UNIVERSITY OF EDUCATION, WINNEBA

USING INSTRUCTIONAL MATERIALS TO HELP LEVEL "100 A" STUDENTS OF ATEBUBU COLLEGE OF EDUCATION HAVE BETTER CONCEPTUAL UNDERSTANDING OF REFLECTION AND REFRACTION OF LIGHT

PRINCE DUKU

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A DISSERTATION IN THE DEPARTMENT OF SCIENCE EDUCATION, FACULTY OF SCIENCE EDUCATION, SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF EDUCATION DEGREE IN SCIENCE EDUCATION

DECEMBER, 2017

DECLARATION

STUDENT'S DECLARATION

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

SIGNATURE:……

DATE:……

SUPERVISOR'S DECLARATION

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

Prof. Victor Antwi

SIGNATURE:……

DATE:……

ACKNOWLEDGEMENT

Glory be to God for his protection, guidance and mercy upon me throughout my course of study.

I am highly grateful to my supervisor, Professor Victor Antwi, for his suggestions, constructive comments and guidance which have made this work a success. Prof., may you live to influence many more generations.

My sincere thanks also go to all the other lecturers of the Science Department of the University of Education, Winneba. I wish to express my heartfelt gratitude to the Principal and staff of Atebubu College of Education for their support.

DEDICATION

This work is dedicated to my beloved mother and siblings.

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ABSTRACT

The purpose of the study was to use instructional materials to help level "100A" students of Atebubu College of Education have better conceptual understanding of reflection and refraction of light. The study was an action research which falls under descriptive research design. The population of the study was all students of Atebubu College of Education. The target population for the research was all the Level 100 students of Atebubu College of Education but the accessible population was the level "100A" students of the College. The class was made up of forty (40) students. The researcher used purposive sampling to carefully select the students based on their peculiar problems. The instruments used for the research were observation, regular class exercises, interview, pre and post- tests. From the analysis of the data from the study, the following major findings were observed. During the pre-intervention exercise, it was revealed that most of the students were lacking the basic knowledge and understanding about the concepts of reflection and refraction of light, and that; they performed poorly in their pre-test questions. After the implementation of the intervention activities, results from the post-test did indicate that about 85% have improved in their conceptual understanding of reflection of light. Again, about 75% also improved in their conceptual understanding of refraction of light after the intervention. These showed that a great majority of the students have overcome their difficulties in the concepts of reflection and refraction of light. Thus students' conceptual understanding of reflection of light as well as refraction of light improved. There were mixed opinions to the research question three. Students' opinions showed that majority of them supported the use of instructional materials in the learning process. Based on the research conducted, the following recommendation was made, Physics teachers should solely depend on the use of instructional materials for effective delivery and achievement of lesson objectives.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter includes an introduction to the research study. It contains the background to the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the research, delimitations and limitations of the study and organization of the study.

1.1 Background to the study

Light is a very complex phenomenon, but in many situations its behaviour can be understood with a simple model based on rays and wave fronts.

In general, scientific concepts of light refraction and reflection are basic and yet important contents in physics education. In the context of Ghana education, students need to gain this scientific concept properly in order to understand related and advanced physics concepts in the future, i.e., interference of light wave and spectrum of light. Without understanding the concept of light and its properties, students may not understand many scientific domains (Djanett, 2013). Unfortunately, researchers have reported that the Ghanaian students hold alternative conceptions in science phenomena

about refraction of light. A few examples are that, they are confused about the meaning of light reflection and refraction; the direction of propagation of light; how light refraction occurs at an interface; and how to determine the position of an image

(Kaewkhong, 2010). These alternative conceptions arise because of their pre-existing ideas and beliefs based on their everyday experience with light (Galili & Hazan, 2011)

The theoretical parameters associated with light, such as its speed, wave length, pressure, and discrete nature, are all far removed from the range of perceptions of the human senses, and in the case of optics instruction which is heavily based on graphic symbolism and which are subject to interpretation, there is a need for careful consideration in physics teaching process. However, students find the subject of optics to be obscure and difficult, and teachers help is often inadequate (Galili & Hazan, 2010; 2011) because of its complex and abstract relations. These learning difficulties can be significantly reduced by embedding essential process and content explanations within the classroom learning environment. Unfortunately, students face most of the light concepts in school learning in the context where teachers mostly use the traditional transmission model. The traditional transmission model of teaching is ineffective in physics concepts learning (Dega, Kriek, & Mogese, 2013) because the teaching process of delivery of new knowledge to students does not focus on detecting their pre-existing ideas and beliefs and correcting their alternative conceptions (Jaakkolaa & Nurmi 2008; Jaakkolaa, Nurmi, & Veermans, 2011). As such, new instructional strategies must be developed to assist in active construction and meaningful adaptation of their knowledge (De Jong & Van Joolingen, 2008). In order to help students obtain meaningful understanding of the refraction of light phenomena, students' alternative conceptions, therefore, must be established and removed (Aydin, 2012). Therefore, a learning process in which students' alternative conceptions were changed, transformed, or reconstructed into the intended scientific conceptions was officially called for physics instruction.

The teacher alone cannot provide all the needed conditions for an effective teaching and learning process, other supporting materials should be provided. The students learn better when most of the senses are appealed to the instruction and use of instructional materials in physics education has added a new dimension in the positive promotion of the teaching and learning process. It provides the much needed sensory experiences needed by the learners for an effective and meaningful behavioural change. Instructional materials are meant to improve the quality of education for effective academic performance of physics students in schools. The performance of the students on the intended learning outcome provide the validation – loop on the success of the interaction and instruction (Bakare, as cited in Umaru, 2011).

Teachers normally dodge the use of instructional materials in most of their teaching topics, while they try to do all they could during their practical teaching in their course of study; even though some of these materials are not usually available in the schools for teachers' use. If instructional materials are used in Colleges of Education, it would help improve the teaching and learning and hence the academic performance of students in Physics effectively. It is on this background that this research will focus on the use of instructional materials to help level 100 students of Atebubu College of Education have better conceptual understanding on reflection and refraction of light.

1.2 Statement of the Problem

Many of the school authorities have very lukewarm attitude over the provision of needed tools and equipment required for effective Physics, especially practical work in Colleges of Education. This attitude tends to retard genuine efforts of some teachers of Physics in the Colleges of Education. The researcher observed that most teachers in Colleges of

Education did not fully make use of instructional materials in the teaching of physics to their students. This negligence of the effective use of the instructional facilities and materials in teaching and learning of physics common to both the trained and untrained teachers affected the successful academic performance of students in physics in Colleges of Education.

The appropriate utilization of instructional materials and teaching of physics by experienced and qualified teachers may probably be the main solution to poor performance in physics. In order to develop interest of the students to the study of physics in Colleges of Education and the participation of physics teachers to teach the subject as a practical, the researcher deems necessary for the use of appropriate instructional materials for the teaching of physics in Colleges of Education. It is on this background that this research will focus on the use of instructional materials to help level 100 students of Atebubu College of Education have better conceptual understanding on reflection and refraction of light

1.3 Purpose of the study

The purpose of the study was to use instructional materials to help level 100A students of Atebubu College of Education have better conceptual understanding on reflection and refraction of light.

1.4 Objectives of the study

The following objectives were designed for the study.

1. Determine the use of instructional materials on students' achievement in concepts of reflection of light.

2. Determine the effect of the use of instructional materials on students' achievement in concepts of refraction of light
3. Evaluate the opinions of students with the use of instructional materials on their conceptual understanding of reflection and refraction of light.

1.5 Research Questions

The following research questions guided the study.

1. What is the effect of the use of instructional materials on students' achievement or performance on the concepts of reflection of light?
2. What is the effect of the use of instructional materials on students' achievement or performance on the concepts of refraction of light?
3. What are the opinions of students with the use of instructional materials on their conceptual understanding of reflection and refraction of light?

1.6 Significance of the study

It is believed that the outcome of the study will add to the existing literature on reflection and refraction of light. It is expected that this work will prompt school authorities to find appropriate intervention to educate pupils on the use of instructional materials to improve students' understanding on the concept of light. And it will serve as basis for further research and also serve as reference material on reflection and refraction of light.

