept in group based on the hand on activities and questions, Explain phase; this phase is a minds-on activity that follows the exploration phase. Before I explained the concepts, the students had an opportunity to express their own explanations and ideas on bones and the types of bone concepts. The explanation phase students to describe their understanding and pose questions about the concepts, at elaboration phase students related the concept on their own daily life activities for example; students compare the length of baby and adult bones this got an idea on bones can grow and it can need nutrients from food and vitamin D from sun light, at evaluation phase the researcher asked the open ended questions that related to bones. Therefore, students in experimental group captured more conceptual understanding on bone concepts throughout the learning phases.

The researcher also asked this question for the control group students, most of students in this group answered this question; Bones are living tissue in our body but did not told the reason why bones as a living, bones are hollow but did not understand the space filled with it. Students in control group answered knowledge questions but didn't answer reasoning questions because students followed the teacher explanation and demonstration of the concepts, without allowing time for students to reflect on the material presented. This result indicated that, from bones concepts experimental group students had more conceptual understanding change that compared with control group students.

The fourth question that concerned about muscles that is: *Explain how do muscles work inside human body?* Most of experimental group students' answered this question correctly by using detailed explanation and gave examples, students' said that, "muscles are involved in body

movement; muscles work together in pair in antagonistic manner." "One muscle pulls while the other muscle relaxes (one muscle in the pair contract the other must relax) for example; to bend our arm at the elbow, the following sequences of event would takes place. The biceps contracts and at the same time triceps relaxes; this is the skeletal system voluntary movement of muscles, in our heart also, the upper chamber contract the lower chamber relax during this time blood pumping occurred in our body involuntary movement." Make sure students realize that smooth and cardiac muscles inside the body contract involuntarily to control important body functions, such as moving food through the digestive system and pumping the heart by involuntary manner, the involuntary muscles controlled by the nervous system and skeletal muscles contract voluntarily under controlled, muscles also found in all part of the body. One student said that "smooth muscle used as blood pumping because found in the walls of blood vessels" this is not correct, (in fact, it squeezes the stream of blood flowing through the vessels to help maintain blood pressure).

These conceptual understanding change for experimental group students had developed by using 5E learning cycle model, students' used a hand on activities by using human arm model, students' were observed and discussed the antagonistic movement and explain their understanding on the concepts then students' had related the concept to their daily life activities of our body muscles movement.

Whereas, the control group students have answered this question by memorizing from the teacher explanation, most of students' answered this question, muscles work inside our body by contraction and relaxation process of arms. Some students responded that; "voluntary muscles include skeletal muscle, and involuntary muscles include smooth and cardiac muscles." Control group students have answered this question without detailed explanation of the concepts.

Students in control group taught with teacher directed explanation and demonstration, students are passive. Therefore, the result has shown that most of the experimental group students answered the questions briefly that compared with the control group students.

For the fifth question that concerned about types of joints in our body: *We cannot twist our waist as much as we can twist our arm. We cannot move our necks as much as we can move our fingers. What is the reason for this?* They did meet my expectations because most of the experimental group students have answered this question correctly. Students in this group said that, "we can twist our arm and fingers because joints in arm and fingers allow us to move in many different directions we cannot twist our waist and necks because joints in waist and neck don't allow for much movement." "The range of Waist movement is quite limited," because it made up of the five vertebrae that emerge from the pelvis bone we always use it related to other stretches, it allowed considerable motion. "The neck corresponds to the vertebrae in the spine.'' They are like stacked cylinders separated by a cushion, so their range of movement is limited. "The arm is being composed of two parallel bones, for this reason the arm can twist in both directions.'' "Fingers can be quite flexible as well when they bend back," because hinge joints allow movement in back and forth directions. In general flexibility is the ability to stretch a joint to the limit of its range of movement and how joints can and cannot move. These answers were a surprising explanation and scientific facts on the concept of joints in our body. So this conceptual understanding change was the result of the 5E instructional model of constructivist approach, students followed the five-phase of learning cycle to use hand on activities, students used human skeletal model, video and arm model observed and discussed on each type of joints and how to limit their movement and mind on activities explain the concept and extend their understanding related the concept by using their own body movements.

However, most of the control group students have responded to this question by memorizing without detailed explanation. Students' answered that, "In gliding joints found in neck and waist, hinge joint found finger, ball and socket joints found in shoulders and hips.'' These all answer simply list the types of joints and their examples without reason why movements limited in our body, this difficulty was the result of students passive involvement in the lesson. From the control group one student answered partially reasonable; "We can twist our arms and fingers because joints in arm and fingers allow us to move but we cannot twist our waists and necks because joints in waists and necks not allow us to move." The result shows that most experimental group students were given reasonable answer for this question that compared with control groups. Therefore, experimental group students taught with the 5E instructional model of constructivist approach more conceptual understanding change in these concepts that compared with control group students taught with traditional teaching instruction.

The researcher asked the last question that is: *Explain how the muscular and skeletal systems work together to produce movement?* For both groups, this question addressed how muscles and skeleton connect and work in our body. After intervention, most of experimental group students answered this question; "muscles contract and pull on tendons," which pull on the bones to create movement because muscles connect to bone by tendon connective tissue, the skeletal system is covered with muscles that enable us to move. Muscles are attached to the bones through tendons and stretch from one end of the bone to the other. Our bones and muscles work together to make move through a series of signal communicated between the brain and skeletal muscles. Some students in this group stated that, muscular system consists of skeletal muscles (attached to the skeleton), "skeletal muscles are attached to bones by tendons," "ligaments connect bones to bones to form joints" and ligaments used to hold structures together

and keep them stable. “Bone and joints have no power to move on their own because it needs tendons because muscles connect to bones by tendon, muscles pull on tendons to create movement.” “The muscular and skeletal systems work together like a pulley system.’’ The skeletal system and muscular system work together as the framework for the body as well as providing the parts that allow for movement. All these above-stated were the correct answer. But one student said that, “muscles can push on bones,” this is not correct, (in fact muscles can pull on bones, but they can't push them back to their original position, so the muscles work in pairs of relaxation and contraction).

