UNIVERSITY OF EDUCATION, WINNEBA

DEPARTMENT OF SCIENCE EDUCATION

THE IMPACT OF THE UTILIZATION OF IMPROVISED LABORATORY MATERIALS IN TEACHING INTEGRATED SCIENCE ON THE ACADEMIC PERFORMANCE OF BASIC SCHOOL STUDENTS IN SOUTH TONGU DISTRICT

FRANCIS ANANI-AMEKO

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DECEMBER, 2016

DECLARATION

Candidate's Declaration

I, Francis Anani-Ameko, declare that this dissertation, with the exception of quotations and references contained in published works which have all, to the best of my knowledge, been identified and acknowledged, is entirely my own original work, and it has not been submitted, either in part or in whole, to any institution anywhere for the award of another degree.

……………………… Date………………….

(Francis Anani-Ameko)

Supervisor's Declaration

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

…………………… Date………………………

Dr. Ruby Hanson

(Supervisor)

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Lastly I am highly indebted to the staff of Dabala Junction D/A Basic School especially Mr Francis Avedetsifor their encouragement and valuable contributions towards the success of this research.

May the Almighty God richly bless you all.

DEDICATION

I dedicate this work to my lovely sonDeladem Seth Anani and my wife Georgina AtsufeDomey.

ABSTRACT

The purpose of this study was to examine the impact of the use of improvised science instructional materials on the academic performance of basic school students. The study focused on ten basic schools in the South Tongu District of the Volta Region of Ghana.

The instruments that were used to collect data includedResearcher-designed Performance Test in Integrated Science (PTIS) and a census sheet. The research design employed in this study was a cross-sectional survey that used pre- and post-tests as the prime instrument for data collection.

The population for this study was all the 5,962 JHS students in the 47 JHSs in the South Tongu district. Ten (10) Junior High Schools were used in this study. JHS 1, 2 and 3 students were randomly selected from the 10 purposively selected schools. Thirty (30) students each comprising 10 students each from JHS 1, 2 and 3 were selected from each of the 10 schools to make a sample size of three hundred (300). Out of the 300 sampled students, 115 were females and 185 males.

The study revealed that science laboratory materials needed for effective teaching and learning of integrated science were woefully inadequate in the selected schools. This was contrary to the recommendation given by the JHS syllabus that for effective teaching and learning science, schools should have science equipment and materials and other requirements such as space for raising crops and animals.

The study also disclosed that the students involved in the study performed poorly in the pretest and therefore have difficulty in the topics selected for the study. The pre-test results showed that as many as 137 students obtained below 10, 92 scored from 10 to 13 and 71 got from 14 to 17. The mean score of the pre-test was 10.69. However, the findings from posttest show that after the students were taught the selected topics through the use of improvised instructional materials,

they performed credibly. The results indicated that, 121 students obtained from 12 to 14, 142 scored from 15 to 17 whilst 47 got from 18 to 20. The mean score of the post test was 15.23.

As regards the impact of the use of improvised materials on the academic performance of male and female students, the study results showed that 78 male students scored from 12 to 14, 73 scored from 15 to 17 and 34 scored from 18 to 20 in the post-test. The mean score was therefore 15.12. The female students however performed better in the post-test than their male counterparts with a mean score of 15.41. Thus, 43 female students scored from 12 to 14, 59 scored from 15 to 17 while 13 scored from 18 to 20.

There was significant difference [$t\ (1.97) = -19.82$, $p < 0.05$] between the pre-test and post-test scores of students selected for the study. In view of this, the null hypothesis (Ho) which stated that there was no significant difference between pre-test and post-test results of students taught with improvised materials was rejected.

There was statistical significant difference between the performance of male and female students in the post-test [$t\ (1.97) = -1.26$, $p < 0.05$]. The negative t-test obtained shows that there was an increase in the mean score of the female students. In view of this, the null hypothesis that there was no significant difference between the academic performance of male and female students taught with improvised science materials was rejected.

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CHAPTER ONE

INTRODUCTION

1.0 Overview

The chapter covers the background to the study, the statement of the problem, the purpose of the study, educational significance of the study, and the research questions addressed by the study as well as the research hypotheses. It also contains the limitations and delimitation of the study. The chapter concludes with the description of the organization of the research report.

1.1 Background to the Study

The provision of quality education and life is a constitutional and social obligation of a government to her citizenry if it is to attain sustainable development (Muhammad &Lawal, 2015). Sustainable development is one that meets the needs of the present without compromising the ability of future generations to meet their own needs (Muhammad &Lawal, 2015). In light of this, Ghana's mission statement for education, which isto provide relevant education with emphasis on science, information, communication and technology to equip individuals for self-actualization, peaceful coexistence as well as skills for the workplace for national development (Ministry of Education (MOE), 2012) is in place.

According to Huang (2006), science education is distinctive, in that, it places pedagogical emphasis on activities such as experimentation, which largely relies on physical facilities like the laboratory. The laboratory is the place that students are trained in the skills of observation, measurement, problem solving and the inductive spirit of science.Learning by 'doing' as a concept has been described as a learning situation where hands-on and minds-on activities or concrete sensory experiences are used to aid understanding of learning experiences.Learning by 'doing' is student-centered and contrary to the traditional lecture pattern of instruction which is teacher-centered. Trowbridge, Bybee and Powell (2004), are of the view that science teaching without laboratory experience is not really science.Therefore, the government of every nation should foster an enabling environment for learning asthis would guarantee quality science education. Theywould have to make adequate provision for laboratory facilities, equipment and instructional materials that are necessary for learning science in an interactive manner. Learning by ‘doing’ (inquiry-based) is advocated in school science by American Association for the Advancement of Science (AAAS) (2010) by quoting the ancient proverb:

Tell me and I forget

Show me and I remember

Let me do it and I understand.

According to AAAS (2010), young people can learn most readily about things that are tangible and directly accessible to their senses-visual, auditory, tactile, and kinesthetic. With experience, they grow in their ability to understand abstract concepts, manipulate symbols, reason logically and generalize. These skills develop slowly, however, and the dependence of most people on concrete examples of new ideas persists throughout life.

The difficulties many students have in grasping abstractions are often masked by their ability to remember and recite technical terms that they do not understand. As a result, teachers-from kindergarten through university-sometimes overestimate the ability of their students to handle abstractions. The teachers take the students' use of the correct words as evidence of understanding. As shown in Figure 1, concrete experiences are most effective in learning when they occur in the context of some relevant conceptual structure.

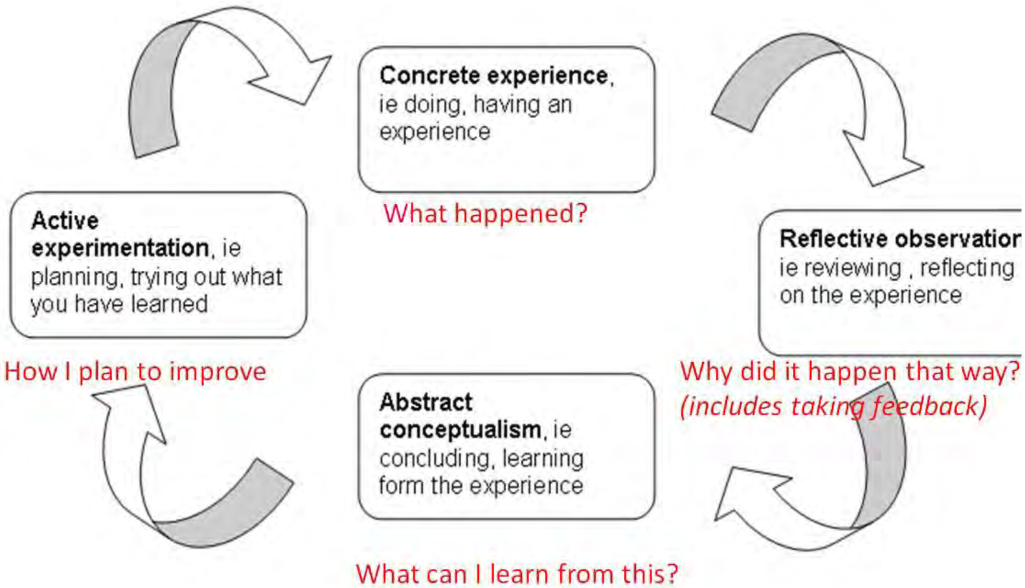

Figure 1: Kolb's learning cycle(Kolb, 1984)

If students are expected to apply ideas in novel situations, then they must practice applying them in novel situations. If they practice only calculating answers to predictable exercises or unrealistic "word problems," then that is all they are likely to learn (AAAS, 2010). Similarly, students cannot learn to think critically, analyze information, communicate scientific ideas, make logical arguments, work as part of a team, and acquire other desirable skills unless they are permitted and encouraged to do those things over and over in many contexts.

The mere repetition of tasks by students-whether manual or intellectual-is unlikely to lead to improved skills or keener insights. Learning often takes place best when students have opportunities to express ideas and get feedback from their peers. But for feedback to be most helpful to learners, it must consist of more than the provision of correct answers. Feedback ought to be analytical, to be suggestive, and to come at a time when students are interested in it. There must also be time for students to reflect on the feedback they receive, to make adjustments and to try again.

Students respond to their own expectations of what they can and cannot learn. If they believe they are able to learn something, whether balancingchemical equations or riding a bicycle, they usually make headway. But when they lack confidence, learning eludes them. Students grow in self-confidence as they experience success in learning, just as they lose confidence in the face of repeated failure. Thus, teachers need to provide students with challenging but attainable learning tasks and help them succeed.

What is more, students are quick to pick up the expectations of success or failure that others have about them. The positive and negative expectations shown by parents, counselors, principals, peers, and-more generally-by the news media affect students' expectations and hence their learning behaviour. When, for instance, a teacher signals his or her lack of confidence in the ability of students to understand certain subjects, the students may lose confidence in their ability and may perform more poorly than they otherwise could have. If this apparent failure reinforces the teacher's original judgment, a disheartening spiral of decreasing confidence and performance can result.

Results of a research carried out in four countries (Ghana, Tanzania, Cameroon and Uganda) by Female Education in Mathematics and Science in Africa (FEMSA, 2010) showed that in all four countries, majority of theprimary and secondaryschools, lacked functional laboratories. Thiswas due to lack of equipment and consumables. Some schools had no laboratories butfew equipment and they used classrooms which did not provide suitable settings for practical work. In such schools, equipment are always moved to classrooms that are already overcrowded and have sloping desktops that are inappropriate for glass equipment. Most schools were unable to replenish chemicals and consumables regularly. In some schools, the study (FEMSA) found unopened boxes of chemicals and apparatus that had remained unused due to fears by the teacher that students might damage the apparatus.It could also likely be due to ignorance on the part of the teacher on how to use the equipment. In other schools, poor storage of chemicals had led to contamination. In some cases, countries like Tanzania had done away with practical examinations altogether and teachers therefore did not see the need to spend time on practical activities which were not going to be examined. A laboratory therefore did not make much difference to their teaching methods. They concentrated on the lecture method and used demonstration and explanations for the practical aspects of the syllabus.

In terms of performance, the FEMSA study showed that girls scored significantly lower than boys in all science and mathematics subjects in the secondary schools that participated in thestudy (FEMSA, 2010). Therefore, poor expectation of girls' performance in the mathematics and science subjects is a common spectacle. The following set of statements have been a common feature in science and mathematics classes with respect to the performance put out by the various sexes:

Comfort Owusu, 38%. Connie! You have really made an effort during this test!

KwadwoMensah, 74%. Hey, my brother! You did not try enough! You must really work harder next term!

Statements like buttress the assumption that it is not unheard of, if females under-perform in mathematics and science examinations but very much unacceptable if a male student's performance is above average but not excellent. After over a decade of enhanced awareness of the need for more gender equitable treatments, the messages that such comments can convey to students cannot be overlooked.

Furthermore, the FEMSAstudy revealed that poor expectations of girls' performance on the part of teachers leads to the kind of science and mathematics classroom dynamics, where girls are treated very differently from boys. The study revealed that teachers do not encourage girls during mathematics and science lessons to do their best, but actively discourage them. One way they do this is by directing more challenging, high order thinking questions to males, while only simple recall type of questions to females.

For science to be effectively and properly taught, the practical approach to teaching must be viewed as an essential component of studying Integrated Science. The “hands-on” approach has the potential to stimulate students’ interest in the subject matter. Teaching laboratory skillsenhances scientific knowledge and gives students insight into scientific attitudes worth developing. It also gives the students the opportunity to learn and practice all the activities involved in the inquiry processes of science. The Junior High School (JHS) Integrated Science syllabus buttresses this by recommending that, schools should have science equipment and materials and other requirements like land space for raising crops and animals for effective teaching and learning of science (MOE, 2012).

Figure 2 points out ways by which teaching science using the practical approach is beneficial to students.

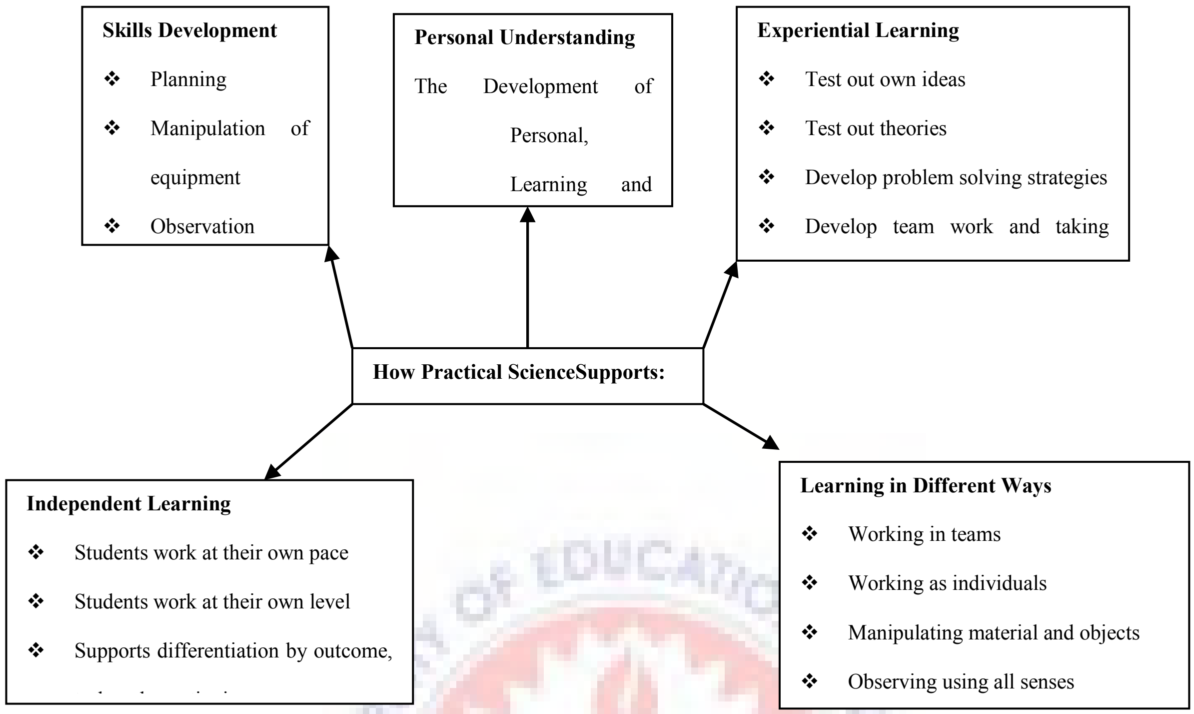

Figure 2: Benefits of teaching science using the practical approach

Source: Score (2009)

According to Taale and Antwi (2012), institutions that prepare science teachers need to incorporate programs that will prepare teachers well for activity-based learning such as laboratory work. Theybelieve that inadequate laboratory equipment and materialscould also lead teachers to improvise science teaching and learning materials to supplement the existing ones if they are trained well. It is against this background that the Researcher wants to examine the impact that the use of improvised laboratory materialswill have on the academic performance of junior high students so that necessary measures could be put in place to enhance basic school science teachers' improvisation and utilization skills.