1.7 Delimitations

The study should have involved all the level 100 students of Atebubu College of Education and beyond but due to time factor and other logistics beyond the limit of the

researcher, the study was limited to only level 100A students of the said College because they all have relatively similar characteristics.

Also, the study was restricted to the use of instructional materials to help level 100A students of Atebubu College of Education have better conceptual understanding of reflection and refraction of light.

1.8 Limitations of the study

The most significant challenge to this study was the unavailability of instructional materials to teach the concepts of reflection and refraction of light to the students. The college did not have well equipped physics laboratory. There were also time constraints in the data collection.

1.9 Organization of the study

The study is organized into five chapters. The chapter one focused on the general introduction and background to the study, the statement of the problem, purpose and objectives of the study, research questions, significance of the study and organization of the study. Chapter two on the other hand dealt with the literature review related to the study, highlighting theories made by other researchers. The chapter three focused on the methodology, tackling the research design, population, sampling and techniques, research instrument, data collection procedure, pre-intervention, post intervention and limitations. Chapter four is the presentation and analysis of results, as the chapter five discussed the summary of findings, gave recommendations and conclusions.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 Overview

The literature was reviewed under the following sub-headings.

- Theoretical framework

  i. Constructivist theory (approach) of learning

- General instructional materials
- Types of instructional materials
- The importance and uses of instructional materials
- The factors affecting the use of instructional materials
- Factors influencing student achievement or performance
- Factors that affect the use of Instructional Resources
- Students' conception of light and vision
- The concepts of Reflection of light
- The concepts of Refraction of light
- Review of related empirical studies

2.1 Theoretical Framework

This study adopted the constructivist theory. This theory primarily focuses on students being the pivot in the learning environment. The theory was to derail any misconception which students have on the study of physics concepts especially the concept of reflection and refraction of light at Atebubu College of Education.

2.1.1 Constructivist theory (approach) of learning

This research was conducted in line with the constructivist theory of learning physics. This learning theory is one of the most influential theories in education and learning theory.

Clement and Battista (2010) defined constructivism as an epistemology, which follows the basic tenets that**:**

1. Knowledge is actively created by the students

2. New knowledge is created by reflection on physical and mental action.

3. There is no one reality, each person has their own reality based on their interpretation.

4. Learning is a social process.

5. Students learn when they are allowed to explore.

Constructivist theory is premised on the active nature of learning as proposed by Bruner (2000). This is in agreement with the Educational Broadcasting Corporation (2004) that constructivism is basically a theory based on how people can learn on their own with little guidance. According to constructivism, the underlying knowledge resides in the individual learner and, as such, learning is a process through which an individual tries to make sense of what is taught by tying to fit into his / her existing knowledge structure prior to experience. Learning becomes meaningful only after the new materials are well connected with the existing related knowledge or schema. For instance, when we encounter something new, we have to reconcile it with our previous ideas and experience, changing what we believe or maybe discarding the new information as irrelevant.

From the constructivist of point view, we are active creators of our own knowledge for effective learning. Therefore, the learner needs to attain cognitive equilibrium by seeking

stability through assimilation and accommodation, hence , it is important to help students build their own schema by letting them learn more specific and general knowledge before moving onto higher order of problem-solving which requires the ability to connect ideas. It is on this basis that Svinicki (1999) emphasizes that a new learning material must fit with whatever the learner already knows if it is well understood. This means that a teacher either will help the students to build relevant prerequisite knowledge or refresh their knowledge before they are exposed to new materials. The constructivist view of learning is reflected in the developmental theories of Dewey (1997) and Vygotsky (1978) among others.

2.2 General Instructional Materials

Instructional materials are all the objects, things, people and places used to promote the teaching and learning process. The organized combination and utilization of materials, facilities, equipment and people ease the presentation of content for the realization of stated objectives. Ema and Ajayi (2004) state that instructional materials are all the tools, which can be used by the teacher to provide help and encouragement to learners` learning activities. In addition, instructional materials are anything and anybody that can be used by the teacher and learners before, during and after the lesson to facilitate the achievement of objectives.

In other words, instructional materials are devices that facilitate the transmission, understanding and appreciation of concepts, skills, values and attitudes. The reason is that, the uses of such materials task the various sense organs of the learners. It encourages students' active participation in the instructional process through their various senses. Student's understanding is promoted. The teacher is saved from making lengthy

explanations that further confuse the learners. Again, the more of the senses contributed in a lesson by instructional materials the more reality is stimulated. It is in line with this thought that Ema and Ajayi (2004) stated that instructional materials are all the tools which can be used by the teacher to provide help and encouragement to learners learning activities. Such materials bring together humans and materials in a systematic cooperation to effectively solve educational problems.

2.3 Types of instruction materials and resources

Instructional materials are variedly categorized. For instance, Dubey and Barth (1980) grouped them into two, namely reading materials and non-reading materials.

Another categorization provided by Dubey and Barth (1980) has reading materials, audio-visual materials, community resources and human resources. They made a distinction between the following:

1. Materials which offer content for example chart, graphs, audio recordings, tools and implements, print materials of all kinds, globes, map, painting, resources in the community.

2. Materials for presenting content such as audio and video recorders, bulletin boards, chalkboard, flannel board, slide projectors, computers, television, etc. Another grouping of instruction materials includes:

3. Human resources which consist of individuals who provide various services in the teaching and learning process. They include: professionals and non-professionals.

4. Non-human resources which include physical facilities and instructional materials, which serve as tools and devices through stimuli can be passed or obtained. They are all forms of information carriers.

Dubey and Barth (1980) adopted the following taxonomy:

i. Non-projected visual materials further sub-divided into printed and non-printed media. The printed media include textbooks, teachers' handbook, posters, newspapers, and journals. The non-printed media include chalkboard, models, games and real things.

ii. Projected and electronic media sub-divided into software and hardware. This group of materials requires the use of electronic devices. Software materials consist of audiotapes, video tapes, transparencies, slides, filmstrips, etc.

iii. Hardware materials are: audio tape recorders, video tape recorders, slide projector, film projector, overhead projector, etc.

2.3.1 Instructional resources for basic and senior high schools

To support teaching and learning, as well as improve overall education management, a variety of ICT-assisted instructional approaches may be implemented, ranging from the use of radio or television to computers, Internet and newly-emerging mobile devices. While newer battery-operated ICTs are emerging, in addition to mobile devices that may be recharged off-site. The majority of ICTs including television, computers and the Internet continue to require a more stable energy source. To summarize, the integration of ICT into schools requires electricity (e.g. grid/mains connection, wind, water, solar or fuel-powered generator, etc.) that is regularly and readily available.

Telecommunication facilities are another basic element which helps to build the educational and administrative capacity of schools. Defined as a fixed telephone line, cable connection, mobile phone or other sustainable communication technology that connects a school's terminal equipment to the public switched telephone network, or other telecommunication network, and which is intended for pedagogical or administrative purposes, telecommunication facilities can be used for communication between teachers with students, parents, various service providers to the schools, local education authorities, and other administrative organizations.

Telecommunication facilities may also provide the requisite infrastructure to provide various types of Internet connectivity. Fixed telephone lines can provide both narrowband and broadband Internet, while mobile telephones can provide varying levels of broadband connectivity through 3G or 4G technology. Generally, faster than mobile broadband Internet, wired connections (including ASDL, cable, fixed wireless, fibre optic cable, satellite, etc.) allow for upload and download broadband speeds that are faster.

There are some instructional resources that are best suitable and effective for basic school children because at their age they are most curious, and want to use their sense of touching, vision and feeling. Thus materials such as pictures, charts, tools, drawing, maps, physical features, model, and posters and so on, will be very effective for them. At the secondary school level, use of printed materials such as newspapers, textbooks, photographs, audio-visual materials, globe, chalkboard and many others will be appropriate for their age, content for learning and the objectives of teaching the content.