Most of the students’ have eliminated their misconception on muscular and skeletal system work in our body movement by using the 5E instructional model of constructivist approach, shown human skeletal model, arm model, video and asked questions as an engage, then student observed, demonstrated and discussed on the hand on activities teacher asked probing questions a students reflected their idea, then teacher introduce the scientific information, then students extend their understanding related the concepts to their own body activities, finally I assessed students understanding by asking open ended conceptual questions like, describe how bones, joints, ligaments, tendons and muscles work together in human body? Based on these all above activities students were developed their understanding on the role of bones, joints, ligaments, tendons and muscles in our body movement.

However, most of the control group students answered this question, muscles and skeletons have a special job. “Skeletons help us with posture and muscles to create movement, muscles give our strength, skeleton used for mineral storage.” These students answered about the functions of the systems individually, but did not make the connection between muscles and skeleton work in our body. Some students said that, tendons used to connect bone to mussels but

did not explain the movement between them. Control group students' answered this question by memorizing what the teacher explained and demonstrated during the lesson and based on the text book reading without active classroom involvement. Therefore, this result shows that experimental group students had better understanding on these concepts than control group students.

4.3. Result obtained from classroom observation

Classroom observation was used to evaluate various aspects of lesson presentation with regard to students' roles in the 5E instructional model of constructivist approach and traditional instruction on muscular and skeletal system lesson. Therefore during the intervention program the researcher did self-observation on students' classroom activities based on the observation checklists (See in Appendix B).

4.3.1. Observation in experimental group classroom

In the implementation program the researcher observed that the overall activities of students' participation, interaction with in the teaching materials, interaction among the groups, students' interaction when taught with the new methodology; 5E instructional model and the ability to answer conceptual questions and relate the concept to daily life experience on muscular and skeletal system concepts.

During 5E instructional model of constructivist approach implementation, the researcher observed the participation of students' in each contents of muscular and skeletal system lesson. Students' participated highly, students' raise their hand and presented the concepts like, part of human skeleton types of bones, joints, and muscles. Learners participated highly in the lessons that were observed. The use of 5E instructional model of constructivist approach in muscular and

skeletal system lesson had a positive effect on students' willingness to be actively engaged in the learning process as shown in Figure 12.

Figure 12: Students' participation in experimental group classroom

When the researcher observed the students interaction with the teaching material in muscular and skeletal system topics implemented by 5E learning cycle model, most of the students' were greatly allowed to interact with the teaching materials. Students' used the appropriate teaching material that related to the topic of the lesson such as, human skeleton model, cattle bones and arm model these all teaching material that used to explain part of human skeleton positions, joints size and shape of bones, cattle bones also used to differentiate shape of bones and arm model used to show the movement of muscle in our arms. In all of the lessons, learners were sufficiently allowed to interact with the teaching aids as shown in Figure13.

Figure 13: Students interaction with teaching materials in experimental group

The researcher observed the students interact with each other, students had greatly interacted among the group in all of the muscular and skeletal system lessons implementation with 5E lesson design. This was possible because learners were directly involved in the group discussion during the exploration phase and the teacher only served to facilitate them. The muscular and skeletal system lessons were, characterized by high involvement of the student within the groups and encouraged collaborative learning. Various form of thoughtful discussion and dialogue among the group members as shown in Figure 14.

Figure 14: Students' interaction among the group in experimental group

The researcher also observed students interaction when taught with 5E instructional model of constructivist approach, this learning cycle consists of five phases; Engage, Explore, Explain, Elaborate, Evaluation. During the implementation of this learning cycle phase on the muscular and skeletal system concepts, the researcher observed the students' interaction in each phases.

When the researcher, observed the first Phase of the learning cycle, students' engaged by teaching models like, human skeletal model, arm model and cattle bones were capture the students' interest towards muscular and skeletal system concepts as shown in Figure 15.

Figure 15: In engage phase for the image of materials and students' interest

When the researcher observed the explore phase the students involved in hand on activity, during this activity, the students have a time to observe the skeletal model then differentiated the part of human skeleton as axial and appendicular and also identified bones found in axial and appendicular skeleton, students' identified the movable and immovable joints; movable joints that found in shoulder, elbow, knee and hip shape and size of bones; cattle bones also to differentiated shape of bones, used arm model to investigate how skeletal muscle work in our body as shown in Figure 16.

Figure 16: Image of students in explore phase

Explain phase: when the researcher observed the students activity in this phase, students' were explained the concept that related to muscular and skeletal system. Students' connected in their explanations to experiences in the engagement and exploration phases of the instructional model as shown in Figure 17

Figure 17: Image of students in explain phase

Elaborate phase: the researcher observed students interest in this phase students' related the concept in to daily life activity that means students' used human skeletal model that relate their own body parts. Students get information from each other, printed materials, electronic records, and experiments they conducted by their own body parts for example students' used

their arms to demonstrate the movement of muscles. I am surprising students' were very happy because every activities in the topic that exactly related to their body parts and it applied in daily life activities of body movements as shown in Figure 18.

Figure 18: Image of students in elaborate phase

Evaluate phase: the researcher observed this phase; students have interested to answer the conceptual questions that related to muscular and skeletal system contents in written form and orally explained form so students had interested to answer the questions during the evaluation phase as shown in Figure 19.