1.2 Statement of the Problem

Although laboratory work is an important component of science teaching and learning, most basic schools do not have well equipped science laboratories. In South Tongu district for instance, only one out of fifty-seven basic schools has a science laboratory. In addition to this, the Chief Examiners' Reports over the years have revealed that, apart from a relatively low proportion of JHS pupils who perform credibly in science in the Basic Education Certificate Examination (BECE), most pupils do not do well (West African Examination Council (WAEC), 2011- 2014). The Reports thus suggest that candidates should be exposed to a lot of practical exercises as a remedy to this problem (WAEC, 2011-2014)

Dueto the low identifiedacademic performance in Integrated Science in the South Tongu Directorate of Education, there isthe need for an urgent intervention into the situation in view of the importance of science in the socio-economic development of South Tongu in particular and Ghana as a whole. For this reason, this study was designed to examine the impactthat the use of improvised laboratory materials would have on the performance of JHS students in Integrated Science in the South Tongu district since most of the schools lack science laboratories and basic science equipment.

1.3 Purpose of the Study

The purpose of the study was to examine the impact that the use of improvised laboratory materials will have on the performance of JHS students in Integrated Science. In addition to this, the study sort to document available science instructional materials in the selected schools.

1.4 Objectives

The main objective of the study was to investigate the impact the use of improvised science instructional materials would have on the academic performance of students. The specific objectivesthat guided the study were:

1. Identify the standard science laboratory materials present in basic schools in South Tongu district.
2. Examine the impact of the use of improvised science laboratory materials on the performance of basic school students in South Tongu district.
3. Compare the performances of male and female students when taught using improvised science instructional materials.

1.5 Research Questions

The following research questions were addressed in the study:

1. What standard laboratory materials relevant for teaching integrated science are available in schools in South Tongu District?
2. What would be the impact of the use of improvised laboratory materials on the academic performance of students in South Tongu in Integrated Science?
3. What is the impact of the use of improvised laboratory materials on the academic performance of male and female students in South Tongu in Integrated Science?

1.6 Research Hypotheses

The following null hypotheses were formulated and testedat 0.05 level of significance.

HO1: There is no significant difference between pre-test and post-test results of students taught with improvised materials.

HO 2: There is no significant difference between the academic performance of male and female students taught with improvised science materials

1.7 Significance of the Study

For any research to be useful it must contribute to the volume of existing knowledge of the field under investigation. In view of this, it is the conviction of the Researcher that information obtained from this study will help address the challenges of unavailable and ill-equipped laboratories that affect teaching and learning of science at the JHS level of education.

The research will suggest remedies that will make teachingand learning of science interesting and enjoyable. It will also provide information to the Ministry of Education, Ghana Education Service and other stakeholders in education to train teachers in the art of improvisation.

1.8 Delimitations of the Study

In order to ensure a good coverage, the study was restricted to only ten JHS schools in the South Tongu district. In addition, the study was limited to only schools in the DanyikpoCircuit because the Researcher is a teacher in the circuit. Integrated science teachers in the selected schools were given the same scheme of work and lesson notes prepared by theResearcher to use in their lessons. This was to minimise any teacher effect that could affect the results of the study.

1.9 Limitations of the Study

Although the target population comprised JHS students in the South Tongu District, the study focused only on students in Danyikpo Circuit of the directorate due to time and financial constraints.

1.10 Organisation of the Study

The research report was organised under five chapters. Chapter onepresents the introduction of study consisting of the background to the study, the statement of the problem, purpose of the study and objectives of the research. It also presents the research questions, significance of the study, delimitations and the limitations of the study.Chapter two provides the theoretical framework and the review of the literature which are related to the study. Chapter three gives detailed information about the methodology used in the study, describing the research design, areas of the study, the population, sample and sampling procedure, instrumentation, validity and reliability of the main instruments, data collection procedures and methods ofdata analysis.

In chapter four, the data collected have been organised and presented in line with the research questions. The findings/results of the study have been presented in this chapter. In addition, interpretations and analysis of the findings with reference to the results of related research work have been presented as the discussion in this chapter. The final chapter, chapter five provides the summary of the major findings, the conclusion of the study, recommendations and suggestions for further research work.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

This Chapter comprises a review of relevant and related literature on the topic under investigation. A critical conceptual and theoretical framework was done to justify the need for the study under the headings and sub-headings listed below:

1. Nature of Integrated Science at the Basic Level of Ghana
2. Social Constructivism in Teaching and Learning Science
3. Teaching Science with Limited Laboratory Resources
    a. Teaching Science through Demonstration
    b. Teaching Science using Locally Available Materials
4. The Concept of Improvisation
    a. Meaning of Improvisation
    b. Types of Improvisation
    c. Need for Improvisation
    d. Basic Considerations for Improvisation
    e. Influence of Improvised Materials in Integrated Science Teaching and Learning
    f. Guides on Improvisation
    g. Advantages of Improvisation
    h. Disadvantages of Improvisation
5. Sources of Producing a Catalogue of Science Teaching Materials
6. Selection and Utilisation of Improvised Instructional Materials
7. Some Improvised Experiments and Instructional Materials when Teaching Science

a. Verification of Characteristics of Image Formed by Plane Mirror

b. An Experiment to Illustrate Breathing in and out

c. Treatment of Water for Domestic Consumption

d. Some Improvised Instructional Materials when Teaching Science

2.1 Nature of Integrated Science at the Basic Level in Ghana

Modern life requires general scientific literacy for every Ghanaian citizen, a requirement that will result in the creation of a scientific culture in line with the country's strategic programme of achieving scientific and technological literacy in the shortest possible time. Scientific culture should therefore become the common property of every citizen of this country because it is the antithesis to superstition and the catalyst that will help us toward faster development (MOE, 2012).

According to Parker (2011), the focus of the study of Science is to understand the natural world. There are generally two main goals of Science education. First, it inculcates scientific literacy and culture for all, so that people can make informed choices in their personal lives and approach challenges in the workplace in a systematic and logical order. Second, it aims to produce competent professionals in the various scientific disciplines who can carry out research and development at the highest level. For meaningful scientific education, it is important for pupils to be trained in the investigative process of seeking answers to problems. This requires pupils to physically explore and discover knowledge within their environment and in the laboratory to be able to contribute new scientific principles and ideas to the body of knowledge already existing in their culture.

The integrated science is a conscious effort to raise the level of scientific literacy of all students and equip them with the relevant basic integrated scientific knowledge needed for their own survival and for the development of the country. It is also expected that scientific experiences in Junior High School will cultivate in pupils an interest and love for science that will urge some of them to seek further studies in science as preparation for careers in science. The study of science will also provide excellent opportunities for the development of positive attitudes and values which include:

- Curiosity to explore their environment and question what they find.
- Keenness to identify and answer questions through investigations.
- Creativity in suggesting new and relevant ways to solve problems.
- Open-mindedness to accept all knowledge as tentative and to change their view if the evidence is convincing.
- Perseverance and patience in pursuing a problem until a satisfying solution is found.
- Concern for living things and awareness of the responsibility they have for the quality of the environment.
- Honesty, truthfulness and accuracy in recording and reporting scientific information.
- Love, respect and appreciation for nature and desire to conserve natural balance (MOE, 2012).

The content of the Junior High School Integrated Science covers the basic sciences and includes topics in Health, Agriculture and Industry. The course has been designed to offer a body of knowledge and skills to meet the requirements of everyday living, and provide adequate foundation for those who want to pursue further education and training in science and science related vocations.

Specific issues covered are the following:

1. Science for all students

2. Science as an active inquiry process

3. Science and the satisfaction of individual needs

4. Science as a profession

5. Science and culture.

The approach of Ghana'sJHS syllabus is based on scientific themes that pupils can relate to in their everyday experiences, and related also to commonlyobserved phenomena in nature. The basic aim is to enable pupils to appreciate the links between seemingly different topics and thus allow the eventual integration of scientific ideas. The five themes chosen are: *Diversity of matter (the Living and Non Living things), Cycles, Systems, Energy and Interactions of matter*. These themes provide a broad based understanding of the environment and scientific phenomena, and should help build a foundation upon which pupils can rely for further study. Although the content of the syllabus is organized into five themes, the units under each theme are not to be viewed as separate blocks of knowledge (MOE, 2012).

In general, there are no clear boundaries between the themes since there are some common topics between the different themes. In particular, it should be noted that Systems, Energy and Interactions are closely related.

Another feature of the syllabus is the *Spiral Approach*. This is characterized by revisiting concepts and skills at different levels with increasingdegrees of depth at each stage. The spiral approach has the benefit of matching scientific concepts and skills to pupils' cognitive development. It therefore helps pupils to build a gradual mastery of scientific skills.

The titles of the sections are the same for each class level. However, the knowledge, understanding as well as the activities and range of process skills presented have been extended at the different class levels.

The syllabus covers three years of Junior High School education. Each year's work is organized under the five themes or sections. Under each theme or section are a set of units or topics. The knowledge, understandings as well as the activities and range of process skills presented in each theme have been extended at the different class levels. The focus of each theme is provided below.

Section 1 - Diversity of matter

The study of diversity should enable pupils to appreciate that there is a great variety of living and non-living things in the world. It also aims at helping pupils to recognize that there are common threads that connect all living things and unifying factors in the diversity of non-living things that help to classify them. The study of diversity in the world will allow pupils to appreciate the importance of living and non-living things and the necessity for sustaining them.

Section 2 – Cycles

The study of cycles should enable pupils to recognize that there are repeated patterns of change in nature. Examples of these cycles are the day andnight cycle, life cycles of living things, the recycling of resources and the cyclic nature of agricultural production. Studying these cycles helps us to predict events and processes and understand the Earth as a self-sustaining system.

Section 3 - Systems

The study of systems should enable pupils to recognize that a system is anything that consists of parts that work together to perform a function.

There are systems in nature as well as artificial systems. Examples of systems in nature are the digestive and respiratory systems. Examples of artificial systems are electrical systems. A study of these systems allows humans to understand how they operate and how parts influence and interact with one another to perform a function.

Section 4 – Energy

The study of energy should enable pupils to appreciate that energy affects both living land non-living things. Energy makes changes and movement possible in everyday life. There are many forms of energy and one form can be converted to another. Humans use energy in many ways for many different purposes. Humans are not the only animals that use energy; all living and non-living things obtain and use energy. The study of this theme should help pupils to develop energy conservation habits.

Section 5 – Interactions of matter

The study of interactions between living and non-living things within systems helps humans to better understand the environment and the roles they should play in it. There are many types of interactions. There are interactions between the living world and the environment at various levels; i.e. interactions which occur within an organism, between organisms as well as between organisms and the environment. There are also interactions between forces and objects. At the societal level, the interaction of humans with the environment drives the development of Science and Technology. At the same time, Science and Technology influence the way humans interact with the environment. By studying the interactions between humans and the environment, pupils can better appreciate the consequences of their actions.

For effective teaching and learning in this course, it is recommended that schools should have science equipment and materials. Other requirements include space for raising crops and animals. It is also recommended that crops and farm animals in at least one of each of the following groups must be reared.

Crops

1. A Vegetable crop

2. A Cereal/Legume

3. An Ornamental plant

Animals

1. Fish (Tilapia)

2. Chickens/ducks/turkeys,

3. Goats/sheep/cattle

4. Rabbits and Guinea Pigs

The method of teaching science as stated by the science curriculum requires every science teacher to provide enough materials in the teaching of science to enable students to learn by constructing their own ideas using all their senses (MOE, 2012).

2.2 Social Constructivism in Teaching and Learning Science

Many theories have talked about teaching and learning. However, this study focuses on socialconstructivism. Social constructivism has been drawn upon by many researchers while explainingthe importance of teaching and learning science (Driver, 2000; Leach & Scott,2003). Social constructivism is the extension of constructivism which incorporates the role ofsociety in teaching and learning. According to social constructivists, knowledge cannot be achievedby an individual but it can be acquired through social processes (Leach & Scott, 2003; Newman,Griffin& Cole, 1989). In view of that, classroom interaction is very important as it engagesstudents to interact with their peers, teachers, as well as with the learning materials to construct theirown knowledge. In teaching and learning of science, interactions may be hampered by limitedlaboratory resources and this negatively impacts on the learning process.

Additionally, social constructivists argue that teachers cannot transfer knowledge from their headsto the students and that students construct their own knowledge through negotiation within theirsocial setting (McLaughlin, 2001). This theory implies that during the teaching and learning processa teacher should be a facilitator not an instructor. Therefore, the role of the teacher is to provide scaffolding so that the students can accomplish the task which the students alone could otherwisenot complete, thus helping the students through the Zone of proximal development (Bransford,Cocking& Brown, 2000). Thus in teaching and learning science, teachers should provide alearning environment that will promote students' understanding through meaningful peer andteacher interactions (Skamp, 2011). In other words, this theory emphasizes student-centeredapproach and learning through hands-on activities where students work collaboratively ondeveloping their own understanding. This is in line with Ghana’sscience curriculumthat encourages students' participation in the construction and acquisition of knowledge (Parker,2011). Competence based learning can be achieved when a school or classroom is well equippedwith the teaching and learning resources like laboratory equipment. It was also observed by Marshall(2006) and Taylor (2008) that school climate can create a fabric of support that enables all membersof the school community to teach and learn at optimum levels when teaching and learning resourcesare readily available.