2.4 Characteristics of instructional materials

Champagne, Gunstone and Klopfer (1985) saw learning materials as essential part of practical teachings as such, in classrooms, pictures, charts and drawings should also be clear and neat. Champagne et al., added that, it is not good for a teacher to plan a lesson without some ideas of how he or she will stimulate or motivate his/her students by using pictorials illustrations (pictures, diagrams and apparatus) or materials illustrations. Olaitan (1994) stressed that graphic materials to be used in classroom should be simple, attractive, large enough and not to be crowded with illustrations and colours. Ogundele (1987) pointed out that good teaching aids must have the following characteristics. This is because the importance of any instructional materials lies in its ability to:

a. appeal to the senses (sound and sight)

b. attract and hold attention

c. focus attention on essential elements to be learned at the proper time.

In order to achieve the above objectives, any materials to be used as teaching aids must satisfy the following characteristics.

Flexibility: In the college or university, the teacher has been taught different ways of teaching hence, while in the classroom a good agricultural science teacher will attempt to teach his/her lesson using a variety of methods and materials. He/she should therefore, select or construct teaching aids that can be instantly modified to suit change in the approaches to construction.

Colour**:** Since pupils are attracted by bright colours, these should be used in the preparation of teaching also however, too much brightness should be avoided since it

may distract students' attention from the objectives of the lesson and the instructional materials.

Simplicity: Teaching aids must be simple and present only few ideas at a time. This is because, students cannot comprehend complex ideas presented to them at a short-time. If pictures are used, they should illustrate only a very few words or actions. If more detailed pictures are used, student will not know that they are to notice.

Visibility: All the smallest detailed to be used in instructional materials should be large enough to be seen by every student in the class. So, such should be placed conspicuously in front of the class to present a clear view to every student.

Anyawu (2009) added that the characteristics of good teaching aids can be seen under the followings:

a. Sufficiency: Teaching aids must be sufficient enough for use.

b. Writing and Lettering: The Lettering or writing must be bold, clear, neat and readable.

c. Attraction: That the aids must be neat and attractive to arouse the interest of students. All the lettering must be bold and attractive.

d. Purpose: The information in the aids must help the students in learning and must be relevant to the lesson.

e. Accuracy: They must be accurate in content and language. There should be no mistakes of facts or spelling, that is, misinformation.

f. Clarity: All details in the aids, e.g. drawings, pictures, etc., should be easily seen by the students farther away from it. Aids such as radio, tape and television should be clear enough to be heard by all students.

2.5 Importance and Uses of Instructional Materials

According to Bajah (1982) the followings were some of the reasons for using instructional materials.

(i) A good instructional material can supplement spoken or written words.

(ii) It can bring teaching to life in a way that words cannot.

(iii) Words can describe people, places and objects but a picture immediately brings reality

(iv) A teaching aid can simplify and clarify what is complex and difficult to express in words.

(v) Instructional materials have motivational value for them to develop the interest of the student.

(vi) Instructional materials can also promote retention as we can understand from the Chinese proverb that says "what I hear I forget what I see I remember what I do I understand".

(vii) They save time, and energy what you will explain in ten minutes, will be possible in less time with the use of instructional materials.

Aids implied to help in teaching of physics, not to be substitutes for teaching the subject, nor for teachers, rather, it should be used to supplement oral explanation and descriptions. Adeyemo (2010) stated that physics involves a lot of simple tests and activities while the students must involve in, at the secondary school level so as to acquire the necessary skills and experiences. This can only be enhanced with the aid of instructional materials. Bakare (1986) said, "Instructional materials include self-supporting materials which are used by the teacher to present a complete body of instruction". They make a lesson to

become more explicit and interesting. Teaching aids are prime importance of both dull and bright students.

Ogundele (1987) considered teaching aids as an essential part of teaching methods which helps the teacher to express its subject concept to the learners thus promoting students' academic performance. That, such aids or materials, should be the responsibility of the physics teachers. Olaitan (1994) stated that instructional materials are normally used during instruction to enhance proper or effective learning and to encourage retention. They reduce the workload of the physics teacher in the classroom, reinforce and add clarity to learning.

Ozorehe (2008) said that instructional materials aids teachers' competence and effectiveness of instruction and class control. It makes the learning environment more attractive, appreciable, conducive, bearable and realistic. The learners' attention is better controlled and sustained. Section ten in the National Policy in Education states that objectives of learning materials are to:

(i) Enhance teaching and improve the competence of teachers

(ii) Make learning more meaningful for students.

(iii) Develop and promote the effective use of innovative materials in schools (Ozorehe, 2008)

In the same line, Ajayi and Salami (1999) outlined the following reasons for the importance of using teaching aids in teaching and learning process in our educational settings. They aid learning by aiding the sense of seeing, hearing and touching. They direct teachings to its goals, makes lesson become interesting, arouse students' interest and motivate them to learn. Teaching aids are valuable in the following situations:

(a) When the object of instruction is either too big or too small or too spread out to be seen effectively by the students, e.g., tractor, plough, ridges, and insect pest.

(b) When an object is inaccessible to students, for example, fish pond, dams and irrigation scheme, such should be displayed to the class with models.

(c) If an object is too expensive, dangerous or delicate for the students to use, for example a lesson on the treatment or prevention on a certain livestock disease may involve the use of syringe and drugs; both may be impractical to have in the classroom.

(d) When a process being studied is very slow – the agricultural science teacher may use pictures or diagrams to illustrate the various stages involved, for example plant growth, insect stages – metamorphism, rather than physical observation of plant growth and stages of an insect (Ajayi & Salami, 1999).

When using teaching aids, it is important that physics teachers do consider the following suggestions.

(i) Ensure that the material is accurate and acceptable to the students.

(ii) Preview such materials before using them in the class

(iii) Arrange the materials in such a way that the students will see it from the place they are sitting.

(iv) Use the materials in the appropriate time in the lesson and after that remove them.

(v) Do not use only one type of teaching aid to the exclusion of others. Ensure there is change and variety.

(vi) Always remember that students are different in age/maturity, interest and experience. (Ajayi & Salami, 1999)

It is always an advantage to combine the aids to meet the needs of various students. The class needs showed determination of the types of aids to be used. Do not cause confusion by presenting too much information (Champagne, Gunstone, & Klopfer, 1985).

2.6 Factors Affecting the Instructional Materials Usage

In determining the instructional materials to be used for the conveyance of information in science, the followings were the factors affecting the use of instructional materials. Bakare (1986) outlined the following factors:

a. Nature of the subject matter and the objectives to be attained: If the subject matter is such that is diversified, it may involve the use of more than one type of instructional material to achieve its objective.

b. Number of learners/students involved: If the numbers of learners to be taught are up to one hundred (100), it would be more logical and efficient to use microphone for the presentation of information.

c. The space of time available: Time is always limited and has its effect upon the kind of instructional materials used. If there is ample time, the physics teacher is more likely to use the chalkboard and other techniques that encourage maximum participation. But when time becomes a limiting factor, the chalk and talk would be preferred.

d. Facilities and materials available: The kind and extent of physical facilities and the instructional material available, including community resources, affect the choice of instructional materials that can be used.

e. Interests and ability of physics teacher: Most teachers have personal preferences and more security conscious in using selected instructional materials. Other things being equal, the teacher should use the methods that he/she likes or uses best. This does not

mean that he/she should not be sensitive to other development that supplement or improve upon the instructional materials he/she frequently uses.

f. Effectiveness of instructional materials: All science teachers should evaluate instructional materials used in terms of the objectives to be accomplished, and the situation at hand, and choose the one that will best meet the goals of the programme.

Balogun (2006) explained that school environment as the physical and material resources otherwise known as infrastructural facilities available to teachers and students to facilitate their teaching and learning. If the school environment is not conducive and thus affect student academic performance. "Resources, human and material, are not equitably distributed among schools in Nigeria". Fakomogbon (2000) observed that one of the causes of failure in Nigerian Secondary Schools is inadequate school resources. He further explained that it cannot be over-emphasized that the provision of adequate resources is a prerequisite for adequate performance in schools. Most of our schools lack necessary infrastructural facilities required for effective learning

2.7 Factors Influencing Student Achievement

In contemporary Ghana, great emphasis is being placed on science and technological development and also on achievement in examination in the sciences. As a result, students are being encouraged to take up science related subjects. One subject that is paramount is Physics. Today, Physics as a subject pervades literally every field of human endeavour and places a fundamental role in educational advancement.