Figure 19: Image of students in evaluate phase

In the lessons that were observed, the majority of experimental group students were able to answer conceptual questions and related concepts into daily life experience. During the intervention period, the researcher asked students conceptual questions, which related to human muscles and skeleton. Examples of questions like, explain how muscle work in our body? From the given human skeleton model differentiated axial and appendicular parts of the skeleton, movable and immovable joints and classify bones based on shape and size? Students' answered these conceptual questions and relate the concepts in their own body parts.

4.3.2. Observation in control group classroom

During the intervention, the researcher also observed the role of students in control group. In this group, students' were passively received information from the teacher. Students' did not actively participated; interacted with the teaching materials and groups in muscular and skeletal system topics and also students did not able to answer conceptual questions. In these lessons the idea flow from teacher to students, student took on a passive role in this classroom, students used a single textbook only as shown in Figure 20.

Figure 20: Image of students in traditional classroom

Classroom observation result indicated that, students in experimental group taught by 5E instructional model of constructivist approach actively involved in the classroom that compared with students in control group taught by traditional teaching instruction

In general from classroom observations and students' comment the 5E instructional model is aligned with many processes involved in scientific inquiry that means an excellent way for students to evaluate their understanding in these topics. The students who preferred the 5E learning cycle over traditional teaching instruction thought that the 5E learning cycle gained their interest more and keep them engaged in activities and the topics that have been studied. As shown in Figure 21, students used comment on the 5E instructional model of constructivist teaching approach such as "I like the way that you did this lesson, it helped me engaged and motivated", "it is more daily life connected" and "learning with this method makes the lessons more fun" indicated their specific reasons why all of the students favored 5E learning cycle instruction. Therefore, the result from observation indicated that experimental group students' actively involved in the classroom and favored 5E learning cycle instruction.

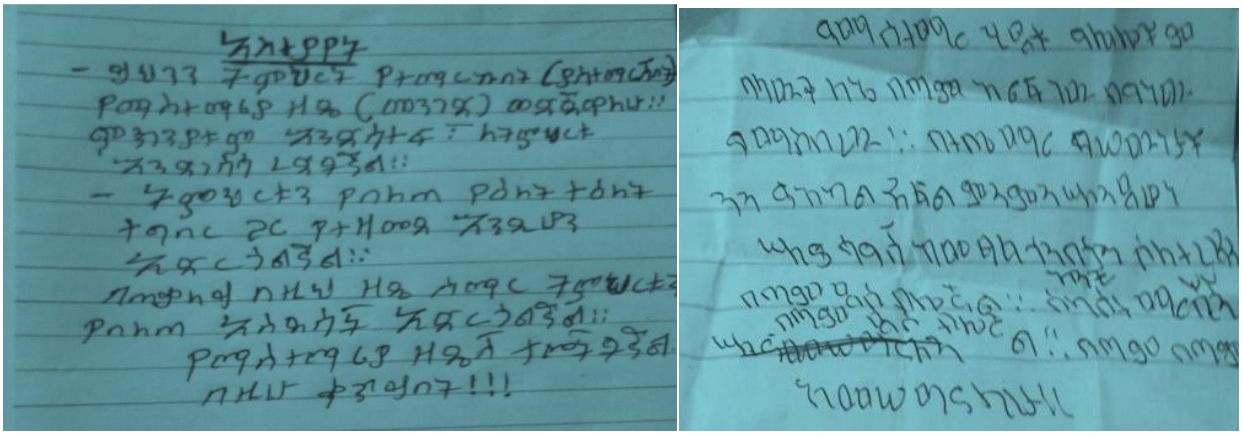

Figure 21: Samples of experimental group students' comment on the new teaching methodology

CHAPTER FIVE

5. DISCUSSION AND IMPLICATIONS OF RESULTS

This chapter involves a discussion that obtained from the results in relation to the existing literature and implications needs to indicate the practical significance of the results obtained in the study.

5.1. Discussion of the results

The main purpose of this study was to investigate the effectiveness of 5E instructional model of constructivist approach on grade seven students' conceptual understanding of muscular and skeletal system concepts. To see the effectiveness, the 5E instructional model of constructivist approach was compared with traditional teaching instruction.

Before the lesson implementation, both control and experimental group students' took pre-tests on muscular and skeletal system concepts. When the mean scores were checked by descriptive statistics as shown in Table 2, and the independent sample t-test as presented in Table 4, the pre-test results indicated that, prior understanding on muscular and skeletal system concepts of the students were not different across the control and experimental groups. This statistically, insignificant t-test results also support the idea that the groups were assumed to be equal in terms of their prior understanding therefore, these low mean scores showed that both groups had limited prior understanding level of the muscular and skeletal system concepts before the implementation period. This result is consistent with previous researcher finding in which prior knowledge has great influence on students' understanding of science concepts (Duschl & Gitomer, 1991; Tekkaya & Ozkan, 2001). As Duschl and Gitomer (1991) and Tekkaya and Ozkan (2001) emphasized that the prior knowledge plays a critical role in understanding

construction so, conducting study with the group had similar prior understanding would be better for quasi-experimental study.

After 3 weeks implementation period with the 5E instructional model of constructivist approach for experimental groups and traditional classroom instruction for control group, both experimental and control groups took post-tests on students' conceptual understanding of muscular and skeletal system concepts. When the mean scores were checked by descriptive statistics as shown in Table 2, and the independent sample t-test as seen in Table 5, the results post-test indicated that, statistically, a significant difference is found about the effectiveness of the 5E learning cycle improving in students' understanding of muscular and skeletal system concepts compared to traditional classroom instruction. As presented in Table 3, paired sample t-test result also showed that, experimental group students' have a better conceptual understanding of muscular and skeletal system concepts after the implementation period.