Moreover, science deals with scientific ideas which are within students' environment and theseideas must be tested against their prior beliefs (Richardson, 2003;Matthews, 1997). Therefore, engaging students in hands-on and laboratory activities that willenable them to challenge and reconstruct their existing ideas will make contextual scientificlearning possible. The engagements of hands-on activities assist students in constructing meaningfulscience concepts and understanding how scientists develop knowledge of the natural world (Akar, 2003). Furthermore, hands-on activities help to substantiate scientific knowledgeand understanding; hence, it is hard to imagine learning about science without doing laboratoryactivities

(Dahar&Faize, 2011). This implies that, laboratories are wonderfulvenues for teaching and learning science. They offer students opportunities to think about scientificconcepts, discuss, and solve the problems (Abimbola, 2006; Woodley, 2009). Experimental learningmay provide a strong base for students to develop long term memory as they get the opportunity tolearn by doing (Tobin, 2008). Deep understanding of science concepts comes with practicalinstructions (Olufunke, 2012). Practical activities engage students in theinvestigation through data collection, interpretation and making inference (Mortimer & Scott,2003). Consequently, the teaching of science which does not incorporate practical work is out ofstep with the ideals of science teaching (Omolo, 2009) becausestudents may not be able to connect theoretical scientific concepts with the real world they live in.

To put it briefly based on literature, teaching and learning science is effective when there isclassroom interaction in which students are engaged in laboratory or hands-on activities. This playsa significant role in students' understanding since they may be able to construct their ownknowledge. In a constructivist science classroom, teaching and learning is facilitated by availabilityof laboratory equipment.

2.3. Teaching Science with Limited Laboratory Resources

To promote deep conceptual understanding of scientific concepts and positive attitudes towardscience, it is recommended that science teaching and learning should be focused on the use ofscientific activities to investigate real-life phenomena (Hofstein&Mamlok-Naaman, 2007; Tobin, 2008). However, the inadequacy of laboratory resources challenges theeffectiveness with which teachers can able to implement hands-on curriculum (Kadzera, 2006; Thomas& Israel, 2012; Voogt, Tilya, &Akker, 2009). Consequently, in teaching and learningscience, teachers could use other innovative ways to teach science when there are inadequatelaboratory resources so as to make the lesson effective. These innovative ways include teachingscience through demonstration and using locally available resources.

2.3.1. Teaching Science through Demonstration

Many studies in science education indicate that students are better served by hands-on activitieswhich lead to higher-order cognitive skills (Hofstein&Lunetta, 2003;Hull, 2000). However, the resources available to perform these recommended types of activities aresometimes very limited. Due to these factors, in some cases demonstration-laboratory is designed toallow students to make observations through demonstration rather than through hands-on laboratoryactivities (McKee, Williamson, &Ruebush, 2007). Thus, demonstrations in teaching and learningscience may be used to supplement lecture method of teaching.

In teaching and learning science with limited laboratory resources, demonstration helps studentsconceptualize the scientific concepts more effectively than chalk-and-talk where students arechallenged to connect theories to actual practice (Kandjeo-Marenga, 2003). On the other hand, astudy conducted by Bell, Blair, Crawford and Lederman (2012) indicates that since demonstration usually consists ofa teacher or student doing an activity with the rest of the class observing, demonstrationswould seem to benefit only those students who assisted the teacher. Nevertheless, this is not alwaysthe case because demonstration always engages students in observation which is very important inteaching and learning science. Ahtee, Suomela, Juuti, Lampiselkä and Lavonen (2012) contend thatmaking observations is the first step in doing investigations as it contains all the components of ascience inquiry process. In addition, a study conducted by McKee et al. (2007) reveals that studentslearn roughly the same from laboratory experiment and laboratory demonstration and that thedemonstration-laboratory at least does no harm to the students' conceptual understanding. Thisimplies that demonstration can have a positive impact in teaching and learning of science.

2.3.2. Teaching Science Using Locally Available Materials

Science is an experimental subject, thus teaching and learning become more effective when studentsare given opportunity to develop their own idea through hands-on activities (Garbett, 2011). However, it has been found that in most of the developing countries, manyteachers do not engage their students in laboratory activities due to inadequate laboratory materials(FEMSA, 2010). The use of locallyavailable materials in teaching and learning science has become increasingly popular due toinadequate funds allocation to public schools (Thomas & Israel, 2012). This is because insufficientfunds make it impossible to purchase enough laboratory equipment for teaching and learningscience; hence in a situation where teachers depend on industrial laboratory materials they may notmanage to teach science effectively. Therefore, improvisation is suggested to provide teachingmaterials from one's locality when there is a shortage or lack of the standard ones (Mboto&Udo,2011). Thus, in order to provide effective teaching and learning experiences, improvising the use oflocally available material may enable students to achieve desired scientific results in the classroom. This idea was supported by Ademi, 2007 asquoted by (Thomas & Israel, 2012) that:

It is no excuse for any science teachers to hide under inadequate laboratory equipment for notconducting practical activities for their students, this is because even Isaac Newton, Pythagoras, Galilee Galileo and the rest of the pioneers in sciences started building for themselves objects from around them to explain scientific concepts that are still relevant tillthese days (p.44).

The above reveals that the use of locally available materials should not be undermined in teachingand learning science since hands-on activities is very important in the field of science.Therefore, where schools lack standard science instructional materials or are isolated or inaccessible, instructional materials could be improvised to enhance science teaching and learning.

2.4 Concept of improvisation

2.4.1 Meaning of Improvisation

Improvisation in science dates back to the genesis of experimental science when the earliest pioneering scientists had originated both their ideas and the methods needed to empirically demonstrate and authenticate their validity (Ergul,Simsekli, Calis, Ozdilek, Gocmencelebi&Sanli, 2011). Various authors have described the concept 'improvisation' in different ways.Igwe, Arop and Ibe (2013) defined it as the act of substituting for the real thing that is not available. According to Atadoga (2012), improvisation is the act of substituting for the standard equipment or instructional material that is not available, or making it up for inadequate available materials with locally made equipment or instructional material from readily available natural resources.Ergul et al. (2011) see improvisation in science, technology and mathematics education as the preparation and use of materials and equipment obtainable from the local environment for the enhancement of the effectiveness of teaching and learning.Ige (2004) on the other hand opined that improvisation is the making or inventing of a piece of science teaching equipment in emergency; it is an essential part of laboratory management for the purpose of maximizing the use of the available resources.

Improvisation can best be described as an 'escape route' or a way out for teacher and the pupils/students, when they are faced with the problem of instructional materials (Muhammad &Lawal, 2015). It is an attempt to bring the life-like situation into the laboratory in the absence of real objects or materials. In the process of improvising caution must be taken about the kind or nature and purpose of instructional material the teacher is improvising. Improvisation could also be defined as using alternative materials or equipment obtainable from the local environment, designed or constructed by the teacher(s) or with the help of local resource person(s) to facilitate instruction (BhukuvhaniKusure, Munodawafa and Sana 2010).

Bhukuvhaniet al (2010) believe that improvisationis a pedagogical intervention strategy where teachers are being resourceful in the making and usinglocally available materials where conventional equipment may be inadequate or not available at all.Improvisation in teaching and learning science provides opportunities for creativity anddevelopment of manipulative abilities (Limjuco, Glover, & Mendez, 2011). Moreover, duringimprovisation scientific concepts are learnt and internalized easily by the students rather thanproceeding with chalk and teacher talk. This implies that studentsunderstand better when they are engaged in hands-on activities. Moreover, the findings of the study of Bhukuvhaniet al. (2010) emphasized that the use of improvised apparatus in science teachingcould be a solution to the problem of inadequate laboratory equipment. Therefore, in the context ofTanzanian secondary schools and community schools in particular where most of them lackadequate laboratory resources (Hakielimu, 2010; Ndibalema, 2012), the use of locallyavailable materials such as plastic bottle, clay, empty pen tubes and other such materials are alsoimportant to make science teaching and learning in a practical way possible. All in all, literaturereveals that in teaching and learning science with limited laboratory resources, the materials that areavailable in our local environment can often serve the same purpose as conventional laboratoryequipment.Therefore, where schools lack standard science instructional materials or are isolated or inaccessible, instructional materials could be improvised to enhance science teaching and learning.

The whole mark of improvisation in the process of teaching and learning is to ensure that concepts, ideas and principles are clearly made open and clear to the students through effective display, demonstration and illustration (Ergul et al. 2011). The principle of improvisation in Integrated Science aims at revealing the way or manner improvised materials are integrated and applied into the teaching of the subject or course. Integration is the systematic step-by-step presentation or application of improvised materials in teaching. The application of the material has to be done carefully and tactfully with the lesson objectives as guide throughout. To integrate and apply improvised instructional materials, certain basic steps should be followed. The steps to follow include:

a. Preparation of the teacher

b. Preparation of the learners

c. Actual presentation

d. Presentation of the following-up activities

In teacher preparation, effective application of improvised material is very crucial to objectives of the lesson. Therefore, the teacher has to:

- Plan the integration in the lesson and follow it
- Consider how the material can help in achieving the objectives
- Process the materials well ahead of time, that is, prepare and test them before the lesson commences

Learners must be prepared psychologically with some explanation and reasons for the particular materials to be used. Clear guidance must be given to learners as to areas of importance to study. This involves step-by-step directions of what the students need to do during the lesson. Where necessary, new words associated with the material must be clearly defined.

The improvised materials must be appropriately applied at:

- Introductory stage
- Content presentation stage
- Summary stage

The teacher should be in control of every stage, directing and maintaining the learners' interest and attention. Learners should not be carried away at any stage whether or not they are directly involved in manipulation of the material(s). The whole lesson should be guided by the objectives.

In the preparation of the follow-up activities, the only way to evaluate the success or otherwise of an improvised instructional material is to obtain feedback from the learners. Therefore, the teacher must evaluate the integration and application of the material immediately. To this end, the teacher will do the followings:

- Ask questions that have direct bearing to the presentation
- Allow the learners to respond freely at every stage of the lesson
- Evaluate the presentation using instructional materials already used in the lesson, based on the objectives of the lesson
- Evaluate the lesson based on learners' interest

The improvised instructional materials should be preserved so that they can last long. Improvisations may be damaged or destroyed due to learners' handling or repeated display, frequent retrieval or long period of storage. To preserve them from tear and wear, they may be laminated, mounted on harder materials like plywood or kept in boxes or special spaces created for them.

2.4.2 Types of Improvisation

Mboto (2011), points out two main types of improvisation in his research. These are:

i. Improvisation by substitution, where an already existing local material is used in place of equipment that is not available.

ii. The other is improvisation by construction in this case a teacher or the student constructs a new material entirely to teach his lesson, when the required material or equipment is not available.

Ige (2004) said that the improvisation of the basic equipment for teaching science could be through two main ways.

- By role substitution
- By role simulation

The role substitution of instructional materials involves the slight modification or adaptation of the original material in order to make it perform new function in the laboratory. Among the various examples is the Bunsen burner, which could be substituted with the kerosene stove. Old newspaper could also substitute the import plant press with a heavy support such as a weighty piece of wood or heavy metal incorporated to provide the desired pressure. Imported reagent bottles can be substituted with a clear colourless soft drink bottle with a plastic cork available in local market.

The role simulation on the other hand is the construction of items or apparatus. It is necessitated by an emergency or a need that cannot be met for reasons of cost and availability. This may be accomplished by using direct labour, locally available materials and skills. In some cases, an apparatus has to be improvised if the specification of the conventional one does not serve the desired purpose of the experiment.

2.4.3 Need for Improvisation

In an ideal world, all science students would be taught in small classes held in well-equipped laboratories. In the absence of those well-equipped laboratories, the place of practical activities cannot be over emphasized, yet those materials required for teaching of science are very much in short supply. Alonge (1999) lamented that thistotal or partial absence of the science teaching resources and gross inadequate finances most especially for the purchase of science equipment, general down ward trend in the nation's economy, poor maintenance culture and at times attitudes of some school heads towards science and science equipment call for efforts at making science teaching and learning what it is supposed to be.

With all these heinous problems, it seems that the best option is the improvisation of science teaching materials.Improvisationis imperative in a situation where there are scarce resources and facilities. The Ghanaian school system today is experiencing a boost in population explosion, giving rise to greater demand for classrooms, laboratory facilities and equipment. With limited government resources, the teacher's ingenuity to improvise becomes tasking for learning to be effective and productive.

2.4.4 Basic Considerations in Improvisation

When embarking on any improvisation in the teaching and learning process certain basic pedagogical considerations are necessary. Some of these considerations according to Mudulia (2012) include:

i. What is to be taught?

ii. The objectives of the lesson.

iii. The background knowledge of the learners.

iv. The durability of the improvised materials.

v. The cost advantage of the improvised material

The degree of sophistication of the improvised materials will be determined by what is to be taught and the objective of the lesson. Knowledge of the students' academic background would provide the teacher with insight to whether the improvised materials would be appropriate to the learner to perform the task at hand or not. It is also necessary to give consideration to the durability of the improvised materials. A durable material reduces cost as well as saves time and labour.

2.4.5 Influence of Improvised Materials in Integrated Science Teaching and Learning

Some influence improvised materials would have on teaching and learning process are:

i. Improvised materials provide a cognitive bridge between abstraction and reality to students.

ii. Improvisation undertaken by the teacher enables him de think and research for cheaper, better and faster methods of making the teaching and learning process easier for students.

iii. Improvisation presents next to real situation to students in the absence of the real materials.

iv. Improvisation saves cost and in addition the teacher and the student make positive efforts towards effective instruction.

2.4.6 Guides on Improvisation

Having known what improvisation really is it becomes necessary to have guides for people embarking on it. In other words, improvised materials should possess certain qualities and these are:

1. Appropriateness of teaching aids to the age of the learners for whom they are meant.

2. Its clarity in illustration and simplification of concepts.

3. Its adequacy in size.

4. Its relevance to the lesson they are meant to serve.

5. It should be interesting to the learners, durable and improvisable among others.

Nbina (2012) stated that when the desirable is not available then the available should become the alternative if it performs the same or similar functions as the desirable. It should be borne in mind that resource materials do not achieve any of the attributed values on their own. The usefulness depends on what the teacher makes out of them that is the influence made on the students by the teacher with the materials.