Unfortunately, achievement of students in physics at the end of secondary school has not improved in the past decade (Umoinyang, 1999). However, the interest of students in physics have been related to the volume of work completed, students' task orientation

and skill acquisition, students personality and self-concept, feeling of inadequacy, motivation, self-confidence, anxiety, shortage of qualified teachers (Aikens, 2006), poor facilities, equipment and instructional materials for effective teaching (Odogwu, 2004), use of traditional chalkboard and talk methods (Edward & Knight, 2004), large students to teacher ratio, over loaded curriculum (Okebukola, 2002), poor delivery of content.

Research results (Ajagun, 2006) have shown that physics teachers continue to teach using the lecture method despite the recommended guided discovery or inquiry methods. The inability of physics teachers to apply guided inquiry/ discovery approach and other modern methods of science teaching , might be hinged on some problems which include, lack of laboratories, equipped with facilities in schools, large class size, lack of qualified teachers, and incompetency arising from the training of science teachers. In an effort to improve students' cognitive and affective outcomes in physics and /or school achievement, educational psychologists and science educators have continued to search for variables (personal and environmental) that could be manipulated in favor of academic gains. Of all the personal variables that have attracted researchers in this area of educational achievement, motivation to improvise instructional materials by students seems to be gaining more popularity and leading other variables (Tella, 2003). This study therefore, will help to know if students' improvised instructional material will improve on students' achievement in physics concepts especially on reflection and refraction of light.

2.8 Factors that affect the use of Instructional Resources

Teachers have been found to have difficulties in selecting and using instructional materials for teaching. Part of the difficulties has been that teachers tend to teach the way

they were taught in their training (Nigeria Educational Research and Development Council (NERDC), 2009). Consequently, teachers use the materials they were exposed to during their training. This habit is often difficult for teachers to change.

Other reasons advanced for the inability of teachers to use instructional resources effectively include:

• Inability to identify/ locate resources;

• Inability to develop appropriate materials from local resources;

• Lack of school- based resource Centre; and

• For instructional materials development, selection and utilization and Lack of short term training to update teachers' knowledge and skill for instructional materials development, selection and utilization (NERDC, 2009).

In line with the stated reasons, the physics laboratories are to be equipped appropriately to make teaching and learning conducive. According to Nwakonobi and Igboabuchi (2010), Physics laboratories are places where different types of experiments and researches concerning all disciplines of physical and engineering sciences take place for skills acquisition.

However, these skills cannot be acquired in the absence of well-equipped Physics laboratories to enhance effective teaching and learning which is geared towards empowering the students to become functionally and qualitatively educated, productive, self-reliant, and self-sufficient and create enabling environment. All these are aimed at devising a proper opportunity to salvage the medium of instruction in the national educational system.

2.9 Students' conceptions of light and vision

Ayodele and Anyaegbuna (2012) researched into students' ideas about this topic and have identified the following non-scientific conceptions:

Light as an entity

• The effects of light are instantaneous. Light does not travel with a finite speed.

• Light is only associated with either the source or area of illumination.

Rectilinear (straight-line) motion of light

• Light is associated only with either a source or its effects. Light is not considered to exist independently in space and hence light is not conceived of as 'travelling'.

• Light bends around objects, like clouds.

• Lines drawn outward from a light bulb represent the 'glow' surrounding the bulb.

• A shadow is something that exists on its own. Light pushes the shadow away from the object to the wall or the ground and is thought of as a 'dark' reflection of the object.

• Light actually consists of rays.

Vision

• The only condition to see an object is if light shines on the object. Light does not travel from the object to the eye.

• Something is emitted from the eye when looking at an object.

• Only the object and observer need to be bathed in light for the observer to see the object.

• The eye receives upright images.

• The lens is the only part of the eye responsible for focusing light.

• The lens forms an image (picture) on the retina. The brain then 'looks' at this image and that is how we see.

• The eye is the only organ for sight; the brain is only for thinking.

Isotropic emission of light from luminous objects

• Light is not necessarily conserved. It may disappear or be intensified.

• Light from a bulb only extends outward a certain distance, and then stops (or fades away). How far it extends depends on the brightness of the bulb.

Reflection of light

• Light reflects from a shiny surface in an arbitrary way.

• Light is reflected from smooth mirror surfaces but not from non-shiny surfaces.

• Curved mirrors make everything distorted.

Refraction of light

• Light always passes through a transparent material without changing direction.

• When an object is viewed through a transparent solid or liquid material, the object is seen exactly where it is located

2.10 The concepts of Reflection of light

According to Ayodele and Anyaegbuna (2012) when light shines on a shiny surface such a mirror, the light is reflected back, away from the surface. This reflection occurs in a regular and specific way.

2.11 Important Terminology

Ayodele and Anyaegbuna (2012) defined the following terms associated with reflection of light;

 The **normal** is an imaginary line perpendicular (at 90º) to the surface. All angles are measured from the normal.

 The **incident ray** is the original light ray

 The **reflected ray** is the ray that is reflected off the surface.

 Θ_i is the **angle of incidence**. It is the angle between the normal the incident light ray

 Θ_r is the **angle of reflection**. It is the angle between the normal the reflected light ray

2.12 Laws of Reflection

Ayodele and Anyaegbuna (2012) stated the laws of reflection as follows;

1. The incident ray, the reflected ray and the normal are all in the same plane.
2. The angle of incidence is equal to the angle of reflection.

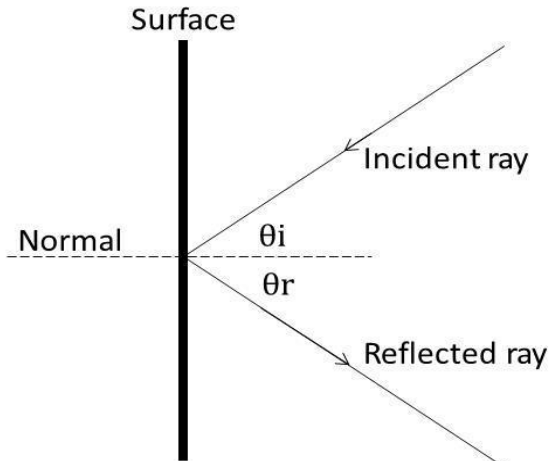

Figure 1 : Reflection of light

The diagram above illustrates the reflection of light, describes the laws of reflection of light and defines the terms associated with reflection of light.

2.13 The concepts of Refraction of light

Ayodele and Anyaegbuna (2012) defined refraction of light as the bending of light as it crosses the interface between two different transparent media. They proposed the following;

- Refraction occurs because the wave speed differs in different media.
- For light, the index of refraction n describes the speed change.
- The speed of a wave in a medium is $v = c/n$.
- The angles of incidence and refraction are related by Snell's law: $n_1 \sin\theta_1 = n_2 \sin\theta_2$
- There's also a reflected ray at the interface.