This results provides further empirical support for the studies reported significant results about the effectiveness of 5E learning cycle instruction over traditional instruction on students understandings levels in several biology concepts (Balci, Cakiroglu, & Tekkaya, 2006; Kaynar & Tekkaya, 2009; Sadi & Cakiroglu, 2010). Balci, Cakiroglu, and Tekkaya (2006) reported significantly better performances after 5E learning cycle instruction on students' conceptual understanding in photosynthesis and respiration subject compared to traditional instruction. Sadi and Cakiroglu (2010), reported significant mean differences among the groups receiving 5E learning cycle instruction and traditional instruction in the favor of learning cycle with respect to their conceptual understanding of circulatory system in high school level. Similarly, Kaynar and Tekkaya, (2009) stated that, 5E learning cycle instruction significantly improved their conceptual understanding of students in comparison with traditional instruction in cell concepts. And also

these authors argued that the instructional strategies utilized in experimental group supported change in elementary science students from passively receiving knowledge to actively examining their own conception.

In addition to the pretest, the researcher also conducted pre informal classroom assessment open-ended questions for both groups before the lesson implementation. The pre informal classroom assessment results indicated that, both experimental and control group students' had common misunderstandings on muscular and skeletal system concepts. This result provided evidence to the previous studies identified misunderstanding on the muscular and skeletal system concepts (Aydin &Balima, 2009; Caravita & Falchetti, 2005; Trefil, Rita & Cutler, 2005) . In the study of Aydin and Balima (2009), grade 6^{th} students' misunderstandings on the unit systems in our body, the skeletal system, the circulatory system, and the respiratory system, based on problem the qualitative analysis of the result showed that students' have misunderstandings on the unit systems in our body. Caravita and Falchetti (2005) emphasized that students have common misconception on bones are not living tissues because of their solid, strong and rock-like appearance. Similarly, Trefil, Rita and Cutler (2005) students have misunderstanding on body movements, muscles push on bones directly our body movement can occur.

The researcher also conducted post informal classroom assessment open-ended questions for both groups after lesson implementation period on muscular and skeletal system concepts. The post informal classroom assessment results indicated that, conceptual understanding difference among experimental and control groups in terms of muscular and skeletal system concepts. Students who received 5E learning cycle instruction outperformed in all these concepts compared to the students who received traditional instruction. The comparison of students

answered between experimental and control groups on post conversation questions, experimental group students had better improvement in muscular and skeletal system topics conceptual understanding after intervention, experimental students' answered the post informal assessment questions by briefly explanation and reasoning but control group students answered these questions by memorizing of the concepts. This result implied that 5E instructional model constructivist approach is more effective in conceptual understanding of learning muscular and skeletal system concepts compared to traditional teaching instruction.

This result is in line with Aydin (2013), who stated that technologically-supported mind-mapping technique combined in 5E learning cycle constructivist approach, activities that provide the linkage among the concepts enhance better conceptual understanding and to enhance students' reasoning ability about skeletal and muscular system than traditional teaching instruction. On the other hand, Taasoobshirazi and Carr (2008) emphasized that traditional ways of teaching science, which usually involve memorization of concepts and encourages poor conceptual understanding and limited understanding of learned in science concepts and ideas. As Bybee (2009) stated that each phase of the 5E learning cycle has a specific function and contributes to the teacher's coherent instruction and the students' formulating a better understanding of scientific concepts.

Classroom observation result showed that, students in experimental group taught by 5E instructional model of constructivist approach highly participated in lesson, interacted with teaching materials and groups, to answer conceptual questions and related the concepts to daily activities that compared with control group taught by traditional teaching instructions. This finding is consistent with Taylor and Fraser (1991), who emphasized that constructivist-oriented instruction or strategies can promote students' participation and get meaningful learning. Similar

observations have been stated by Adula and Kassahun (2010), constructivist teaching approach has the conception that students learn for understanding of natural science when they learn using teaching materials that the expertise in the concerned area are using and perform the real activities and also delivery of materials and activities in learning science for learners helps them to test their ideas and relate the theoretical to practical part of the lesson with students discussion and explanation of the concepts. Similarly, Liang and Gabel (2005) examined the effectiveness of the instruction based on the constructivist approach by focusing on class teacher- student and student-student interaction within small groups over traditional method of instruction.

5.2. Implications of the study

Based on the findings of this study, 5E instructional model of constructivist approach was found to be more effective than the traditional teaching instruction. The implication here is that teachers need to develop themselves in the use of 5E constructivist approach in biology classroom. The approach requires that students have access to resources like, teaching models, books, laboratory and science apparatus since the learners actively construct knowledge and are encouraged to explore the real world, discover knowledge, reflect and think critically. There is also the implication for learners to be engaged in an active process of learning such as hand-on, minds-on and discovery. The approach is learner-centered as students search for knowledge, meaning or create a product by themselves with the teacher as facilitator or guide. The implication for government is that government should provide adequate infrastructures and materials for the laboratory so that students can interact with this apparatus to enhance their ability to explore and construct their own understanding by avoiding their misconceptions.

CHAPTER SIX

6. SUMMARY, CONCLUSION, AND RECOMMENDATIONS

This chapter involves a summary of the results reported in the previous chapter, the conclusion obtained from the results, and recommendations for further research.

6.1. Summary of the study

The main purpose of this study was to investigate the effectiveness of 5E instructional model of constructivist approach on grade seven students' conceptual understanding of muscular and skeletal system concepts. In order to guide this study the researcher forwarded the following research questions; Is there a significant difference in the test score of students' taught with 5E instructional model of constructivist approach and those taught with traditionally designed instruction? Do students' have better conceptual understanding of muscular and skeletal system when they are taught through 5E instructional model of constructivist approach? What is the students' reaction towards the new methodology?