2.4.7Advantages of Improvisation

Some advantages of improvisation according to Atadoga (2012)are:

1. It enables the learners and teachers make proper use of their environment this is because in improvisation we mainly make use of the available materials in the environment.

2. The use of local materials reduces cost in terms of financial expenditure in buying ready-made materials.

3. The development of resource materials for instruction can lead to discovery of new knowledge.

4. When parent or learner or community members assist in improvising a resource material such a donating personal material, this will improve school-community relationship.

5. They provide experience not easily obtained through other means and contribute to efficiency, depth and variety of learning.

6. Improvisation helps to bridge the gap between theoretical knowledge and practicability.

7. When the teacher and learners succeed in improvising an instructional material, there is a high sense of achievement and they are encouraged to higher exploits.

8. Talents in the students are discovered.

Adamu(2003) also identified the following advantagesof improvisation in science teaching and learning as it is used in lesson delivery.

1. If managed effectively and appropriately, it will increase the rate of learning and will allow the teacher to use more on other useful activities.

2. It encourages involvement of teachers in curriculum design and development.

3. It allows for effective lesson planning from objective determination and evaluation.

4. It encourages students' participation in the process of learning.

5. It makes room for individualising education, as alternative paths and variety of resources available at the student's choice.

6. Learning becomes real and immediate because improvised instructional materials utilizationemphasizes understanding and practical activities. Improvisation provides bridge for the world outside and outside the classroom.

7. Improvised instructional materials utilization makes access to science education more equal and plentiful for all learners since improvised materials can be moved to any place.

8. It provides various materials and procedure and therefore, it assists the student to discover himself/herself and his/her true ability.

9. Visual support is very helpful in the teaching and consolidating vocabulary which in turn affects the reading ability of students and helps student to associate words of objects or comprehend what is happening in a particular concepts or area of study.

10. Improvisations are very useful and dependable in capturing students' imagination if used correctly.

2.4.8 Disadvantages of Improvisation

As important as improvised instructional materials are, they are not substitutes forteaching, rather they depend on skillful employment by the teacher. Improvising science instructional materials are challenging as well as their effective usage. There are problems and shortcomings, which can be broadly, classified into two: non-human and human. Non-human can further be categorized into two:

i. Teaching factor, and

ii. Financial factor.

i. **Teaching Factor:** Durability of the materials, cleanliness of compactness and convenience or otherwise of use of the materials are part of factors that relate to teaching. All these qualities may be found in the materials improvised, thus a limitation.

ii**. Financial Factor:** This is all about availability of funds for the purchase of raw materials and for handy simple workshop tools, though improvisations are expected to be made from cheap sources, there are basic tools and materials that require money in the school. Lack of such funds can frustrate the effort and interest of the science teacher.

Human factors take a critical look at the teachers' professional commitment, competence, creativity, mechanical skills, initiative and resourcefulness. Researchers and classroom experiences have shown that many classroom teachers are aware of the importance of improvisation but majority of them do not practice it. Some of the teachers exhibit negative attitude towards improvisation and claim that it is time consuming and fund depleting.

A major problem militating against improvisation in Ghana is lack of adequate professional training of staff. Thomas and Israel (2012) noted that improvisation demands adventure, creativity, curiosity and perseverance on the part of the teacher such skill are only realizable through well-planned training programmes on improvisation.

Olufunke (2012) noted that improvisation whether they cost less than standardized manufactured ones or not cost money. This money is usually not readily available. Improvisation can also expose teacher and students to some-hazards.

2.5Sources of Producing a Catalogue of Science Teaching Materials

Science teaching materials as resources for teaching science can be broadly grouped into two: human and non-human resources. The human resources include science teachers, laboratory technologists, laboratory assistants, guests (professionals in science and science related fields), and artisans. The non-human resources include, laboratory, textual materials, reagents, charts, models, natural environment and assorted laboratory equipment. Most of the science teaching materials could be obtained either from the immediate or distance environment. Immediate environment include school and home environments. It is the environment we live in-the dwelling place(s) of the teacher and the students. Also, immediate environment include roadside mechanic workshop, tailor workshop, blacksmith workshop.

Our immediate environment is blessed with various kinds of science instructional materials that could be sourced from. The sourcing for producing a catalogue of science teaching materials in the immediate environment should involve the teacher and students. Table 1 shows sources ofsomeinstructional materials in the immediate environment for their production and topics to be taught.

Table 1: Sources of Some Instructional Materials in the Immediate Environment

Topic	Instructional Material	Where to source for Material
Various topics	Sand bucket, pictures, charts	Improvised by the teacher by using simple production techniques learnt.
Matter	Bottle top, stone, water	School compound, shops
Electrical Energy Magnetism	Fan, battery, regulators, electric bulb, pieces of magnet	Roadside mechanic, and Radionic workshops
Various topics	Posters on various science topics, gravel, grass, wood	Students can improve on topics such as model of houses as well as the teacher. Others from the community, school environment
Hazards	First Aid Box	Improvised by students and teachers
Force	Lubricants, different metal or wood surfaces, students' palms, rugs	Roadside mechanic workshop, teacher/students' homes and school based technology workshop
Life cycle of flowering plants	Assorted fruits	From school farm and community

Source:Atadoga (2012)

Apart from the immediate environment, science instructional materials could also be sourced from the distant environment. Distant environment connotes educational centre that is not within the location of the school and the students and teachers' community. To some it is called out door laboratory. By this, it implies that all forms of environments have one type of science resource material or the other. Table 2 below shows sources of science teaching materials from the distant environment.

Table 2: Sources of Science Teaching Materials from the Distant Environment.

Topic	Instructional Material	Where to source for material
Hazards	Fire extinguishers	Sourced commercially
Chemical compounds	Various types of ceramic and glass products	Outdoor laboratory; ceramic/glass industries
Light Energy	Glass block, triangle prism	Sourced commercially
Ecosystem	Wild animals, e.g. lion, elephant	Zoo and game reserve , outdoor laboratory
Chemical Compounds Acids, Bases and Salt	Chemicals e.g. acids, bases, salts	Sourced commercially
Life Processes	Models of human organs and organ systems	Sourced commercially
Electrical Energy	Electronic components e.g. resistor, cell, capacitor	Sourced commercially

Source:Atadoga (2012)

There are numerous sources of raw materials for improvisation. Muhammad and Lawal (2015) pointed out the following in their research:

i. Homes: They are rich sources of discarded plastics, tins, old calendars, medicine bottle, pots, plates, drinking straws, strings, bulbs, bottle tops, old newspapers, coconuts shells, match boxes and other packaging containers etc.

ii. Workshops in the community: Saw dust and pieces of wood can be collected from the carpenter‘s shed. Pieces of rods and metal plates from blacksmith and welders‘ workshops, pieces of cloth from the tailor, old wheels, spokes, hubs, metals balls of various sizes from the bicycle repairer, pieces of wire and cables from the electrical workshop.

iii. Rivers and sea shores: Where applicable, would yield smooth stones of various sizes, sand, clay, shells and reeds.

iv. Farms and forests would give us seeds, nuts, plants, stalk, wood, ropes, bamboo stems, etc.

2.6 Selection and Utilization of Improvised Materials

For improvised teaching and learning materials to get effective meaning, some basic principles or guidelines must follow their selections and utilisation. If a teacher cannot utilise improvised material that will bring positive result in teaching-learning process then the aim of the lesson is defeated.

Atatoga (2012) defined selection and utilisationof improvised material as a careful choosing of and putting into use instructional materials that will enable the teacher to teach his/her lesson within the stipulated period of time and achieve the set objective(s).

Humans are resource materials for utilisation in teaching and learning of science at all levels of education. They include teachers, laboratories technologists, laboratory assistants, laboratory attendants, students, resource persons. Human as resources for utilisation must be knowledgeable in their subject areas, physically, mentally, socially and morally sound. They need to be familiar, firm and friendly for effective utilisation in the teaching and learning of science. For effective utilisation, the teacher must prepare himself/herself well before entering the class, a good classroom manager, respecting students' views and he/she must earn respect of the students.

A resource person as part of human resources for utilisation may come from within the school from another department or unit or from the community or outside the community. A specialist in a field of study, skilled personnel outside or within the school may be invited to come and give a talk on specific topic that will benefit the students and even the teachers. Examples of resource persons for utilisation in science teaching include; medical doctors, mechanics, plumbers, goldsmith, carpenters, hair dressers, pilots, to mention a few.

Physical resources for utilisation for science teaching refer to the entire school environment. The school environment comprises classroom, furniture, building, laboratory, playground, school farm, botanic garden. The classrooms, laboratories should be well equipped with modern facilities and made conducive by the teacher and laboratory staff for effective science teaching and learning. The facilities should be well managed and organised. There should be routine check on the reagentsand all laboratory materials should be correctly labelled. The students should be taught on how to maintain clean environment and given guidelines and laboratory rules written to safeguard proper use of the facilities with little or no laboratory accidents.

Although improvised materials have several purposes, for which they are selected, there are certain guidelines that must be followed for effective utilization. The guidelines for selection include the followings:

1. The characteristics of the students should be analyzed so that the improvised materials can be within their abilities and interest. The characteristics of the students include age, ability level, number in the class, gender and physical impairment.

2. Behavioural objectives of the lesson must agree with the improvised materials to be used. For instance, if the behavioural objective is to help students demonstrate static electricity, it is important to use ebonite rod or biro, small piece of paper and wooling piece of cloth or dry hair on the head.

3. The number of students should be considered as teacher selects and uses the materials. Some classes are very large while others are small. The teacher should bear in mind that whatever he/she selects should meet the desired purpose(s).

4. Constraints attached to the materials should also be considered. Improvised science instructional materials are not easily available.

5. Time is another factor when selecting. There should be sufficient time and daily routine.

6. Cost of materials involved in the improvisation.

7. Sourcing the materials; place of location should be considered.

8. The effectiveness of the materials is also an issue in the selection. Improvised materials selected must be suitable and their design must meet the aesthetic value.

9. Improvised materials selected must meet the policy of the immediate environment or culture of the students. This is so because not all materials are accepted by all cultures; as some materials are considered taboo. Therefore, to avoid friction, the teacher should confide with the authority and the community before such materials are brought out for use.

10. The safety, durability and visibility of the improvised materials must be considered during selection and usage.

2.7Some Improvised Experimentand Instructional Materials when Teaching Science

In science (Integrated Science inclusive) formulae, laws and theories are postulated or arrived at through series of tasks, exercises, trial-and-error in laboratories. These series of scientific activities/exercises are carried out by scientists using equipment and apparatuses that are factory-made to obtain results. Experiment involves orderly procedure carried out with the goal of verifying, refuting, or establishing the validity of hypothesis. When an experiment involved control, it provides insights into cause and effect by demonstrating what outcome occurs when a particular factor is manipulated. There also exist natural experimental studies.

Experiments can vary from personal and inform natural comparisons (e.g. testing a range of improvised science instructional materials), to highly sophisticated (e.g. testing requiring complex – factory-made apparatus) by many scientists that hope if the results obtained from the two sets of instructional materials are the same. Experiments carried out using improvised instructional materials are referred to as improvisable experiments.

2.7.1. Verification of Characteristics of Image Formed by Plane Mirror

Image formed by plane mirror has certain characteristics, which include the following:

i. It is the same size as the object.

ii. It is as far behind the mirror as the object is in front.

iii. It is literally inverted.

iv. It is virtual.

v. It is upright.

The following improvised materials are required:

- A discarded broken mirror can often be cut into a number of small rectangular plane mirrors

- Pieces of ceiling board can be cut into a number of small rectangular drawing boards.
- Straight pins, popularly known as office pins. Straight pins substitute for optical pins

a. Finding the Image in a Plane Mirror

To locate the image of a pin, a plane mirror is placed with its reflecting surface vertical on the surface of paper on a ceiling board. An object pin is placed a few centimeters in front of the mirror. If you look pass the object pin into the mirror, you will see an image of it. A second pin, called the search pin, or image pin, is now placed behind the mirror, so it appears to be in the same position as the image of the object pin. When the image pin is correctly placed, the top of the image pin should remain exactly in line with the bottom of the image of the first pin as you move your head from side to side. If the pins do not move together, but move relative to one another, there is parallax between them.

The image pin has to be adjusted to another position until there is no relative movement as you move your head from side to side. There is then no parallax between the image pin and the image of the object pin. The position of the second pin is marked and a line is drawn from this position to that of the object pin. If measured, the angle between this line and the mirror will be found to be 90°. It will also be found that object distance in front of the mirror equals the image distance behind the mirror.

b. Nature of the Image Formed by a Plane Mirror

You can repeat the experiment for finding the image in a plane mirror for nature of the image formed by a plane mirror but this time you draw a large capital **U** on a paper in front of the mirror to serve as the object. A pin is put at various points of **U**, such as at positions 1, 2, 3, 4 and 5 in turn, and each time the corresponding image is located by the method of no-parallax. The position of the image in each case is marked by a dot. In this way we plot the position of the image of the letter **U** as a set of dots, you observe that the **U** has been turned around, as shown in figure 3. From this, you will now say that the image in a plane mirror is laterally inverted. Because of literal inversion, you will notice in placing your left palm in front of a plane mirror that its image appears in the mirror as a right palm. Lateral inversion arises from the fact that an object is perpendicularly opposite its image behind the mirror.

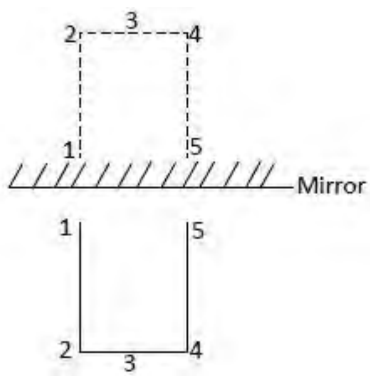

Figure 3: Lateral inversion of an image formed by a plane mirror

Source:Atadoga (2012)

c. Laws of Reflection

You can investigate the laws governing the regular reflection of light from a plane mirror. The laws known as laws of reflection states:

i. The incident ray, the reflected ray and the normal at the point of incidence all lie in the same plane.

ii. The angle of incidence is equal to the angle of reflection.