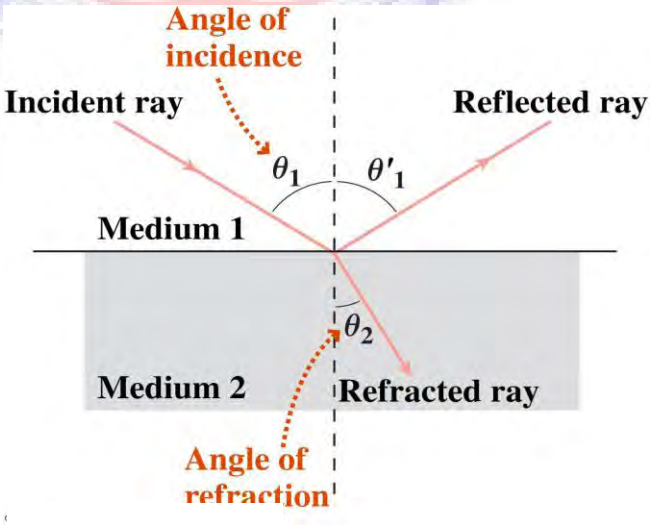

Figure 2: Refraction of light

2.14 Review of Related Empirical Studies

Onasanya and Omosewo (2010) carried out a study on the effect of using standard instructional materials and improvised instructional materials on Secondary School Students' Academic Performance in Physics in Ilorin, Nigeria. The sample consisted of selected Secondary Schools in Ilorin Metropolis of Kwara State. The research employed a quasi-experimental design of the pretest posttest non-randomized control group design. Two hypotheses were designed and tested at 0.05 level of significance. From the analysis, the following findings were made:

(1) there was significant difference between the students taught with standard instructional materials and those thought with improvised instructional materials, i.e., mean scores on the posttest ($t = 4.09$, df 14, $p = 0.05$).

(2) there was no significant difference between the post test scores of the experimental group and control group. This shows that the improvised instructional materials in the comparison of the male mean scores of experimental and control groups were the same entry level with regard to academic ability ($t = 1.23$, $df = 7$, $p = 0.05$). The implications of improvised instructional materials were discussed. Recommendations for the improvement of standard instructional and improvised instructional Aids in teaching of physics and suggestions for further studies were made.

Aremu (1998) carried out a study on the effect of improvised instructional materials on students' achievement in physics. The researcher expressed that learning is an activity that takes place in a contact and not in a vacuum. The researcher reiterated that students with teaching aids do not have a bank mind but a consolidated and developed library of knowledge. Furthermore, the result of first research hypothesis revealed that those who

were taught with standard instructional materials performed equally better with those who were taught with improvised instructional materials. This could be because the improvised materials are also of high quality and standard. It can be deduced now that no significant difference exist between students taught with standard instructional materials and those taught with improvised instructional materials during students exposure to the treatment conditions. In other words, students acquire more information through many instructional materials so as to bring deeper understanding of the topics under consideration. The analysis of scores between the post test of male students taught with standard instructional materials and male students taught with improvised instructional materials as outlined in the serial number four in the table revealed that the hypothesis was rejected because the calculated correlation coefficient is greater than that of the table value.

Achor and Musa (2011) carried out a study on the comparative effect of using improvised freefall apparatus and bomb calorimeter in teaching the concept of enthalpy in Nigeria Senior Secondary Schools Physics. The purpose of the study was to determine the effectiveness of using improvised freefall apparatus and bomb calorimeter in teaching the concept of enthalpy. The study was in response to the call for the deployment of materials within the learners' immediate environment as a means of finding a solution to persistent shortage of learning resources for the teaching of physics in Nigeria Secondary Schools. A total of 93 Senior Secondary two (SS2) physics students were involved in the study. This number was made up of 48 females and 45 males from four secondary schools in Calabar Educational Zone of Cross River State of Nigeria. A pretest – posttest control group design was used for the study. Analysis of Variance (ANOVA) was used to

analyze the data. From the finding, it was observed that improvised freefall apparatus as a resource for teaching the concept of enthalpy was more effective in enhancing students' academic performance in physics as compared to bomb calorimeter. The result also showed an insignificant difference existing between the performance of male and female students when taught the concept of enthalpy using freefall apparatus.

CHAPTER THREE

METHODOLOGY

3.0 Overview

The chapter three dealt with the study area and design employed, the population and sampling techniques used. The sampling procedures, research instrument, data collection procedures, pre-interventions, interventions, post-interventions, challenges with the implementation of the intervention and data analysis, were also discussed.

3.1 Study Area

Atebubu College of Education is located in the Atebubu District in the Brong- Ahafo Region of Ghana. Atebubu is quite a sizable farming settlement and is often noted for its massive production of yam, vegetables and maize. Atebubu College of Education is one of the four public colleges located in the region and the only college in the community. It is located at the outskirt of the town. As a single stream College, it is having an enrolment of about one thousand and two hundred student population comprising five hundred and fifty nine girls (559) and six hundred and forty one boys (641) with forty-two (42) teachers.

Admission is usually opened to eligible applicants from across the length and breadth of the country. Therefore, the school is fed with students from different cultural and ethnic backgrounds; however, a quota is usually given to eligible applicants who are natives of the land.

3.2 Research Design

The study was an action research which falls under descriptive research design. Putliklovic (2010) defined action research as "an immediate intervention for an existing problem in practicality after a close analysis of its effect on a process. Steps taken to rectify these problems are often described as intervention." Also, Kemmis and Mc Taqquart (2005) argues that action research design is said to be a systematic inquiry that is critical, collective and self – reflective and undertaken by participation in any inquiry. Action research is a study which is concerned with finding an immediate solution to a local problem. Action research does not only focus on generating new knowledge but also enables the participants to develop appropriate interventional strategies aimed at finding solutions identified in the teaching-learning situation. The rationale for this research is to aid in facilitating educational practice and strategies and also help improve teaching and learning.

With Elliot (2007), action research combines diagnosis with reflection, focusing on practical issues that have been identified by participants. The topic should be problematic yet capable of being changed. Therefore, action research should contribute not only to practice but also to a theory of education. The research design selected was very appropriate based on the nature of the problem at stake.

Dana, Nancy and Fichtman (2010) also opine that action research is used in real situations, rather than in contrived, experimental studies, since its primary focus is on solving real problems. It can, however, be used by social scientists for preliminary or pilot research, especially when the situation is too ambiguous to frame a precise research question. Mostly, though, in accordance with its principles, it is chosen when

circumstances require flexibility, the involvement of the people in the research, or change must take place quickly or holistically. In most cases, it involves descriptive processes of events, process, a practice or phenomenon in a particular case under study. It is often the case that those who apply this approach are practitioners who wish to improve understanding of their practice, social change activists trying to mount an action campaign, or, more likely, academics who have been invited into an organization (or other domain) by decision-makers aware of a problem requiring action research, but lacking the requisite methodological knowledge to deal with it (Dana, Nancy, & Fichtman, 2010).

3.3 Population

Howell (2013) argued that a research population is generally a large collection of individuals or objects that is the main focus of a scientific query. A research population is also known as a well-defined collection of individuals or objects known to have similar characteristics. All individuals or objects within a certain population usually have a common, binding characteristic or trait. Usually, the description of the population and the common binding characteristic of its members are the same. It is for the benefit of the population that researches are done. However, due to the large size of populations, researchers often cannot test every individual in the population because it is too expensive and time-consuming. This was the reason why researchers rely mostly on the Purposive sampling techniques for the selection of this population.

Atebubu College of Education as at the time of this study was having an enrolment of about one thousand and two hundred student population comprising five hundred and fifty nine girls (559) and six hundred and forty one boys (641) with forty-two (42)

teachers. The population of the study was all students of the Atebubu College of Education. The targeted population for the research was all the level 100 students of Atebubu College of Education but the accessible population was the level "100 A" students of the school. The class was made up of forty (40) students of which seventeen (17) are females and twenty three (23) are males.

3.4 Sample and Sample Selection Procedure

Jackson (2003) explained sampling as means of selecting a given number of objects from a defined population as a representation of that population. Sample size can be defined as the act of choosing the number of observations or replicates to include in a statistical sample (Creswell, 2005). The researcher selected all the forty (40) level "100 A" students for this study and the class is also where he teaches. The researcher chose this intact class because it was the class that has difficulties with the conceptual understanding of reflection and refraction of light. The researcher used purposive sampling to carefully select the students.

3.5 Research Instrument

A research instrument is what a researcher uses to collect information (data) to answer research questions and it applies to both qualitative and quantitative approaches and can produce quantitative and/or qualitative data (Creswell, 2005)

The instruments used for the research were interview, observation and tests (pre and post-tests). The observation was used to gather data on students' interactions (questions, responses and efforts) with teacher during and after lessons (i.e. teaching learning and

evaluation processes). Pre and post tests as well as exercises were used to gather data on scores of students' during the pre and post intervention exercises.