In this study, a quasi-experimental design was utilized. Out of four grade seven sections, two sections (N=122) were selected randomly and students assigned as experimental and control groups. Students' conceptual understanding assessed by using multiple choice muscular and skeletal system understanding pre and posttests, informal classroom assessment open ended questions were used as pre informal classroom assessment in order to determine what prior understanding students already had on these concepts and post informal classroom assessment was used to determine the effectiveness of teaching approach on students' conceptual understanding change in the concepts of muscular and skeletal system and classroom observation was applied during lesson implementation. The data obtained from pre and post tests were analyzed quantitatively through descriptive statistics and t-tests and data obtained from

classroom observation and informal classroom assessment were analyzed qualitatively. The treatment lasted for three weeks. The treatment covers of muscular and skeletal system topics include; part of human skeleton (axial and appendicular skeletal), type of bones, type of joints, structure and function of muscle, type of muscles and muscles and skeletal health.

At the beginning of these topics both experimental and control group students were tested with the multiple choice muscular and skeletal system understanding pretest that covers the questions related with the implemented topics. The conducted analyses of independent sample t- test result revealed that, there is no significant difference between control and experimental group based on their pre muscular and skeletal system understanding tests score. In addition to this quantitative result, the qualitative results that obtained from pre informal classroom assessment (classroom conversation) showed that, both group students' had common misconception on these concepts. That means there were no pre-existing difference among the experimental and control group in terms of muscular and skeletal system concepts understanding.

During the course of instruction, experimental group students received the 5E learning cycle instruction which involves hands-on and minds-on activities. The instruction followed five phases designed based on the constructivist views in learning that means, Engage students to learn, Explore the concepts and Explain their understanding, Elaborate the concept by applied their knowledge in new situations and Evaluate students understanding by asking conceptual questions. On the contrary, the control group was taught by using traditional teaching instruction based on teacher introduction, explanation and summarization, students followed teacher introduction, explanation, demonstration and activities suggested in the textbook.

At the end of muscular and skeletal system topics or after three weeks implementation periods, students in both groups re-administered the post-test to determine the change and the difference among the groups in terms of understanding of muscular and skeletal system concepts. The independent sample t- test analysis of posttest result showed that, there is a significant difference between the posttest of the students' taught by 5E instructional model of constructivist approach and those taught by traditional teaching instruction or the experimental groups' students had better conceptual understanding of muscular and skeletal system concepts after the implementation period. In addition to this quantitative result, the qualitative results that obtained from post informal classroom assessment (classroom conversation) also provide evidence supporting this findings that 5E instructional model of constructivist approach group students constructed more conceptual understanding than traditional teaching instruction group students according to both their explanations and drawings of muscular and skeletal system concepts and also the result of classroom observation indicated that, students in experimental group taught by 5E instructional model of constructivist approach highly participated in lesson, interacted with teaching materials and groups, to answer conceptual questions and relate concepts to daily activities that compared with control group taught by traditional teaching instruction.

6.2. Conclusion

The results of this study revealed that, the experimental group students' taught with 5E instructional model of constructivist approach have shown higher results in the post-test and more correct response in the post informal classroom assessment and also highly participated in lesson compared to the control group students taught with traditional teaching approach. These positive changes from the experimental group of students receiving the 5E instructional model activities based on the constructivist approach have an effect of increasing conceptual

understanding when learning about the muscular and skeletal system concepts. It was observed that newly learned concepts were constructed in the mind correctly by removing concept errors existing in their pre-information. Therefore, from the results of this study, it is possible to conclude that the 5E instructional model of constructivist approach is a more effective method to improve students' conceptual understanding of muscular and skeletal system concepts compared to the traditional teaching approach.

6.3. Recommendations

The following recommendations are made from the findings of this study;

- Future studies can be carried out for different grade levels and topics to investigate the effectiveness of 5E Instructional model of constructivist approach in biology education because my study is limited on grade seven and only muscular and skeletal system topics.
- Studies should be conducted to investigate the effectiveness of instruction based on the 5E instructional model on the students' understanding of science concepts in different schools because my study is limited at Ewket Fana primary school.
- Similar studies can be conducted to investigate the effectiveness of instruction based on 5E instructional model of constructivist approach on students' understanding of concepts and learning strategies in other subject areas such as chemistry and physics.
- The government should provide enough facilities for biology teaching because 5E learning cycle model approach is activity-oriented so students should be the use of enough instructional materials.
- Curriculum developers should incorporate constructivist strategy such as the 5E learning cycle model into the biology curriculum as an instructional model for teaching biology in primary and secondary school.

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APPENDICES

Appendix A: Muscular and skeletal system conceptual understanding test

Pre and post- test for both experimental and control groups (15%).

Name: ----------sex……. Age----------

Group: ---------- School: ---------- Time allowed 40'