In the experiment improvised mirror, straight (office) pin, plane sheet and ceiling board were used. As shown in figure 4, two pins are placed vertically at points P and Q along the incident ray. Two other pins R and S are placed to find the reflected ray by placing them in line with the images of P and Q as seen in the mirror. The angles of the incidence and reflection are measured as before. For each angle of incidence it is found that the angle of incidence is equal to the angle of reflection.

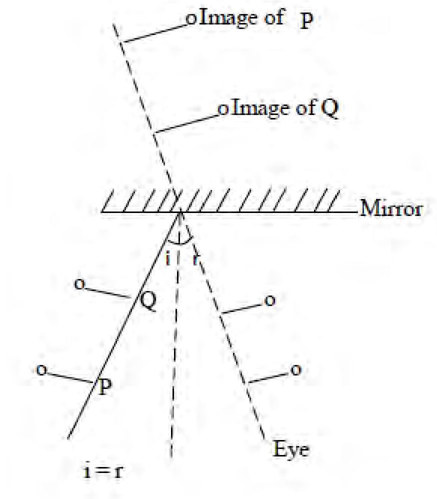

Figure 4: Demonstrating the Laws of Reflection

Source:Atadoga (2012)

2.7.2An Experiment to Investigate Inhalation and Exhalation

The lung provides an avenue for gas exchange between air from the outside and gases in the blood. Lung controls breathing. To construct a lung model, the following materials are required:

Materials

1. Plastic bottle – 2 liter,

2. Rubber band

3. Plastic tubing,

4. Scissors

5. Y-shaped connector,

6. Electrical tape

7. Balloons (3 large ones)

Procedures

- Fit the plastic tubing into one of the openings of the hose connector.
- Make airtight seal around tubing and hose connector using electrical tape.
- Place a balloon around each of the remaining two (2) openings of the connectors.
- Wrap rubber tightly around balloons when the balloons and hose connector meet.
- Measure two inches from bottom of 2 liter bottle and cut bottom off.
- Place the balloons and hose connector structure inside the bottle, threading the plastic tubing through the neck of bottle.
- Use tape to seal the opening where the plastic tubing goes through the narrow opening of the bottle at the neck. The seal should be airtight.
- Tie a knot at the end of the remaining balloon and cut the large part of the balloon in half horizontally.
- Using the balloon half with knot, stretch the open end over the bottom of the bottle
- Gently pull down the balloon from the knot. This should cause air to flow into the balloons within your long model as shown in figure 5.
- Release the balloon with the knot and watch as the air is expelled from your lung model.

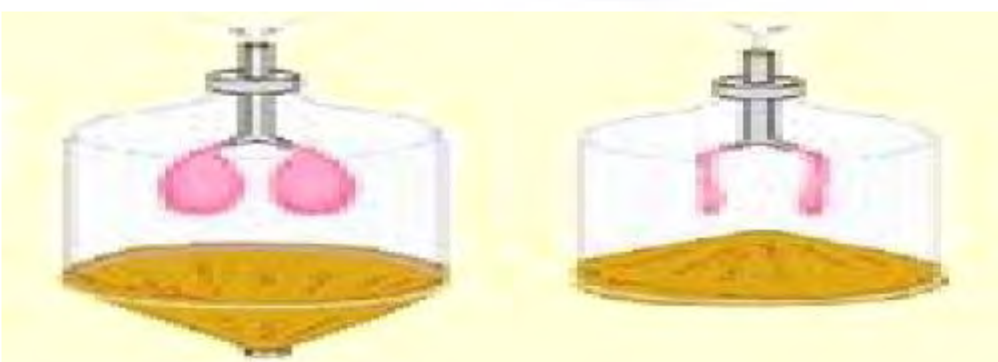

Figure 5 Schematic diagrams of improvised lungs when breathing in and out

Source: Bailey (2015)

2.7.3 Filtration of Water for Domestic use

Teaching treatment of water for domestic consumption could be done by drawing the treatment process on a hard card as shown in figure 6.

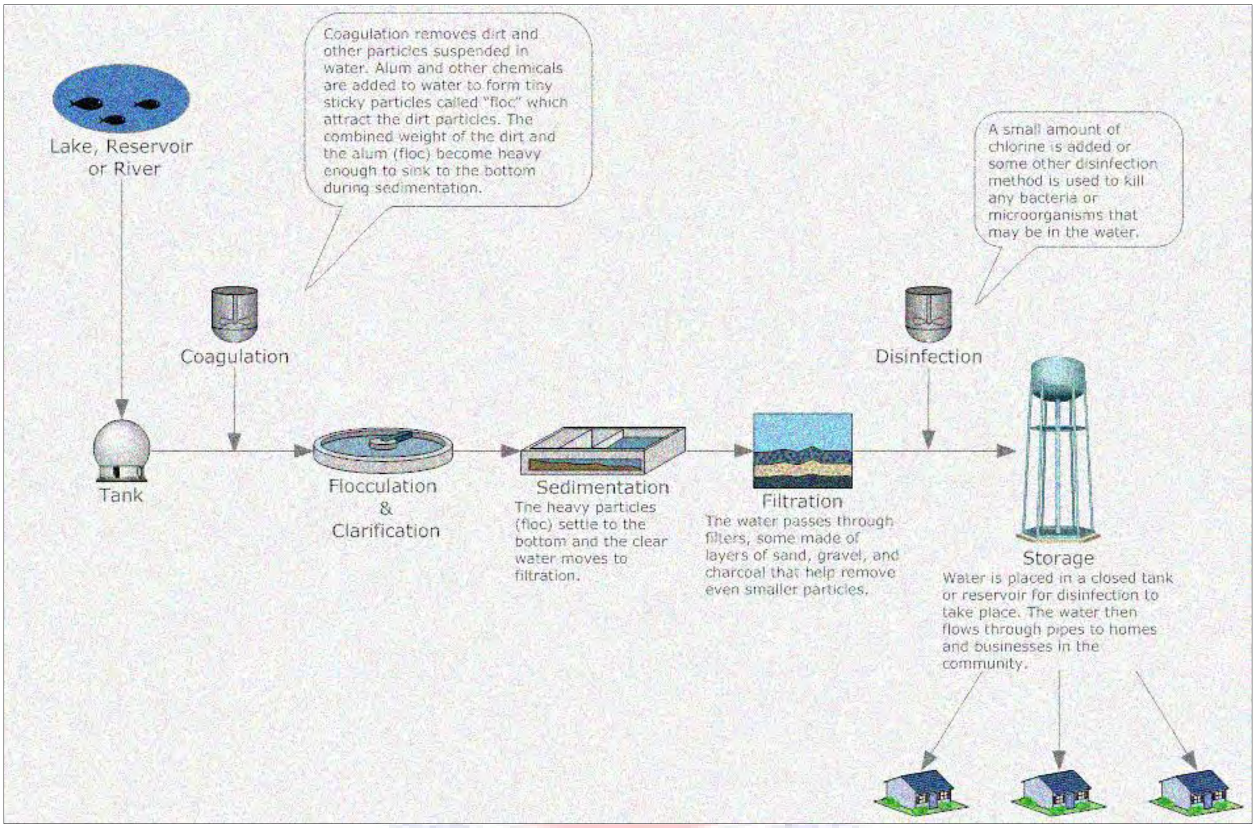

Figure 6:Schematic Diagram of Filtration of Water for Domestic use

Source:Sileshi (2012)

2.7.4 Some Improvised Materials and their uses

Science apparatus and equipment can be improvised for use in the classroom through the use of discarded materials around the environment. Such equipment as magnifying glass, beakers, funnels, electro-magnets, metre rule, concave and convex mirrors, test tube holders and temporary magnets are all materials that can be used to improvise useful science equipment in classroom.

Table 3 below showssome instructional materials that could be improvised, the standard material and the use of the material.

Table 3:Some Improvised Materials for Science Teaching and Learning

Improvised Material	Standard material	Use
Kerosine Stove	Bunsen burner	Heating
Coca-Cola/Pepsi-Cola plastic Bottle	Measuring cylinder	Measurement
Bottled Lemon juice & Baking powder	Fire extinguisher	Putting out fire
Hibiscus flower	Methyl orange	Acid-base indicator
Dissolved wood ashes	Sodium hydroxide	Base
Drinking straws	Delivery tube	Experiment
Dead electric bulb with water	Hand lens	Magnification
Graduated feeding bottle	Measuring cylinder	For measuring liquid volume
Plant and animal cells	Strips of cardboard	Illustration of cells
Cloths hanger (peg)	Test tube holder	For holding test-tube during experiments
Voltic Bottle	Beaker	For holding liquids
Lids of plastic container	Petri dish	Drying or displaying

Source: Muhammad et al (2015)

CHAPTER THREE

METHODOLOGY

3.0 Overview

In this chapter consideration was given to the study area and the research design used for the study. The chapter also discusses the population, the sampling procedures and the instrument used for data collection. There is also the description of the validity and reliability of the instrument, followed by the description of data collecting procedure and the method of data analysis.

3.1 Study Area

The South Tongu District was established by Legislative Instrument 1466 (LI 1466) in 1989 with Sogakope as its capital town. The district lies between latitudes 6°10’ and 5°45’ North and longitudes 30°30’ and 0°45’ East. It is located in the southern part of the Lower Volta Basin and bounded to the north by the Central and North Tongu Districts, to the east by the Akatsi South District, to the west by the Ada East District of the Greater Accra Region and to the south by the Keta Municipality. According to 2010 Population and Housing Census Report, the District has a population of 87,950 of which45.5 percent are males and 54.5 percent females. The population density is about 136 persons per squarekilometre. It is thus high in communities along the major roads and in few other communities where the roadnetwork is good. However it is sparse in North- Eastern and South Eastern parts. The District is largely ruralwith a majority of 87.1 percent in this locality and only 12.9 percent living in the urban settings.Figure 7 presents a map of the South Tongu District which shows the Danyikpo Circuit where the study took place.

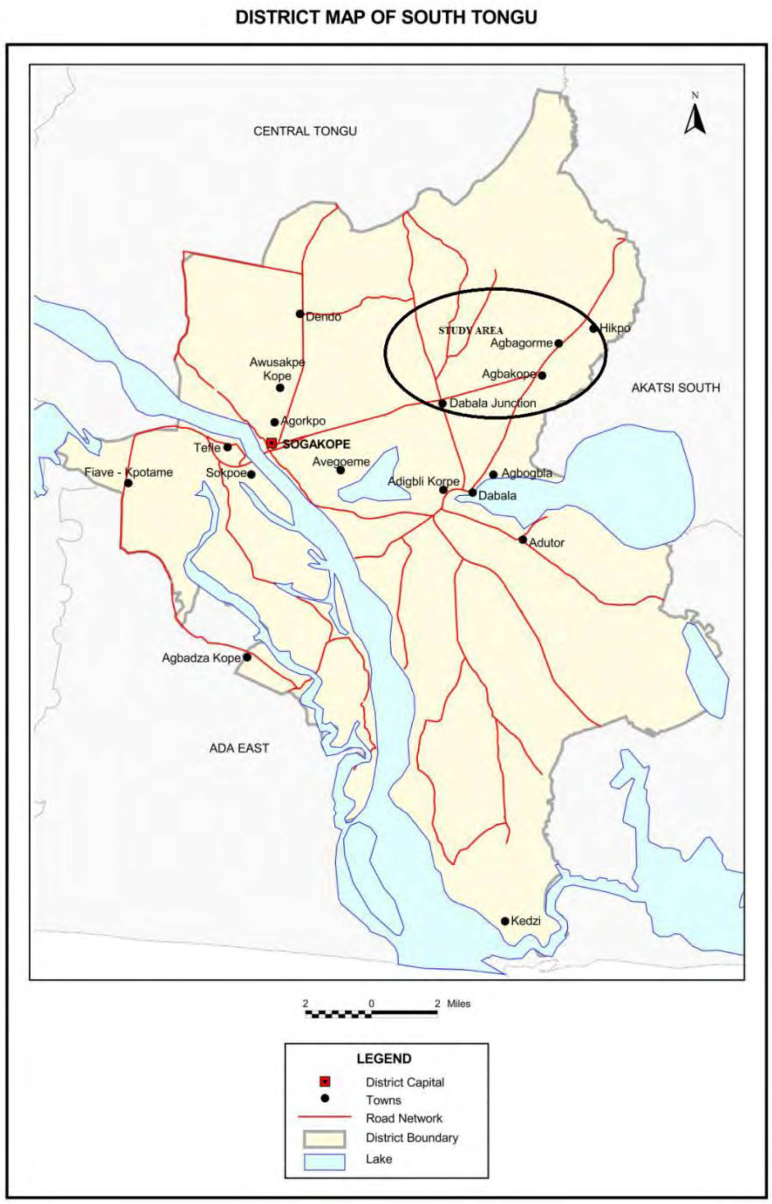

Figure 7. Map of South Tongu District Showing the Study Location

Source: Ghana Statistical Service (GSS) (2014)

3.2 Research Design

The research design employed in this study was a cross-sectional survey that will use pre- and post-tests as the prime instrument for data collection. This survey design was chosen so that generalizations could be made from the samples representing the population (Creswell, 2005;Kerlinger, 1997). Neuman (2000) argues that such an approach could be justified in terms of the nature of information gathered.

3.2 Population and Sampling Procedure

According to 2010 Population and Housing Census Report (GSS, 2014), there are two hundred and ninety nine (299) educational institutions operating within the District. There are a total of 288 basic schools. Public Basic schools account for 212 whiles Private Basic schools account for 76.In addition, there are four (4) Public Second Cycle Institutions in the district namely; Sogakope Senior High School, Dabala Secondary Technical School, Saint Catherine Girl's Senior High and Comboni Secondary Technical School.

The population for this study was all the 5,962 JHS students in the 47 JHSs in the South Tongu district. Ten (10) Junior High Schools were used in this study. The sampling technique for the selection of the schools was purposive, in that schools that are located in the Danyikpo Circuit were selected. The Danyikpo Circuit was selected for the study because the Researcher is a teacher in one of the Junior High Schools in the circuit. JHS 1, 2 and 3 students were randomly selected from the 10 purposively selected schools. Thirty (30) students each comprising 10 students each from JHS 1, 2 and 3 were selected from each of the 10 schools to make a sample size of three hundred (300). Out of the 300 sampled students, 115 were females and 185 were males.The independent variable was the use of improvised materials in teaching whilst the dependent variables were the scores obtained by the students in a researcher designed performance test.