3.6.1 Interview

The interview was based on the guidance of a structured interview guide to solicit for information. The structured interview was therefore conducted to solicit their sufficient views, experiences, perceptions about the lesson on reflection and refraction of light. This will enable the researcher to know their opinions on the use of instructional materials in the teaching of reflection and refraction of light.

3.6.2 Observation

According to Elliot (2007) observation is a research instrument by which data are collected through observing the subject of the study and recording the information that is being observed. Observation is also referred to as taking a critical or close look at something or someone for possible changes or behavioural attitudes. The reasons for using observation as a means of collecting information on the students are that, it helps to easily notice the students' reaction and intention behind their behaviour, which may be positive or negative. Also, the effect of behaviour on the outcome and subsequent events can be discerned.

The researcher employed unscheduled methods of observing the students by closely monitoring them during class activities, inspecting students' exercises, assignments, contributions and participation in class during lesson delivery to find out the extent of their progress in physics subject in order to identify the appropriate intervention measures to be put in place.

3.6.3 Test

Students were tested on the topic 'reflection and refraction of light'. Gathered information from test was kept confidential from students' domain in order to avoid inconvenience such as upsetting any student who performed poorly. In the first stage of the study, students were taken through a pre-test exercise (Appendix B and C respectively) after a little interaction with them. The reason for the pre-test was to determine students' level of understanding on the concept of reflection and refraction of light.

In the second stage of the study, an intervention was introduced to students to enhance their understanding on the topic. After the intervention, the simillar questions were given to them as a post-test. The post-intervention test helped to measure the degree of change that occurred on students' level of understanding on the topic for comparative analysis.

3.7 Validity and Reliability of Instruments

Prior to using the instruments, their validity and reliability were assessed to determine their accuracy and consistency. According to Creswell (2005), the goal of a good research is to have measured that are reliable and valid. Validity is concerned with whether the findings are really about what they appear to be about (Tavakol & Dennick, 2011). According to Tavakol and Dennick (2011), it is based on the view that a particular instrument measures what it purports. Osuala (2005) opined that validation is based on experts' advice. Appropriate modifications were made to the test items based on supervisor's advice. Reliability according to means that scores from the instrument are stable and consistent. The test items were pre-tested to establish the reliability and internal consistency of the instruments.

3.8 Data Collection Procedure

The researcher collected data on students' basic knowledge about the concept of light, reflection and refraction of light. Data was also gathered on students' knowledge about the topic. Marks were awarded to students according to their responses during the pre-tests. Instructional materials were used as the major interventions implemented before the post-test exercises were done using simillar test items as used for the pre-test exercise. Marks of students were based on their individual responses and were recorded for analysis. The analysis were done on the data collected using percentages and represented on tables for interpretation.

3.9 Diagnosis of the problem

The researcher wrote questions on the board and students were asked to provide answers in their class exercises, concerning their basic knowledge about the concept of light, reflection and refraction of light. Sample is in Appendix A.

During this exercise, it was revealed that most of the students were lacking knowledge about the concepts, as such; they performed poorly in their exercises. Through observation it was discovered that some students do not show interest in the learning process in the classroom. Through oral interview with the students, it became clear that students do not understand the concepts of reflection and refraction of light, thus, when some questions were asked they could not answer.

3.10 Pre-Intervention Test

The level "100 A" students were given printed question papers and were asked to answer 20 questions on the topic 'reflection and refraction of light' (in appendix B). They were

to do independent work by filling in the provided spaces with appropriate answers for duration of 30 minutes. Marks were awarded based on students' performance and were recorded for data analysis.

3.11 Intervention

The main intervention adopted was to use instructional materials to help the level "100 A" students to have better conceptual understanding on reflection and refraction of light through the following:

1. Determining the use of instructional materials on students' achievement in concepts of reflection of light.
2. Determining the effect of the use of instructional materials on students' achievement in concepts of refraction of light.
3. Evaluating the opinions of students with the use of instructional materials on their conceptual understanding in reflection and refraction of light.

3.12 How the intervention was implemented

The intervention was carried out in three weeks and on Thursdays each week, within the normal classes' hours and lasted for two hours (double periods) each day, allocated Physics lessons. The implementation begun on Thursday 4th July, 2017 and ended on Thursday 17th July, 2017, the post test was conducted on the same 17th July, 2017 after the main lesson.

Week 1 Intervention 1- This was used to answer research question 1

Research question 1 : what is the effect of the use of instructional materials on students' achievement or performance on the concepts of refraction of light?

Week ending: 5th July, 2017

Day: Thursday 4th July 2017

Duration: 120 minutes

Time: 9:45 am – 11:45 am

Lesson Content Objectives: By the end of the lesson student will be able:

 Use the vocabulary for the lesson: *angle of incidence*, *angle of reflection*, *normal line*, and *Law of Reflection.*

 Use a flashlight, mirror, and construction paper to explore angles of incidence and reflection.

 Generalize the results of the exploration to verify the Law of Reflection

 Construct and describe a diagram of the light's path

Materials Needed:

 One flashlight per group of three

 Several small mirrors per group

 Coloured construction paper

 One compass and straight edge per student

 One laser pointer per group (optional as an extension)

Activities

Steps:

- Students were asked to identify the types of instructional materials available for use to teach the concept of reflection of lights
- They were silent and could not answer the question since they have no idea about

the types of instructional materials available

- Students were briefed and guided by the researcher about the types of instructional materials available for use to teach the concept of reflection of light.
- After the briefing, students were placed in groups of three with their group leaders and were given their materials.
- The researcher led students through their note taking by providing the vocabulary for the lesson: *angle of incidence*, *angle of reflection*, *normal line*, and *Laws of Reflection.*
- Model for students, the flashlight, mirror and construction paper set up.
- The researcher guided students through their exploration reflecting light off a mirror onto a piece of construction paper.
- The researcher checked for students' understanding by asking the key questions provided while students are working.
- The researcher closed the lesson by allowing students to verbally describe what they discovered to be the Law of Reflection

Lesson Description

Introduction

The researcher explained to students that they will be exploring how light is reflected off a mirror to predict the Law of Reflection. The researcher showed students the general set up using a flashlight, mirror and construction paper. He asked the students not to turn on the flashlight when modeling the set up. He allowed the students to explore the path of the light in their own groups. With a mirror resting flat on a table, the researcher asked the students to hold a flashlight at an angle pointing down toward the mirror. He

explained that the light will reflect upward off the mirror and they will need to use a piece of construction paper to catch the light above the mirror.

The researcher explained the terms associated with the reflection of light as follows;

Angle of incidence*: The angle formed by a ray of light that travels toward a surface and a line perpendicular to the surface.* (The researcher demonstrated the angle using a flashlight and an object, such as a string, that forms a line perpendicular to the mirror.)

Angle of reflection: *The angle formed by a ray of light that travels away from the surface and a line perpendicular to the surface.* (Here the researcher did not demonstrate this angle but task the students' to determine it.)

Normal line: *The imaginary line perpendicular to the surface of reflection.* (Researcher demonstrated the normal line using an object, such as a string, perpendicular to the mirror's surface.)

Law of Reflection*: the angle of incidence measured from the normal line is equal to the angle of reflection measured from the normal line.* (The researcher tasked the students to determine the Law of Reflection based on their exploration.)

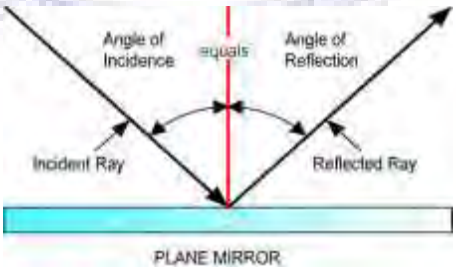

Figure 3: figure showing angle of incidence and angle of reflection

- The researcher gave students directions to write a description of their diagram using the Law of Reflection. Marks were awarded to individual students' responses to questions set as class exercise *(Lesson Evaluation)* based on their responses to the questions set.