Instruction: Choose the correct answer from the given alternatives

1. When a man fall down from the building with his rib is damaged, so which part of skeletal system is damaged?

   A. Axial C. Smooth

   B. Appendicular D. Cardiac

2. What types of joint is found in our waist?

   A. Gliding joint C. saddle joint

   B. Hinge joint D. pivot joint

3. Which bone protects your brain?

   A. Facial C. Cerebrum

   B. Cranial D. Cerebellum

4. In human body ball and Socket Joints are present, where these joints are found?

   A. Elbow and Knee C. Shoulders and hips

   B .Finger and Toes D. Neck and Wrist

5. Besides the brain protection, the skull also provides structure for our body. Which part of the body?

   A. Lung B .Face C. Diaphragm D. Body cell

6. In your body there is a blood pumping, which type of muscles that help blood pumping throughout your body?

   A. Skeletal muscle C. Smooth muscle

   B. Cardiac muscle D. Tendons

7. In your body bones are attached to one another with the tissue, what is that tissue?

A. ligament C. Cartilage

B .Tendons D. joints

8. A man who have weakness in his muscular and skeletal system, why this weakness happen?

A. Lack of physical exercise, proper diet& rest C. Eating well

B. Avoiding bone injuries D. Exercising

9 .The hollow spaces in the middle of bones are filled with

A. Air C. bone cell

B. Water D. bone marrow

10. What makes bones so strong?

A. Blood and marrow C. Cartilage

B. Calcium D. Non-living organ

11. Which of the following is the correct description of a Tendon?

A. A tissue that connect muscle to bone C. A tissue that connect bone to another bone

B. A tissue that connect your organs together D. A tissue that connect bone to skin

12. What is the difference between the joints in your fingers and joints in your skull?

A .The joints in fingers are movable but the joint in skull are not movable

B. The joints in fingers are not movable but the joint in skull are movable

C. The joints in both fingers and skull are movable

D. The joints in both fingers and skull are immovable

13. Which of the following is the characteristic of Bones?

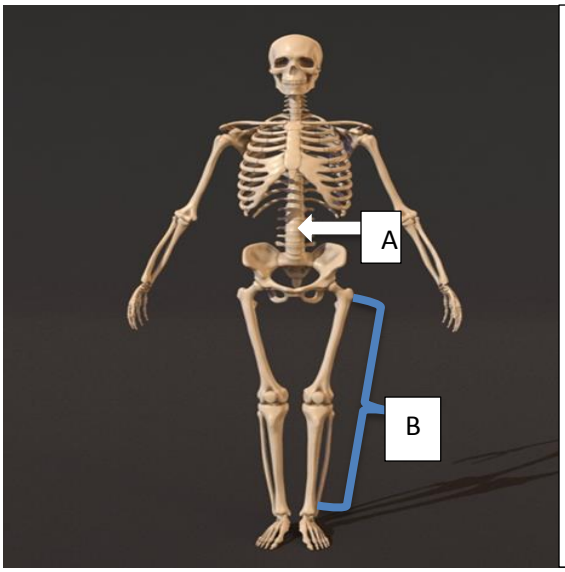
A. Bones are non-living organ when they are inside the living body

B .Bones are not grow and repair when they are inside the living body

C. Bones are living and grow when they are inside the living body

D. Bone is soft while Cartilage is hard

To answer question number 14 & 15 use the diagram given below



14. From the given diagram letter ‘’A’’ indicate

A. Ribs C. Vertebral column

B. Sternum D. Skull

15. From the given diagram letter ‘’B’’ indicate

A. Flat bone C. Short bone

B. Long bone D. fingers and toes

Appendix B: Classroom observation checklist

The objective of this observation checklist is to get additional information on the study

No	Observation checklists
	The main guidelines of classroom self-observation include:
1	Participation of students on muscular and skeletal system topic
2	Students interaction with the teaching material
3	Students interaction among the groups
4	Students interest when taught with 5E instructional model
5	The ability of students to answers conceptual questions and relate concepts in to daily life experience

Appendix C: Intervention plan for both groups

Intervention program	Duration	Time	Lesson	Lesson topics	The outcome of the lesson topics
Before intervention	1class session	40 min	1st	Pre-test	-Measure students prior knowledge or conception on muscular and skeletal system concepts
During intervention	2 class session	40 minx2	2nd	Axial and appendicular skeleton (lesson I)	-Students identify the part of human skeleton and relate them with their functions - Describe axial and appendicular skeletal system
	1 class session	40 min	3rd	Types of bone (lesson II)	-Students identify the types of bones based on the size and the shape
	2 class session	40 minx2	4th	Types of joints (lesson III)	- Students differentiates the movable and immovable(fixed) part of joints in the human body
	1 class session	40min	5th	Structure and functions of muscle (lesson IV)	-Students explain the structure and functions of muscles work in the human body
	2 class session	40 minx2	6th	Types of muscles (lesson V)	- Students identify the position and functions of each muscles in human body
	1 class session	40 min	7th	Muscle and skeletal health (lesson VI)	-Students understand the importance physical exercises diet & rest for the health of muscles and skeleton and the effect of its deficiency.
After intervention	1 class session	40 min	8th	Post-test	Measure students understanding on the concept of muscular and skeletal system after the two different instructional treatment implementation

Appendix D: Daily lesson plan for experimental group

Daily lesson plan format based on Bybee et al. (2006) 5E learning cycle (5E instructional model) teaching strategy. This model includes five stages these are: Engage –Explore –Explain –Elaborate –Evaluate respectively. It is apply on experimental group because one of the innovative lesson design strategies based on constructivist approach.