3.3 Instrumentation

3.3.1 Researcher-designed Performance Test in Integrated Science

The main instrument used in the study was a Researcher-designed Performance Test in Integrated Science (PTIS). The PTIS contained a 4-option, 20 items multiple choice objective test which was based on the topics used in the study. For each item, the students were made to select the correct answer from four options. The PTIS was used to measure the performance of students in both pre-test and post-test. Some intervening variables extraneous to the study such as teacher effect and group interaction effect were controlled by the presence of the Researcher and the subject teachers in the various schools as the students took the tests. The topic selected for the study for JHS 1, 2 and 3 were:

a. Respiratory system of humans.
b. Water
c. Heat energy respectively.

3.3.2Census of Standard Science Laboratory Materials

The Researcher also undertooka census of standard science laboratorymaterials at the selected schools. This enabled the researcher to document the science materials present and their quality for effective science teaching or otherwise.

3.4 Validity of Main Instrument

Expertsin Integrated Science read through the PTISand corrected any ambiguous or inappropriate items.To ensure the PTIS had content validity, the Anderson's taxonomy of test item construction was followed in designing it. The test items were carefully selected so that they fell within the scope of the JHS syllabus and the specific topics that were selected for the purpose of the study.

3.5 Reliability of Main Instrument

Reliability is an essential characteristic of a good test, because if a test does not measure consistency, then one could not count on the scores resulting from a particular administration to be an accurate index of students' achievement. The instrument developed for the study was subjected to scrutiny by given it to my supervisor and other integrated Science teachers for proof reading to make sure that the items were made clearer and unambiguous. The length of the items were shortened and made clear so that the respondents could read an item quickly and select a response without difficulty. Ample time was given to respondents to complete the items.

3.6 Pilot Study

A pilot study wasconducted to test the research instrument. Students from schools not selected for the study wereused for this purpose. The purpose of the pilot study was to gain an insight into the relative strengths and weaknesses of the research instruments for possible improvements prior to the main study.

3.7 Data Collection Procedure

There were six stages involved in data collection for this study. These are outlined as follows:

Stage 1 - Seeking approval to access the schools for the study: An introductory letter was obtained from the Head of Science Education Department of the University of Education, Winneba and sent to each of the headmasters of the ten schools used for the study to seek their approval for the study to be conducted in their respective schools.Theheadmasters usedthe letter to introduce me to the teaching staff and the students involved in the study and called for their needed cooperation.

Stage 2 – Preparation of the improvised instructional materials used for the study: After the headmasters of the selected schools introduced the Researcher to the teaching staff and students, the Researcher together with the Integrated Science teachers in the schools agreed on a day for the preparation of the improvised instructional materials used for the study. On the said day, the Researcher aided the teachers to prepare the improvised materials.

Stage 3 – Census of standard laboratory materials: The next stage in the data collection process was the direct counting of the available laboratory materials present in the selected schools. The Researcher visited each of the selected schools to do the counting of the available science instructional materials.

Stage 4 – Collection of pre-test data: Five working days were used to collect the pre-test data. The Researcher administered the research instruments personally to the sampled students under study. This was to ensure that the instruments got to the targeted respondents and to ensure no student have fore-knowledge about the questions. The instruments were completed within twenty (20) minutes and were personally collected by the researcher instantly.

Stage 5 – Intervention: The sampled studentswere taken through the selected topics using improvised instructional materials. The intervention took one week made up of six (6) periods. Each period is composed of thirty-five (35) minutes. In all, each teacher used two hundred and ten (210) minutes to take the sampled population through the selected topics.

Stage 6 – Post-test: The post-test data were on the other hand collected after the topics selected for the study were taught. The post-test instruments were also completed within twenty (20) minutes and were collected by the researcher instantly.

3.8 Organisation and Analysis of Data

This study employed quantitative method of data analysis. Quantitative data collected were analysed using descriptive statistics, which included frequency counts, percentages and means.

To answer research question one, the data obtained fromthe census of science standard materials present in the selected schools were analysed using descriptive statistical methods involving frequency. To answer research questions two and three, the data obtained from the pre and post tests were analysed using descriptive statistical methods involving means.

The data obtained from the study werecoded and quantified, and then recorded on data summary sheets, following the format required by the statistical package for the social sciences (SPSS) and Microsoft Excel 2010. The means for the pre-test and post-test scores were computed and used to either accept or reject the hypotheses formulated.

CHAPTER FOUR

PRESENTATION AND DISCUSSION OF RESULTS

4.0 Overview

This chapter consists of the empirical data presentation, interpretation and analysis of responses from the sample under study. Tables were provided to illustrate and support the findings. Frequency distribution tables with percentages were constructed. Analysis of data involved inferential statistics of t-test significance. Data collected were analysed to answer the specific research questions. The results were presented in the order in which the research questions were presented in chapter one of this report. The chapter also contains the discussion of the data collected. The discussions were based on the data obtained from the test items. The evidence from the literature was used to support the arguments. The discussion was also based on the research questions.

4.1 Presentation of Results by Research Questions

4.1.1 What standard laboratory materials relevant for teaching integrated science are available in schools in South Tongu District?

The results of a census carried out revealed that there were only a few standard laboratory materials relevant for teaching integrated science available in schools in South Tongu District. Table 4 shows the results of the census.

Table 4: The Number of standard laboratory materials relevant for teaching integrated science present in schools

Serial Number	Standard material	Frequency
1	Test tube	54
2	Measuring cylinder	22
3	Graduated beaker	15
4	Permanent bar magnet	-
5	Hand lens	6
6	Thermometer	2
7	Reagentse.g acids, bases salts	-
8	Weighing scales	1
9	Volumetric apparatus	-
10	Electrical apparatus	-
11	Models of mammalian organs	-
12	Weather apparatus	-
13	Ecological apparatus	-

Source: Field work (2016)

An examination of Table 4 revealed that the teaching and learning of science in schools in South Tongu would be more theoretical thanexperimental as most basic equipment to use for demonstration or ask students to engage with were absent. This situation might affect the students' interest to take sciencesubjects in their further studies.

4.1.2 What would be the impact of the use of improvised laboratory materials on the academic performance of students in South Tongu in Integrated Science?

To answer research question two, a pre-test was administered to the students followed by the intervention and then a post test. The pre-test results showed that as many as 137 students obtained below 10, 92 scored from 10 to 13 and 71 got from 14 to 17. On the other hand, the post test scores showed a better performance by the students. The results indicated that, 121 students obtained from 12 to 14, 142 scored from 15 to 17 whilst 47 got from 18 to 20. Table 5 shows the marks obtained by the students, frequency and the mean scores in the pre-test and post-test.

Table 5: Frequency table of the pre-test scores of students

Mark(x) (Out of 20)	Frequency(f) (N=300)	Mean
6-9	137	10.69
10-13	92	
14-17	71	

Source: Field work (2016)

Table 6: Frequency table of the post-test scores of students

Mark(x) (Out of 20)	Frequency(f) (N=300)	Mean
12-14	121	15.23
15-17	142	
18-20	47	

Source: Field work (2016)

It could be seen from Tables 5 and 6 that students' performance was better in the post-test than the pre-test. The mean score of the pre-test was 10.69 whilst the mean score of the post test was 15.23.

4.1.3 What is the impact of the use of improvised laboratory materials on the academic performance of male and female students in South Tongu in Integrated Science?

This research question sought to compare the performance of male and female students after they had been taught using improvised science instructional materials.The results show that 78 male students scored from 12 to 14, 73 scored from 15 to 17 and 34 scored from 18 to 20 in the post-test. Table 7 shows the performance of male students after being taught with improvised science instructional materials.

Table 7: Frequency table of the post test scores of male students

Mark(x) (Out of 20)	Frequency(f) (N=185)	Mean
12-14	78	15.12
15-17	73	
18-20	34	

Source: Field work (2016)

It could be identified from the table that the mean score of the post-test was 15.12.

Female students performed better in the post-test than their male counterparts with a mean score of 15.41. This result is presented in Table 8 below.

Table 8: Frequency table of the post test scores of female students

Mark(x) (Out of 20)	Frequency(f) (N=115)	Mean
12-14	43	15.41
15-17	59	
18-20	13	

Source: Field work (2016)

Table 8 revealed that as many as 43 female students scored from 12 to 14, 59 scored from 15 to 17 while 13 scored from 18 to 20.

Comparing the mean scoresof the post-test results (Tables 7 and 8) of the male and female students of the selected schools, it is evident that the use of improvised science instructional materials affects female students more than their male counterparts.

4.2 Testing of the Hypotheses

4.2.1HO 1: There is no significant difference between pre-test and post-test results of students taught with improvised materials

In testing this hypothesis, the t-test and standard deviations (SD) of both the pre-test and post-test scores were computed and used. The calculated t-test (t-cal) value was -19.82 andthe critical t-test (t-crit) value was 1.97. The standard deviations of the pre-test and post-test scores were 2.79 and 2.08 respectively.Table 9 displays two sample 2–tailed t-test for the significance of the impact that improvised science instructional materials would have on the academic performance of students.

Table 9: t-test distribution of mean scores and standard deviation of pupils' pre-test and post-test results

Test	N	Mean	SD	DF	t-cal	t-crit	Decision
Pre-test	300	11.25	2.79	552	-19.82	1.97	significant
Post-test	300	15.23	2.08				

An examination of Table 9 reveals that the t-calculated (-19.82) is a negative value unlike the critical t-value of (1.97) at 0.05 alpha level. This means the post-test mean (15.23) is greater than the pre-test mean (11.25). This result shows that the Ho1 which stated that there is no significant difference between pre-test and post-test results of students taught with improvised materials is rejected.

4.2.2 HO 2: There is no significant difference between the academic performance of male and female students taught with improvised science materials

This hypothesis was tested using the t-test and standard deviations of the post-test scores of male and female students. The result shows that female students perform better in the post-test with a mean score of 15.41 and standard deviation of 1.70 than their male counterparts (mean of 15.12 and standard deviation of 2.28). The lower standard deviation of the scores of female students shows their scores were evenly distributed. Table 10 displays two sample 2–tailed t-test analysis ofthe significance of the impact improvised science instructional materials on the academic performance of male and female students.

Table 10: T-test analysis of male and female post-test scores

Post-test	N	Mean	SD	DF	t-cal	t-crit	Decision
Male	185	15.12	2.28				
vs				288	-1.26	1.97	significant
Female	115	15.41	1.70				

From Table 10, it could be observed that there was statistical significant difference between the performance of maleand female students in the post-test. The negative t-test obtained shows that there was an increase in the mean score of the female students. In view of this, the null hypothesis that there is no significant difference between the academic performance of male and female students taught with improvised science materials is rejected.

4.2 Discussion of the Results

According to Amadi(2002), instructional materials play the role of a stimulant in the teaching and learning process. They introduce a learner to first hand materials and convey a quality of intimacy. In furtherance, they focus the mind of the learner on what is taught apart from being aids to memory. They also make learning and teaching more understandable and real. Instructional materials boost teaching and learning as they stimulate thinking and concretize learning (Ige, 2004). Successful implementation of any curriculum is almost fully dependent on the quality and quantity of instructional materials available to teachers and students for use.

The findings from the census of standard laboratory materials present in the selected schools showed that the laboratory materials needed for effective teaching of science were inadequate (Table7). This is in line with the findings of FEMSA (2010). The results of FEMSA'sresearch showed that majority of the primary and secondary schools in the four African countries the research was carried out lacked functional laboratories.The FEMSA study also showed that some schools had few equipment but they used classrooms for practical work,which did not provide suitable settings.

The findings of this study confirm the fact that the utilization of improvised science equipment couldadd value to learning. This is in line with Nnachi(2005), Udosen (2011) and Ibe-Bassey (2012) on the issue that the creation and use of improvised materials and resources can enrich instruction to a guaranteed quality. The problem according to Ibe-Bassey (2012) lies with the teachers' lack of instinct for improvisation of instructional materials. Thus, if teachers will accept to improvise for materials which they lack to teach science, their lessons would be rich and interactive and students would stand to gain cognitively.

The findings from the pretest show that the students involved in the study performed poorly andtherefore had difficulty in performing well in the topics selected for the study. However, the findings from posttest show that after the students were taught the selected topics through the use of improvised instructional materials,they performed credibly. The students'credible performance in the post-test after the intervention as compared to their performance in the pre-testfurther confirms the studies of Ergul et al (2011)and Khan andIqbal's (2011), findings whichshowed that there was statistical significant difference between students who were taught some process skills in Physics and Biology through the use of improvised materials and those taught with the traditional lecture method. This current study has shown that when students are taught scientific concepts using locally available materials in the environment, which students are familiar with, their performance could improve. This shows that students' familiarity with the environment is an important factor to consider in teaching science.

It is obvious from the study that students actively constructed their own meaning of the concept by interacting with the improvised materials. Further, in the improvisation method, students were grouped, encouraged to interact with the improvised materials, and communicated their findings among themselves and other group members. This enhanced the students' understanding in the selected topics and hence, their improved performance. Social constructivists share the view that meaning is constructed before it is internalized; and this is achieved when students communicate among themselves as they actively interact with teaching and learning materials (Woolfolk, 2007).In teaching and learning science with limited laboratory resources, demonstration helps students conceptualize the scientific concepts more effectively than chalk-and-talk where students are challenged to connect theories to actual practice (Kandjeo-Marenga, 2011). However, Alonge (1999) argued that since demonstration usually consists of a teacher or student doing an activity with the rest of the class observing, demonstration would benefit only those students who assisted the teacher. These conclusions agreed with the assertion by Taiwo (2005) that insufficient funding of science programmes, lack of standard laboratories, and lack of general teaching resources limit the effective teaching and learning of science.

The findings on gender indicated that female students benefit more from the use of improvised equipment than their male counterparts.Table 10 revealed thatfemale students performed better than their male counterparts using improvised instructional materials for teaching. This finding agrees with the work of Oladejo, Olusunde, Ojebisi and Isola (2011) who reported that poor performance and negative attitude of secondary school female students towards chemistry could be largely ascribed to teaching problems like the inadequate standardized teaching instructional materials.Oladejoet al (2011) argued that the reason for the positive achievement by female students that weretaught usingimprovised instructional materials was that they were more resultoriented and more critical than their male counterparts. Krüger-Basener (2009), also observed that, the utilization of improvised instructional materials in teaching is easier adapting to female students' personand that theyhave good social contacts.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter discusses the main outcomes of the study. It includes a summary of the major findings, conclusions and recommendations. The chapter also contains contributions and suggestions for further studies.