Week 2 Intervention 2 - This was used to answer Research Question 2

Research question 2 : What is the effect of the use of instructional materials on student's achievement or performance on the concepts of reflection and refraction of light?

Week ending: 12th July, 2017

Day: Thursday 11th July, 2017

Duration: 120 minutes

Time: 9:45 am – 11:45 am

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

 Use the vocabularies for the lesson correctly: *angle of incidence*, *angle of refraction*, and *Law of Refraction and Snell's law of refraction.*

 Use rectangular glass block, pencil, straight edge, identical pins and white sheet of paper to demonstrate angles of incidence and angle of refraction.

 Generalize the results of the exploration to verify the Law of Refraction

 Construct and describe a diagram of the path of light

Materials Needed:

 Rectangular glass

 Identical pins

 Pencil

Straight edge

 White sheet of paper

Activities: Refraction of light through a rectangular block
Steps:

- Students were asked to identify the types of instructional materials available for

use to teach the concept of refraction of light

- They were silent and could not answer the question since they have no idea about the types of instructional materials available
- Students were briefed and guided by the researcher about the types of instructional materials available for use to teach the concept of refraction of light.
- After the briefing, students were placed in groups of three with their group leaders and were given their materials.
- Students were asked to place a glass block on a sheet of paper, and mark its position.
- Students were asked to allow a ray of light to hit one side of the block at an angle of 30^{o}.
- The researcher asked the students to look on the other side of the block to see where the ray of light is emerging.
- Students were asked to mark the directions of the incident and emergent rays to and from the glass block.
- Students were asked to join the two rays to show the direction of the ray through the block.
- The researcher checked for students' understanding by asking the key questions provided while students are working.
- The researcher closed the lesson by allowing students to verbally describe what they discovered to be the Law of Refraction (Snell's law of refraction).

Instructions

The researcher allowed the students to perform their own experiment using the following instructions below. He wanted to build students understanding and confidence. Marks were allocated and graded. Students were asked to do independent work and the researcher went round to supervise the entire procedure. The instructions are as follows;

1. Fix a sheet of white paper on a drawing board using drawing pins.
2. Place a rectangular glass block over the sheet in the middle. Draw the outline of the block with a pencil. Let us name the outline as ABCD.
3. Take four identical pins. Fix two pins, say E and F, vertically such that the line joining the pins is inclined to the edge AB.
4. Look for the images of the pins E and F through the opposite edge.
5. Fix two other pins, say G and H, such that these pins and the images of E and F lie on a straight line.
6. Remove the pins and the block. Join the positions of tip of the pins E and F and produce the line up to AB. Let EF meet AB at O.
7. Similarly, join the positions of tip of the pins G and H and produce it up to the edge CD.
8. Let line HG meet CD at O′. Join O and O′. Also, produce EF up to P.

Week 3 intervention 3 - This was used to answer research question 3

Research question 3: what are the opinions of students' with the use of instructional materials on their conceptual understanding in reflection and refraction of light?

Week ending: 18th July, 2017

Day: Thursday 17th July, 2017

Duration: 120 minutes

Time: 9:45 am – 11:45 am

Objectives: by the end of the lesson, the students should be able to:

- State at least four opinions of instructional materials and its impacts on your conceptual understanding in reflection and refraction of light.

Activities:

Steps:

- The researcher seeks students' opinion on the use of instructional materials in teaching the concept of reflection and refraction of light in physics.
- Students were briefed and guided by the researcher to do independent work and come out with answers.
- After the briefing, students were placed in groups of three with their group leaders and were asked to solve the question.
- After twenty minutes of small group discussion, each group was asked to present their findings or answers.
- There were mixed opinions to the question, majority of them said the use of instruction materials helped them to understand the concept and perform better in class exercise which was evident in the earlier experiment they performed
- Few of them said without the use of instructional materials they were able to understand the concept since they were used to rote learning.

Instructions:

The researcher grouped the opinions as expressed by the students with the use of instructional materials on their conceptual understand in reflection and refraction of light as follows:

(i) A good instructional material can supplement spoken or written words.

(ii) It can bring teaching to life in a way that words cannot.

(iii) Words can describe people, places and objects but a picture immediately brings reality

(iv) A teaching aid can simplify and clarify what is complex and difficult to express in words.

(v) Instructional materials have motivational value to develop the interest of the student.

(vi) Instructional materials can also promote retention as we can understand from the Chinese proverb that says "what I hear I forget, what I see I remember what I do I understand".

(vii) They save time, and energy what you will explain in ten minutes, will be possible in less time with the use of instructional materials.

3.13 Post Intervention Period

After effective discussions, the use of instructional materials made the lesson looked so real and helped the students to understand the concepts better. The learning materials stimulated the awareness and thinking abilities of the learners

After the group, class discussions and follow-up activities, the researcher made the students to write the post-test. The scores of the post test were analysed in the next chapter as well as the pretest and compared.

3.14 Challenges with the implementation of the intervention

- Absence of some students due to ill health
- Frequent break in the academic calendar of the colleges for sports, Untrained Teachers Diploma in Basic Education (UTDBE) resit examinations also impeded data collection since some students do not report to school early after each break.
- Inadequate teaching and learning materials to support teaching and learning process.
- During the researcher's data collection period, students' second semester examination was pending; therefore, they were much concentrated on the content for the examination because this topic was not part of the second semester's examination. The topic was chosen during the first semester.

3.12 Data Analysis

Simple tables and simple percentages were used to analyse the data collected. The results were compiled in a tabular form and students' performances were grouped with the following remarks;

0 – 4 (poor)

5 – 7 (good)

8 – 10 (very good)

T-test was used to test for statistical significance.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION

4.1 Overview

This chapter covers analysis of the data and presentation of the results of the findings. The population of the study was all students of Atebubu College of Education. The targeted population for the research was all the level 100 students of Atebubu College of Education but the accessible population was the level "100 A" students of the school. The class was made up of forty (40) students of which seventeen (17) are females and twenty three (23) are males.

In order for the study to be analyzed in a simplified manner and with clarity, the findings were based on the research questions as outlined:

1. What is the effect of the use of instructional materials on students' achievement or performance on the concepts of reflection of light?
2. What is the effect of the use of instructional materials on students' achievement or performance on the concepts of refraction of light?
3. What are the opinions of students with the use of instructional materials on their conceptual understanding in reflection and refraction of light?

4.2 Analysis of data

Data was collected from the respondents using interview, pre – test and post – test intervention activities. The results in Tables 4.1, 4.2, 4.3and 4.4 show data on the pre-

intervention and post intervention exercises based on the sample test items in Appendix B and C respectively.

The questions in Appendix A were used as diagnostic material which aided the researcher to know that the students have that problem. During this exercise, it was revealed that most of the students were lacking knowledge and understanding about the concepts, as such; they performed poorly in this exercise.

The Pre–test was administered with the aim of finding the knowledge level of students in understanding the concepts of reflection and refraction of light and as well as the instructional materials available to teach these concepts. Data collected from the pre–test guided in formulating and developing suitable teaching activities that reduced the difficulties students encountered in understanding the concepts of reflection and refraction of light using the appropriate instructional materials.

Post–test was also conducted to determine the extent to which the intervention activities improved students' performance in reflection and refraction of light using appropriate teaching techniques.

The response of the students to the pre–test and post–test items 1 to 20, addressing each question was examined, analyzed and studied. Samples are in Appendix B and C respectively. Tables 4.1, 4.2, 4.3and 4.4 represent the marks obtained by the students during the pre–test and post–test in terms of the knowledge levels in reflection and refraction of light and as well as the instructional materials available to teach these concepts.

The results in Tables 4.1 and 4.2 show data on the pre-interventions and post-interventions respectively based on research question 1: What is the effect of the use of instructional materials on students' achievement or performance on the concepts of reflection of light?