The 5E Learning Cycle Model

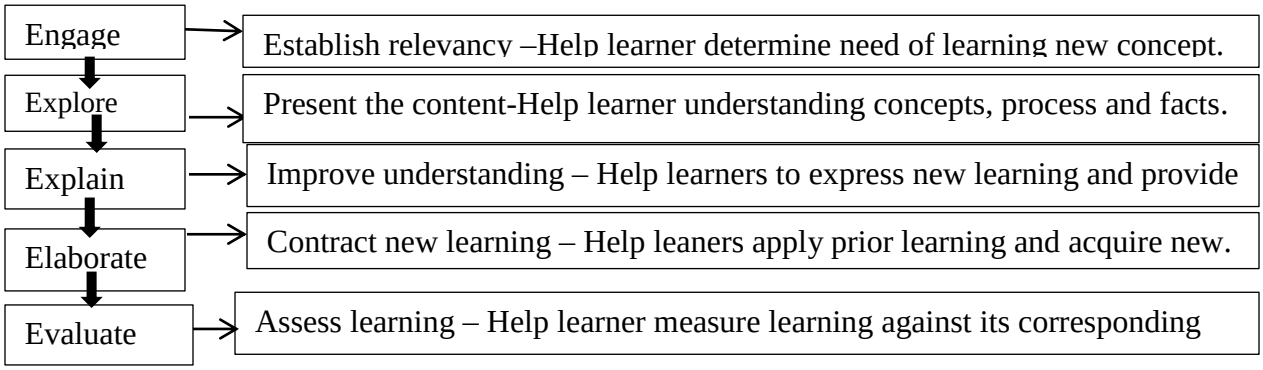


Figure 1 Flow Chart of Bybee et al., (2006) Model

Daily lesson plan arrangement to the experimental group with 5E instructional model is as follows:

Lesson 1

Group: Experimental

Name of school Ewket Fana

Grade 7^{th} section A No of students M **33** F **28** Total **61**

Name of teacher: Dinkale wegayehu

Subject: Biology

Main topic Unit: Three, Human Biology and health

Sub-topic: Muscular and Skeletal system

Lesson topic: Axial and Appendicular skeleton (part of human skeleton)

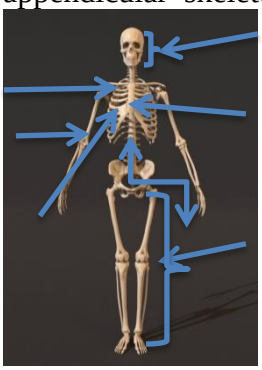
Duration: 40’

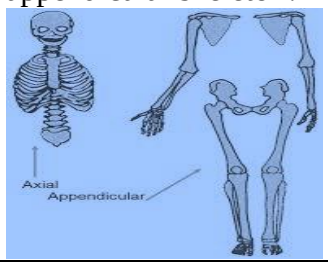
Instructional Materials

- ✓ Model of the axial skeletal system
- ✓ Model of the appendicular skeleton
- ✓ White paper and pen

Learning objectives: At the end of the lesson the student will be able to:

- ✓ Explain skeleton
- ✓ List part of skeletal system
- ✓ Describe axial and appendicular skeletal system
- ✓ List examples of axial and appendicular skeleton
- ✓ Describe structure and function of part of human skeleton
- ✓ Draw and label the structure of axial and appendicular skeleton

Time	Stage of the instructional model	Teacher activity (what the teacher to do?)	Student's activity (what the students to do?)	Assessment activities
5'	**Engage**	-Create a need to know on the topic-capture the students' interest by showing model of human skeleton. -I start the lesson by asking prior knowledge questions about the skeleton system. - I will lead students in a discussion on part of Axial and appendicular skeleton 	-Students make connections to prior knowledge and to what is to be studied. -Students become mentally engaged in the new learning experience. - After the engagement students ask questions themselves - What do I already know about skeleton and bone? -What are Axial and appendicular skeleton? -What are the examples of about Axial and appendicular skeleton include?	-Ask oral question 1. What is the difference between bone and skeleton? 2.List parts of skeleton 3. Draw Axial and Appendicular skeletons correctly, label the major bones correctly and write functions skull, ribs and femur?
10'	**Explore**	I set up the investigation and guide students in inquiry. -Encourage the students to	-Students examine the model of human skeleton in group	Examine model of human

		work together without direct instruction -Observe and listen to students as they interact in the group -Ask probing questions to redirect the students' discussion - -Describe the hands-on activity that the students will be doing.-I will ask conceptual questions that focus on the student exploration. Conceptual Questions1. Describe the organization of skeleton? 2 Show the positions of Axial and appendicular skeleton?  	-identify Axial(skull, ribs, skull, vertebral column) and appendicular skeleton (shoulder, limb, hip) from the model -Investigate and develop their practice skills by drawing structure of Axial and appendicular skeleton and level their name. -Think freely but within the limit of activity -Form new prediction and hypothesis -Record observation and idea -Ask related questions and discusses them with the group member	skeleton
10'	**Explain**	-Encourage the student to explain concepts and definition in their own words -Asks for justification and clarification from students -Uses students' previous experiences as basis for explaining concepts - Assess student growing understanding by asking questions that I students' explanations for the structures and functions of human skeleton justify their explanation. Questions: 1. Using the model , write including part of Axial skeleton and Appendicular skeleton	Explains possible answers -Listens critically to others' explanations -Uses recorded observations in explanations -Form generalizations What is the concept that students should have internalized from doing the exploration? Explain possible answer -Students assess their own understanding Concepts about: 1. The general characteristic of skeleton 2. Part of skeleton Axial skeleton include, Skull, Ribs, sternum and vertebral column Appendicular skeleton include, shoulder, limb, hip.	Reflection

5'	**Elaborate (Extend)**	-Encourage students to apply or extend the concepts and skill in new situation -Explain how students will develop a more sophisticated understanding of the concept. - give awareness how is this knowledge applied in our daily lives?	-Applies new definitions, explanations and skills in a new but in similar situation. -Uses previous information to ask questions, propose solutions -Records observations and explanations - Checks for understanding among peer -Use knowledge of concepts to investigate further extension. -Students should create an analogy for use their competence for: Aware about human anatomy parts.	Construct model of human skeleton by cutting and connecting materials and label name
10'	**Evaluate**	-I Observe students as they apply new concepts and skills-Assesses students' knowledge and skills - Provides students with formative feedback to enhance their thinking about the topic. -Allows students to assess their own learning and group-process skills -Ask open ended questions such as;-Why do you think about skeleton?-What do you know about axial and appendicular skeleton? -How to explain about structure and functions of the skeleton?-What are the examples of Axial and appendicular skeleton and their character? I will ask students' what is the important of learning this topic for your job qualifications and daily life?	-Students draw conclusions using evidence from previous experiences(from engage, explore explain and elaboration) -Demonstrate an understanding or knowledge of concept -Evaluates his or her own progress and knowledge -Answers open-ended questions by using; observations, evidence, and previously accepted explanations - Asks related questions that would encourage future investigations -Students should create their "resume", explanation the important of learning skeletal system on their job qualifications and daily life.	Ask written question: 1.what is the structure and functions of skeleton 2. Draw Axial and Appendicular skeletons correctly, label the major bones correctly and write functions skull, ribs and femur? 3. Explain the role of skeleton in our body?