5.1 Summary

The fundamental purpose of this study was to examine the impact of the use of improvised science instructional materials on the academic performance of basic school students. The study focused on ten basic schools in the South Tongu District of the Volta region of Ghana.

The research was a cross-sectional survey type with three research questions and two hypotheses formulated to achieve the objectives of the study. The main objective of the study was to examine the impact of the use of improvised science laboratory materials on the performance of basic school students in SouthTongu district.

The instruments that were used to collect data includedResearcher-designed Performance Test in Integrated Science (PTIS) and a census sheet of standard science laboratory materials in the selected schools also contributed to gathering data for the study. The purposive sampling technique was used to select the schools for the study. The research design employed in thisstudy was a cross-sectional survey that used pre- and post-tests as the prime instrument for data collection.

The population for this study was all the 5,962 JHS students in the 47 JHSs in the South Tongu district. Ten (10) Junior High Schools were used in this study. JHS 1, 2 and 3 students were randomly selected from the 10 purposively selected schools. Thirty (30) students each comprising 10 students each from JHS 1, 2 and 3 were selected from each of the 10 schools to make a sample size of three hundred (300). Out of the 300 sampled students, 115 were females and 185 were males.

The data collected was analysed to answer the specific research questions. The analysis of data involved the use of frequencies, percentages, means, standard deviations and independent sample t-test of significance.

The discussion of the major findings followed the research questions of the study. The data collected and its subsequent analysis yielded the following major findings:

1. The study revealed that science laboratory materials needed for effective teaching and learning of integrated science were woefully inadequate in the selected schools.This was contrary to the recommendation given by the JHS syllabus that for effective teaching and learning science, schools should have science equipment and materials and other requirements such as space for raising crops and animals.
2. The study also disclosed that the students involved in the study performed poorly in the pretest and therefore have difficulty in the topics selected for the study. The pre-test results showed that as many as 137 students obtained below 10, 92 scored from 10 to 13 and 71 got from 14 to 17. The mean score of the pre-test was 10.69.However, the findings from posttest show that after the students were taught the selected topics through the use of improvised instructional materials, they performed credibly. The results

indicated that, 121 students obtained from 12 to 14, 142 scored from 15 to 17 whilst 47 got from 18 to 20. The mean score of the post test was 15.23.

3. As regards the impact of the use of improvised materials on the academic performance of male and female students, the study results showed that 78 male students scored from 12 to 14, 73 scored from 15 to 17 and 34 scored from 18 to 20 in the post-test. The mean score was therefore 15.12. The female students however performed better in the post-test than their male counterparts with a mean score of 15.41. Thus, 43 female students scored from 12 to 14, 59 scored from 15 to 17 while 13 scored from 18 to 20.
4. There was significant difference [t (1.97) = -19.82, $p < 0.05$] between the pre-test and post-test scores of students selected for the study.In view of this, the null hypothesis(Ho) which stated that there was no significant difference between pre-test and post-test results of students taught with improvised materials was rejected.
5. There was statistical significant difference between the performance of maleand female students in the post-test [t(1.97) = -1.26, $p <0.05$]. The negative t-test obtained shows that there was an increase in the mean score of the female students. In view of this, the null hypothesis that therewas no significant difference between the academic performance of male and female students taught with improvised science materials was rejected.

5.2 Conclusion

In conclusion, there were inadequate integrated science laboratory materials for the teaching of science in basic schools in the South Tongu district. This led to the use of the lecture method or what is popularly referred to as the ‘talk-and-chalk’ method during science lessons. In schools where there were few materials, integrated science teachers used the demonstration method in teaching practical lessons.

In the present study, it is conclusive that when students were taught scientific concepts using familiar locally available materials in the environment their performance improve. This shows that students' familiarity with the environment is an important factor to consider in teaching science.

It is obvious from the study that students actively constructed their own meaning of the concept by interacting with the improvised materials. Further, in the improvisation method, students were grouped, made to interact with the improvised materials, and communicate among group members. This enhanced the students' understanding and performance in the selected topics, in line with social constructivists' views that meaning is constructed before it is internalized; and this is achieved through students' communication among themselves as they actively interact with materials (Woolfolk, 2007).

The findings on gender also indicated that female students benefit more from the use of improvised equipment than their male counterparts. The reason for this positive achievement by female students that were exposed to the use of improvisation is that they were more result oriented and more critical than their male counterparts (Oladejo et al, 2011).

5.3 Recommendations

The following recommendations are proposed based on the findings of the research:

- Large and well-equipped integrated science laboratories should be built in selected JHSs in South Tongu as resource centres for effective teaching and learning of the subject. This can be taken up by the government and supported by NGOs, corporate organisations and interested stakeholders.

❖ In the basic school level, the idea of every classroom teacher teaches all subjects including science whether or not he/she has any knowledge of science, thus, building an improper foundation at that level, should be discouraged.

❖ There should be periodic in-service training for integrated science teachers on the concept of improvisation.

❖ Teachers in the selected schools should take it as a matter of urgency to move away from the demonstration method of handling integrated science practical lessons in class. The activity-oriented method should be embraced with whatever little laboratory equipment and teaching and learning materials that are at hand.

❖ Career models such as doctors, engineers, ICT experts and astronomers should be regularly invited to talk to integrated science students in the selected schools about the jobs or careers that can arise from learning integrated science practical work. With this, the students in the selected study schools would see their future careers brighter to motivate them to learn hard.

5.4 Suggestions for Future Studies

Based on the findings of this study, the following suggestions for further research are made

a) Further studies could be carried out on the relevance of integrated science laboratories to the effective teaching and learning of integrated science practical work at the JHS level.

b) Research can be conducted on the effectiveness of in-service training to integrated science teachers at the JHS level.

c) It is also worthy undertaking a study on the impact of career counselling in the lives of integrated science students in the JHSs.

d) Further research work can be carried out on the influence of attitudes and perceptions in learning integrated science practical work at the JHS level.

e) It is suggested that similar survey be carried out in other basic schools as well. This will help to provide a good basis for more generalization or conclusions to be made on the impact the use of improvised materials would have on the academic performance of basic school students.

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APPENDIX A

TABLES OF SPECIFICATIONS USING ANDERSON'S TAXONOMY

20 Multiple choice questions

CLASS: JHS 1 TOPIC: RESPIRATORY SYSTEM IN HUMAN

Pre-test

REFERENCE: Twumasi, K.D. (2014). Integrated Science in Scope. The Publisher, Kindeb. P.150-162.

Domain	Objective	Item No.	Percentage(%)
Remembering	1. Define the term 'respiration'. 2. State the use of the energy produced during respiration. 3. State the respiratory organs of some organisms. 4. Define breathing. 5. State the processes involve in breathing.	No. 1, 2, 5 No. 9 No. 3, 7, 11 No. 4 No. 18	45
Understanding	1. Explain the characteristics of respiratory organs.	No. 10, 19	10
Applying	1. Demonstrate the passage of air through the respiratory system.	No. 6	5
Analyzing	1. Draw and label the parts of the human	No.12, 13,	

	respiratory system. 2. Compare external and internal respiration. 3. Differentiate between aerobic and anaerobic respiration. 4. Compare burning and respiration.	No. 14, 17 No. 16 No. 15	30
Evaluating	1. Relate air pollution to the hazards, disorders and diseases of the respiratory system.	No. 20	5
Creating	1. Design an experiment to show that expired air contains carbon dioxide.	No. 8	5
Total		**20**	**100**

Post-test

Domain	**Objective**	**Item No.**	**Percentage (%)**
Remembering	1. Define the term 'respiration'. 2. State the use of the energy produced during respiration. 3. State the respiratory organs of some organisms. 4. Define breathing.	No. 1, 2, 5 No. 9 No. 3, 7, 11 No. 4 No. 18	45

	5. State the processes involve in breathing.		
Understanding	1. Explain the characteristics of respiratory organs.	No. 10, 19	10
Applying	1. Demonstrate the passage of air through the respiratory system.	No. 6	5
Analyzing	1. Draw and label the parts of the human respiratory system. 2. Compare external and internal respiration. 3. Differentiate between aerobic and anaerobic respiration. 4. Compare burning and respiration.	No.12, 13, No. 14 No. 17 No. 16	30
Evaluating	1. Relate air pollution to the hazards, disorders and diseases of the respiratory system.	No. 20	5
Creating	1. Design an experiment to show that expired air contains carbon dioxide.	No. 8	5
Total		**20**	**100**

TABLE OF SPECIFICATIONS USING ANDERSON'S TAXONOMY

20 Multiple choice questions

CLASS: JHS 2 **TOPIC: WATER**

Pre-test

REFERENCE: Twumasi, K.D. (2014). Integrated Science in Scope. The Publisher, Kindeb. P.150-162.

Domain	Objective	Item No.	Percentage (%)
Remembering	1. List some sources of water 2. state the physical properties of pure water	No. 3, 8, 9 No. 17, 20	25
Understanding	1. explain the term hard water 2. explain the term soft water	No. 1, 4 No. 2	15
Applying	1. demonstrate the various ways of softening temporary hardness of water 2. demonstrate the various way of softening permanent hardness of water	No. 7 No.6	10
Analyzing	1. examine the health benefits of water to humans 2. examine the benefits of water in agriculture	No. 5,16 No. 10, 15	20
Evaluating	1. evaluate the ways of conserving water	No. 11, 12	20

	in the home 2. describe the steps involved in treating water for domestic consumption	No. 18, 19	
Creating	1. design a filter for the purification of water	No. 13, 14	10
Total		**20**	**100**

Post-test

REFERENCE: Twumasi, K.D. (2014). Integrated Science in Scope.The Publisher, Kindeb. P.306-317.

Domain	Objective	Item No.	Percentage (%)
Remembering	1. List some sources of water 2. state the physical properties of pure water	No. 3, 8, 9 No. 17, 20	25
Understanding	1. explain the term hard water 2. explain the term soft water	No. 1, 4 No. 2	15
Applying	1. demonstrate the various ways of softening temporary hardness of water 2. demonstrate the various way of softening permanent hardness of water	No. 7 No.6	10

Analyzing	1. examine the health benefits of water to humans 2. examine the benefits of water in agriculture	No. 5,16 No. 10, 15	20
Evaluating	1. evaluate the ways of conserving water in the home 2. describe the steps involved in treating water for domestic consumption	No. 11, 12 No. 18, 19	20
Creating	1. design a filter for the purification of water	No. 13, 14	10
Total		**20**	

TABLE OF SPECIFICATIONS USING ANDERSON'S TAXONOMY

20 Multiple choice questions

CLASS: JHS 3 **TOPIC: HEAT ENERGY**

Pre-test

REFERENCE: Twumasi, K.D. (2014). Integrated Science in Scope. The Publisher, Kindeb. P.594-613.

Domain	Objective	Item No.	Percentage (%)
Remembering	1. define the term heat 2. state the sources of heat 3. define the term temperature 4. describe the liquid-in-glass thermometer 5. define the modes of heat transfer	No. 2 No. 9 No. 1 No. 3 No. 18	25
Understanding	1. distinguish between heat and temperature 2. explain the term thermometric liquid 3. explain the term thermal expansion	No. 10 No. 5 No. 4	15
Applying	1. convert temperature on the Celsius scale into the Kelvin scale and vice versa 2. apply the modes of heat transfer in	No. 6 No. 11	10

	everyday life		
Analyzing	1. point out why water is not used as a thermometric liquid 2. point out why boiling water is not used to sterilized clinical thermometer 3. compare mercury and alcohol as thermometric liquids	No. 13 No. 14 No. 17	15
Evaluating	1. explain the formation of sea breeze 2. explain the formation of land breeze	No. 20 No. 12	10
Creating	1. design experiments to demonstrate the modes of heat transfer 2. design experiment to show that water is a bad conductor of heat 3. draw and label the vacuum flask	No. 7, 8 No. 15, 16 No. 19	25
Total		**20**	**100**

Post-test

REFERENCE: Twumasi, K.D. (2014). Integrated Science in Scope.The Publisher, Kindeb.P.594-613.

Domain	Objective	Item No.	Percentage (%)
Remembering	1. define the term heat 2. state the sources of heat 3. define the term temperature 4. describe the liquid-in-glass thermometer 5. define the modes of heat transfer	No. 1 No. 9 No. 2 No. 3 No. 18	25
Understanding	1. distinguish between heat and temperature 2. explain the term thermometric liquid 3. explain the qualities of a thermometric liquid 4. explain the term thermal expansion	No. 10 No. 5 No. 19 No. 4	20
Applying	1. convert temperature on the Celsius scale into the Kelvin scale and vice versa 2. apply the modes of heat transfer in everyday life	No. 6 No. 11	10

Analyzing	1. point out why water is not used as a thermometric liquid 2. point out why boiling water is not used to sterilize clinical thermometer 3. compare mercury and alcohol as thermometric liquids	No. 13 No. 14 No. 17	15
Evaluating	1. explain the formation of sea breeze 2. explain the formation of land breeze	No. 20 No. 12	10
Creating	1. design experiments to demonstrate the modes of heat transfer 2. design experiment to show that water is a bad conductor of heat	No. 7, 8 No. 15, 16	20
Total		**20**	**100**

APPENDIX B

UNIVERSITY OF EDUCATION, WINNEBA

FACULTY OF SCIENCE EDUCATION

DEPARTMENT OF SCIENCE EDUCATION

RESEARCHER-DESIGNED PERFORMANCE TEST IN INTEGRATED SCIENCE

JHS 1 **Topic: Respiratory System of Human** **Sex: M/F**

Pre-test **Time: 20 minutes**

Answer **all** questions by choosing only the correct lettered option for each question.