Teacher's name <u>Dinkale Wegayehu</u> Signature …… Date <u>23/04/2011 E.C</u>

Appendix E: Daily lesson plan for control group

Daily lesson plan sample for control group exposed to lecture method. Traditional Instructional Method

Lesson 1

Group: control group

Name of school Ewket Fana

Grade 7^{th} section B No of students M **27** F **34** Total **61**

Name of teacher: Dinkale wegayehu

Subject: Biology

Unit: Three Topics: Human Biology and health

Sub-topic: Muscular and Skeletal system

Lesson topic: Axial and Appendicular skeleton Duration: 40'

Instructional Material

- ✓ Figure from the text book and skeletal model

Learning objectives: At the end of the lesson the student will be able to:

- ✓ Explain skeleton
- ✓ List part of skeletal system
- ✓ List examples of axial and appendicular skeleton
- ✓ Describe structure and function of human skeleton

Time	Stage	Teacher activity	Student activity
5'	**Starter activities**	- Revising the previous lesson -Introduce daily lesson	--listen and -follow up the teacher revision and introduction
25'	**Main activities**	-Presentation The teacher explains the axial and Appendicular skeleton -Giving notes - Show the diagram from the text book and skeletal model explain by teacher	- Follow up the teacher Presentation -taking notes -listen the teacher explanation
5'	**Concluding activities**	--summarize the daily lesson about Axial and Appendicular skeleton	-Listen the summary
5'	**Evaluation**	Ask oral question	Same active students answer the question

Teacher's name Dinkale Wegayehu Signature …… Date 24/04/2011 E.C

Appendix F: Both experimental and control group students pre-post test result

Experimental group students pretest and posttest result out of 15% (First section)

Students' ID	Sex	Age	Pretest result (15%)	Posttest result (15%)
1	M	14	1	6
2	F	13	6	13
3	M	14	3	7
4	M	12	4	11
5	M	16	5	10
6	M	17	3	14
7	M	18	3	11
8	F	15	4	14
9	M	15	5	12
10	M	13	4	9
11	M	14	0	6
12	M	14	4	8
13	M	13	2	12
14	M	13	6	8
15	M	13	3	10
16	M	15	6	10
17	M	14	2	8
18	M	14	4	8
19	M	14	1	11
20	M	15	1	8
21	F	13	3	10
22	M	14	3	14
23	M	13	3	8
24	M	14	3	8
25	M	15	4	9
26	M	16	3	9
27	M	13	6	13
28	M	14	5	11
29	M	14	4	10
30	F	14	4	8
31	M	13	3	10
32	M	15	7	9
33	F	14	2	9
34	F	14	4	11
35	F	14	7	9
36	F	13	3	10
37	F	14	3	13
38	F	14	4	11
39	F	13	5	11

40	F	14	3	10
41	F	13	7	9
42	F	14	4	12
43	F	14	2	8
44	F	14	2	12
45	F	14	6	15
46	F	14	2	6
47	F	13	6	14
48	F	14	3	14
49	F	13	5	15
50	F	14	4	8
51	F	14	2	8
52	F	14	0	8
53	F	14	3	7
54	M	16	0	9
55	M	15	4	11
56	M	13	2	11
57	F	15	3	11
58	M	13	6	9
59	F	15	5	14
60	F	13	4	15
61	M	14	5	14

Control group students pretest and posttest result out of 15% (Second section)

Students' ID	Sex	Age	Pretest result (15%)	Post test result (15%)
1	M	17	6	7
2	M	13	4	6
3	M	13	6	6
4	M	13	3	7
5	M	14	4	6
6	F	14	4	9
7	M	13	4	9
8	M	14	7	9
9	F	15	2	7
10	F	14	3	6
11	M	13	3	7
12	M	14	3	8
13	F	16	3	6
14	F	15	3	6
15	F	13	3	9
16	F	13	2	4
17	F	14	5	7

18	F	16	3	5
19	F	13	4	7
20	F	13	5	6
21	F	13	6	8
22	F	13	4	7
23	F	15	3	7
24	F	14	3	8
25	F	13	4	9
26	F	13	2	5
27	F	15	5	7
28	F	13	6	7
29	F	14	6	7
30	F	15	4	10
31	F	14	5	5
32	F	15	4	6
33	F	13	5	7
34	F	13	6	5
35	F	13	5	7
36	F	12	3	7
37	F	13	0	7
38	F	15	4	7
39	F	12	5	7
40	F	14	2	7
41	F	13	5	8
42	M	19	5	8
43	M	14	6	8
44	M	15	0	7
45	M	14	4	9
46	M	14	3	8
47	F	14	5	8
48	M	14	4	8
49	F	14	3	3
50	M	15	3	9
51	M	16	3	4
52	M	17	3	5
53	M	13	3	9
54	M	15	3	7
55	M	14	5	6
56	M	13	3	6
57	M	13	3	6
58	M	15	4	5
59	M	14	5	7
60	M	14	4	6
61	M	17	6	9