1. The **main** product of respiration is

   a. Energy b. carbon dioxide c. water vapour d. oxygen

2. Which of the following gases is needed before respiration can occur?

   a. Oxygen b. carbon dioxide c. water vapour d. nitrogen

3. Which of the following is **not** an example of a respiratory organ of animals?

   a. Lungs b. skin c. eyes d. gills

4. The process by which animals take in oxygen into the lungs and give off carbon dioxide is called

   a. breathing b. digestion c. ingestion d. excretion

5. Which of the following are the end products of aerobic respiration?

   a. Carbon dioxide and oxygen b. Carbon dioxide and energy c. Carbon dioxide and and alcohol d. oxygen and energy

6. Oxygen passes out of the alveoli into the blood by…….

   a. Osmosis b. diffusion c. dissolving d. osmosis and diffusion

7. A fish dies shortly after being removed from water. This is because it

a. Cannot swim b. is streamlined c. cannot respire d. has scales

8. The chemical used to demonstrate that expired air contains carbon dioxide is

 a. Water b. lime water c. ammonia solution d. baking powder

9. Which of the following is/are the use(s) of the energy produced during respiration? It is used I to replace worn out tissues II for movement

III for growth IV for reproduction

 a. I only b. I and II only c. I, II, III and IV d. I, II and III only

10. Which of the following is the function of the hairs in the nose of human?

 a. Keep the nose warm b. make breathing easier c. keep the nose moist d. none

11. The organ which enables a fish to breath in water is the

 a. Nostril b. dorsal fin c. pectoral fin d. gill

12. The trachea of humans split into two tubes called

 a. Bronchi b. bronchioles c. alveoli d. lungs

13. Which of the following illustrates the passage of air through the respiratory system of humans?

 a. nostril $\longrightarrow$ larynx $\longrightarrow$ trachea $\longrightarrow$ bronchus $\longrightarrow$ bronchioles $\longrightarrow$ alveolus

 b. nostril $\longrightarrow$ larynx $\longrightarrow$ bronchus $\longrightarrow$ bronchioles $\longrightarrow$ alveolus $\longrightarrow$ trachea

 c. nostril $\longrightarrow$ trachea $\longrightarrow$ bronchus $\longrightarrow$ bronchioles $\longrightarrow$ alveolus $\longrightarrow$ larynx

 d. nostril $\longrightarrow$ larynx $\longrightarrow$ trachea $\longrightarrow$ bronchioles $\longrightarrow$ bronchus $\longrightarrow$ alveolus

14. The equation $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$ + Energy represents

 a. External respiration b. internal respiration c. photosynthesis d. digestion

15. A boy who got trapped in a cupboard will die because

a. All the air in the cupboard will be used up b. only nitrogen gas will be left in the cupboard c. the greater part of oxygen in the cupboard will be used up d. noble gases will run short in the cupboard

16. The gas that supports respiration and burning is

a. Hydrogen b. oxygen c. chlorine d. nitrogen

17. One **main** difference between aerobic and anaerobic respiration is that

a. Aerobic respiration needs oxygen whilst anaerobic respiration does not b. the by-products of aerobic respiration are alcohol and carbon dioxide whilst that of anaerobic respiration are carbon dioxide and water c. aerobic respiration produces little amount of energy whilst anaerobic respiration produces a lot of energy

18. Which of the following statements is **not true** during inhalation?

a. Muscles of the diaphragm contract b. intercostal muscles contract c. intercostal muscles relax d. lungs become inflated

19. Surfaces used for gaseous exchange in mammals have

a. Thin walls with small surface area b. moist and small surface area c. moist surface and well supplied with blood vessels d. large volumes and well supplied with blood vessels

20. All the following human activities are hazardous to the respiratory system except

a. Smoking of tobacco b. sleeping in treated mosquito net c. jogging d. cycling

UNIVERSITY OF EDUCATION, WINNEBA

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RESEARCHER-DESIGNED PERFORMANCE TEST IN INTEGRATED SCIENCE

JHS 1 **Topic: Respiratory System of Human** **Sex: M/F**

Post-test **Time: 20 minutes**

Answer **all** questions by choosing only the correct lettered option for each question.

1. Internal respiration that occurs in the presence of oxygen is known as

a. Anaerobic respiration b. alcoholic fermentation c. simple diffusion d. aerobic respiration

2. Which of the following is **not** an example of a respiratory organ of animals?

a. Lungs b. skin c. eyes d. gills

3. The process by which animals take in oxygen into the lungs and give off carbon dioxide is called

a. breathing b. digestion c. ingestion d. excretion

4. Which of the following are the end products of aerobic respiration?

a. Carbon dioxide and oxygen b. Carbon dioxide and energy c. Carbon dioxide and and alcohol d. oxygen and energy

5. Oxygen passes out of the alveoli into the blood by…….

a. Osmosis b. diffusion c. dissolving d. osmosis and diffusion

6. A fish dies shortly after being removed from water. This is because it

a. Cannot swim b. is streamlined c. cannot respire d. has scales

7. The percentage composition of carbon dioxide in exhaled air is

a. 21 b. 78 c. 0.03 d. 3.5

8. Which of the following is/are the use(s) of the energy produced during respiration? It is used I to replace worn out tissues II for movement

III for growth IV for reproduction

a. I only b. I and II only c.I, II, III and IV d. I, II and III only

9. Which of the following is the function of the hairs in the nose of human?

a. Keep the nose warm b. make breathing easier c. keep the nose moist d. none

10. The organ which enables a fish to breath in water is the

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11. The trachea of humans split into two tubes called

a. Bronchi b. bronchioles c. alveoli d. lungs

12. Which of the following illustrates the passage of air through the respiratory system of humans?

I alveolus II nostril III larynx IV trachea V bronchus VI bronchioles

a. I, II, III, IV, VI, V b. II, IV, I, III, V, VI c. I, II, V, IV, VI, III d. II, III, IV, V, VI, I

13. The equation $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O$ + Energy represents

a. External respiration b. internal respiration c. photosynthesis d. digestion

14. A boy who got trapped in a cupboard will die because

a. All the air in the cupboard will be used up b. only nitrogen gas will be left in the cupboard c. the greater part of oxygen in the cupboard will be used up d. noble gases will run short in the cupboard

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19. All the following human activities are hazardous to the respiratory system except

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20. Which of the following gases is needed before respiration can occur?

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UNIVERSITY OF EDUCATION, WINNEBA

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RESEARCHER-DESIGNED PERFORMANCE TEST IN INTEGRATED SCIENCE

JHS 2 **Topic: Water** **Sex: M/F**

Pre-test **Time: 20 minutes**

Answer **all** questions by choosing only the correct lettered option for each question.

1. Hard water is water which
   a. lather well with soap b. leaves scales in kettles c. boils slowly d. is bitter
2. All the following are advantages of soft water except
   a. the calcium ions in it help in the clotting of blood b. it does not leave fur in hot water pipes c. it is used in the dyeing and tanning industries d. it lathers easily with soap
3. Which of the following sources of water is salty?
   a. stream b. sea c. well d. lake
4. Which of the following is not hard water?
   a. rain water b. pipe-borne water c. water from stream d. water from river
5. The following are health benefits of water to humans except
   a. transport nutrient and oxygen into cells b. moisturizes the air in lungs c. helps with metabolism d. serve as habitat to humans
6. Permanent hardness is caused by
   a. KCl b. NaCl c. $CaCl_2$ d. $FeCl_2$
7. Which of the following methods removes only temporary hardness?

a. distillation b. addition of washing soda c. boiling d. ion exchange

8. Which of the following sources of water is good for human consumption?

a. pond b. bore-hole c. sea d. stream

9. Arrange the following sources of water in increasing order of purity.

I rain II sea III river IV deep well

a. I, II, IV, III b. II, III, I, IV c. IV, I, III, II d. III, II, I, IV

10. Water from rivers and dugout well can best be used in the

a. agricultural industry for irrigation b. brewery industry c. pharmaceutical industry d. food industry

11. One reason why treated water needs to be used wisely is that

a. water is highly volatile b. it is very difficult to pump untreated water c. is very expensive to treat water d. it is dangerous treating water

12. All the following are ways of conserving water in the home except

a. fixing leaky or broken pipes b. washing full loads of laundry at a time c. not keeping the tap running while brushing teeth d. watering lawns frequently when water is in short supply

13. Water purification methods mostly used in the villages are

I boiling II filtration III distillation IV addition of alum

a. I and II b. II and III c. I and III d. I, II and IV

14. The first step involved in treating water for a large community or town is to

a. screen the water b. chlorinate the water c. expose the water to atmospheric oxygen d. add alum to the water

15. Which of the following sources of water will not be suitable for vegetable farming?

a. rain b. dug out well c. river d. sea

16. A condition that occurs when we do not have enough water in our bodies to carry out normal functions is called

a. dehydration b. rehydration c. AIDS d. kwashiorkor

17. Water is

a. colourless, odourless, tasteless gas b. colourless, odourless, tasteless liquid c. colourful, odourless, tasteless gas c. colourful, odourless, tasteless liquid

18. The best method for purifying water from the sea is

a. filtration b. distillation c. addition of chlorine d. addition of alum and Calcium hydroxide

19. All the following are symptoms of water borne diseases except

a. itching of the skin and traces of blood in urine b. severe diarrhoea with blood and mucus c. difficulty in passing out stool d. the appearance of painful blisters on the legs and arms

20. Water which is pure freezes at a temperature of

a. 70 ^{o}C b. 80 ^{o}C c. 90 ^{o}C d. 100 ^{o}C

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RESEARCHER-DESIGNED PERFORMANCE TEST IN INTEGRATED SCIENCE

JHS 2 **Topic: Water** **Sex: M/F**

Post-test **Time: 20 minutes**

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10. Water from rivers and dugout well can best be used in the

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b. I and II b. II and III c. I and III d. I, II and IV

14. The first step involved in treating water for a large community or town is to

b. screen the water b. chlorinate the water c. expose the water to atmospheric oxygen d. add alum to the water

15. Which of the following sources of water will not be suitable for vegetable farming?

b. rain b. dug out well c. river d. sea

16. A condition that occurs when we do not have enough water in our bodies to carry out normal functions is called

b. dehydration b. rehydration c. AIDS d. kwashiorkor

17. Water is

b. colourless, odourless, tasteless gas b. colourless, odourless, tasteless liquid c. colourful, odourless, tasteless gas c. colourful, odourless, tasteless liquid

18. The best method for purifying water from the sea is

b. filtration b. distillation c. addition of chlorine d. addition of alum and Calcium hydroxide

19. All the following are symptoms of water borne diseases except

b. itching of the skin and traces of blood in urine b. severe diarrhoea with blood and mucus c. difficulty in passing out stool d. the appearance of painful blisters on the legs and arms

20. Water which is pure freezes at a temperature of

b. 70 ^{o}C b. 80 ^{o}C c. 90 ^{o}C d. 100 ^{o}C

UNIVERSITY OF EDUCATION, WINNEBA

FACULTY OF SCIENCE EDUCATION

DEPARTMENT OF SCIENCE EDUCATION

RESEARCHER-DESIGNED PERFORMANCE TEST IN INTEGRATED SCIENCE

JHS 3 **Topic: Heat Energy** **Sex: M/F**

Pre-test **Time: 20 minutes**

Answer **all** questions by choosing only the correct lettered option for each question.

1. The degree of hotness or coldness of a substance is referred to as

   a. temperature b. pressure c. force d. energy

2. A form of energy that travels from one point of a medium to another due to temperature differences between the points is known as

   a. light energy b. kinetic energy c. potential energy d. heat energy

3. All the following are liquid in glass thermometers except

   a. bimetallic thermometer b. clinical thermometer c. laboratory thermometer d. six maximum and minimum thermometer

4. Which of the following statements is true when water is heated?

   a. it contracts b. it expands c. kinetic energy of its molecules increases d. its temperature decreases

5. A liquid used in thermometers that expands or contracts appreciably when there is an increase or decrease in temperature is known as

   a. thermophilic liquid b. thermal liquid c. thermometric liquid d. thermodynamic liquid

6. The boiling point of water on the Celsius scale is 100 ^{o}C. What will be the temperature on the Kelvin scale?

   a. 273 K b. 373 K c. 577 K d. 100 K

In an experiment, two nails are fixed with candle wax onto a metal bar and one end of the bar is heated by means of boiling water. Use this information to answer questions 7 and 8

7. What mode of heat transfer is demonstrated in the experiment?

   a. convection b. radiation c. conduction d. boiling

8. Which of the following is an application of the mode of heat transfer demonstrated in the experiment?

   a. cooking utensils are made of metals which are good conductors of heat

   b. white clothes are more comfortable to wear on sunny days

   c. the cooling fins of deep freezers are painted black to emit as much heat

   d. fridges replaces hot air with cold air to cool things

9. All the following are sources of heat except

   a. the sun b. geothermal energy c. friction d. cohesion

10. One difference between heat and temperature is that

    a. heat is measure with thermometer but temperature is not

    b. heat is a form of energy but temperature is the internal friction within liquids

    c. heat is measured in Joules whilst temperature is measured in degree Celsius or Kelvin

    d. heat causes no physical change of an object but temperature does

11. When metal spoon is use to stir hot porridge, the handle of the spoon will become

a. hot b. expanded c. red hot d. cold

12. The process by which cool air blowing from the sea replaces hot air from the land during the day is known as

a. evaporation b. condensation c. sea breeze d. land breeze

13. Water is not use in liquid in glass thermometers because

a. it expands irregularly at certain temperatures b. the temperature range within which it freezes and boils is very large c. it does not cling to the walls of the glass tubing d. it does not vaporises and condenses in the tubing

14. Which of the following is the reason why boiling water is not used to sterilised clinical thermometers?

a. it wets glass b. it is a poor conductor of heat c. its temperature is higher than the maximum temperature the clinical thermometer could measure d. it is opaque

A piece of ice is trapped at the bottom of a test tube full of water, and the test tube is heated near the top. The ice remains un-melted even when the water at the top of the test tube is boiling. Use this information to answer questions 15 and 16

15. Which of the following is not a factor that prevents heat reaching the bottom of the test tube?

a. water is a poor conductor of heat b. glass is a poor conductor of heat c. there are no convection currents through the water d. there is no downward radiation through the water

16. What conclusion could be drawn from the information?

a. water is a poor conductor of heat b. glass is a poor conductor of heat c. there are no convection currents through the water d. there is no downward radiation through the water

17. Why is mercury preferred over alcohol in most liquid in glass thermometers

I mercury has a boiling point of 357 ^{o}C and a freezing point of -39 ^{o}C

II mercury expands and contracts regularly III mercury has a high specific heat capacity IV alcohol is volatile

a. I, II, III only b. I,II, IV only c. I, II, III, IV d. II, III, IV only

18. By what process is heat transferred from the bottom of a container of water to the top

a. conduction b. convection c. radiation d. transmission

19. In the thermos flask, the silvered inner walls of the glass container prevent heat transfer by

a. convection b. radiation c. radiation and conduction d. conduction and convection

20. The process by which warm air from the sea replaces cool air from the land during the night is known as

a. land breeze b. sea breeze c. night breeze d. night breeze

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RESEARCHER-DESIGNED PERFORMANCE TEST IN INTEGRATED SCIENCE

JHS 3 **Topic: Heat Energy** **Sex: M/F**

Post-test **Time: 20 minutes**

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