Table 4.1:the effect of the use of instructional materials on students' achievement or performance on the concepts of reflection of light (Pre-Intervention)

MARKS	STUDENTS	PERCENTAGES %
1- 2	12	30
3- 4	4	10
5- 6	16	40
7- 8	8	20
9-10	0	0
11- 12	0	0
13-14	0	0
15-16	0	0
17-18	0	0
19-20	0	0
Total	**40**	**100**

From Table 4.1, the pre-intervention exercise, it was revealed that most of the students were lacking the basic knowledge and understanding about the concept of reflection of light, as such; they performed poorly in their exercises. About 12 students (30%) had scores between 1 and 2, four students (10%) had between 3 and 4, 16 students (40%) had

between 5 and 6 and eight students (20%) had between 7 and 8. None of the students had scores beyond eight (8) out of twenty (20).

This shows an abysmal performance since greater percentage of the students scored below average. The poor performance by the students in the pre-test in my view was due to the teaching strategy and instructional materials used to teach the concept of reflection of light. That is the lecture method. Because of this, the students find it difficult to understand the concept and interact effectively with the teachers. Since it is one sided, that is teacher-centred. The students lack the basic knowledge on the concept of reflection of light; hence, almost all of them scored low marks. The researcher observed that most physics teachers in the college did not fully make use of instructional materials in the teaching of physics especially on the concept of reflection of light to their students. This negligence of the effective use of the instructional facilities and materials in teaching and learning of physics topics especially the concept of reflection of light affected the successful academic performance of students in physics in the college.

Results on post–intervention exercise based on research question (1): What is the effect of the use of instructional materials on students' achievement or performance on the concepts of reflection of light?

Table 4.2 : the effect of the use of instructional materials on students' achievement or performance on the concepts of reflection of light (Pre-Intervention)

MARKS	STUDENTS	PERCENTAGES %
1-2	0	0
3-4	0	0
5-6	2	5
7-8	4	10
9-10	10	25
11-12	10	25
13-14	8	20
15-16	6	15
17-18	0	0
19-20	0	0
Total	**40**	**100**

Table 4.2 shows the scores obtained by students in the post – intervention test on ability to understand the concept of reflection of light. From the table, only six (6) students scored below 10 marks. These numbers represent 15% of the total number of students. Only 10 students (25%) scored within the range of average. The rest scored above average (above 10 marks) representing 60%.

Table 4.2 indicates that there is 85% increment in the number of pupils who have overcome their difficulties on the concepts of reflection of light as compared to that of the holistic poor performance of the 100% at the pre- intervention stage. The relatively high performance of the students on the post-test items is true reflections of what is suggested by the literature that how much a student learns depend on whether the instructional experiences are linked to the learning styles. That is, the learners learning style should be compatible with the teachers teaching style in order to retain information longer and apply it positively. Again the intervention strategies the researcher used in the lesson were very well planned. The students were inspired and interested by the way the lesson was taught, and this helped improved their level of understanding. The post-intervention was also conducted to portray how the intervention helped to improve students' performance and checked their level of understanding. The students were exposed to the various instructional materials needed to enhance their full participation in classroom activities. Based on understanding and explanation, students were able to perform above average and this resulted in high academic performance. This affirms the assertion of Ema and Ajayi (2004) that instructional materials are all the tools, which can be used by the teacher to provide help and encouragement to learners` learning activities. In addition, instructional materials are anything and anybody that can be used by the teacher and learners before, during and after the lesson to facilitate the achievement of objectives. This manifested in the result obtained from the post-test where students were made to express themselves scientifically helped them develop conceptual understanding of the problem before representing them on a paper.

Again the result supports the assertion of Usman (2016) that learning materials form an essential part of practical teachings. As such, in classrooms, pictures, charts and drawings should be clear and neat. Odukwe added that, it is not good for a teacher to plan a lesson without some ideas of how he or she will stimulate or motivate his/her students by using pictorial illustrations (pictures, diagrams and apparatus) or materials illustrations. This shows that instructional materials help to reduce students' difficulties in understanding the concepts and principles of reflection of light.

It also supports the arguments of Ogundele (as cited in Umaru, 2011) that considered teaching aids as an essential part of teaching methods which helps the teacher to express its subject concept to the learners, thus promoting students' academic performance. That, such aids or materials, should be the responsibility of the physics teacher. Also, Ozorehe (2008) said that instructional materials aid teachers' competence and effectiveness of instruction and class control. It makes the learning environment more attractive, appreciable, conducive, bearable and realistic.

The instructional materials identified for the study included the flashlight, mirror, compass, straight edge and laser pointed. These materials were used to explain the concept of reflection in terms of the angle of incidence, reflection and normal to the students. The laws of reflections were explained and students were asked to explore path of the light in their own groups. The researcher gave students directions to write a description of their diagram using the Law of Reflection. After effective discussions, the use of instructional materials made the lesson looked so real and helped them to understand the concepts better. The learning materials stimulated the awareness and thinking abilities of the learners. After the intervention, students understood the concepts

of reflection of light better when exposed to the use of instructional materials and this resulted in high academic performance, they performed very well during the post test.

The results in Table 4.3 and 4.4 show data on the pre-intervention and post-intervention respectively used to answer research question 2: What is the effect of the use of instructional materials on students' achievement or performance on the concepts of refraction of light?

Table 4.3 : The effect of the use of instructional materials on students' achievement or performance on the concepts of refraction of light (Pre-Intervention)

MARKS	STUDENTS	PERCENTAGES %
1- 2	16	40
3- 4	20	50
5- 6	4	10
7- 8	0	20
9-10	0	0
11- 12	0	0
13-14	0	0
15-16	0	0
17-18	0	0
19-20	0	0
Total	**40**	**100**

The data in Table 4.3 indicates that during the pre-intervention exercise, forty (40) students representing (100%) scored marks below average. The majority 20 students

(50%) scored 3-4 marks out of the total of 20; with 16 students (40%) scoring 1-2 mark out of 20 and 4 students (10%) scored 5-6 marks out of 20. No student scored 7 marks and above indicating 0%. This depicts how severely students' lack knowledge and understanding of the concept of refraction of light. The low performance of students may be attributed to poor teaching method, students' attitude and misconceptions towards the study of refraction of light and lack of instructional materials to arouse students' interest in the study of refraction of light. The lecture method was mainly used by the teachers, the students tend to do rote-learning, as such they tend to forget and lose concentration. The students lack basic knowledge in demonstration and the use of instructional materials to enhance their understanding in the concept of refraction of light.

Results on post–intervention exercise used to answer research question (2): What is the effect of the use of instructional materials on students' achievement or performance on the concepts of refraction of light?

Table 4.4 : The effect of the use of instructional materials on students' achievement or performance on the concepts of refraction of light (Post-Intervention)

MARKS	STUDENTS	PERCENTAGES %
1-2	0	0
3-4	0	0
5-6	0	0
7-8	10	25
9-10	10	25
11-12	10	25
13-14	2	5
15-16	8	20
17-18	0	0
19-20	0	0
Total	**40**	**100**

Table 4.4 shows the scores obtained by students in the post – intervention test on ability to understand the concept of refraction of light. From the table, only ten (10) students scored below 10 marks. These numbers represent 25% of the total number of students. Only 10 students (25%) scored within the range of average. The rest scored above average (above 10 marks) representing 50%.

Comparing these results to that of the pre-intervention exercise, there is an indication of absolute improvement in students' performance. This unique performance of students showed that the use of the instructional materials for assisting students effectively was appropriate and this also affirms the argument of Adeyemo (2010) that a good instructional material can supplement spoken or written words. It can bring teaching to life in a way that words cannot. Words can describe people, places and objects but a picture immediately brings reality.

The influence of instructional materials in teaching the concept of refraction of light helps students to have better conceptual knowledge, improve their performance level, encouraging them to full participation in classroom activities and arouse their interest in the study of refraction of light. The concept of refraction of light involves the mastery of skills. These skills are enhanced through the appropriate use of instructional materials.

This affirms the assertion of Usman (2016) that learning materials form an essential part of practical teachings. As such, in classrooms, pictures, charts and drawings should be clear and neat. Usman added that, it is not good for a teacher to plan a lesson without some ideas of how he or she will stimulate or motivate his/her students by using pictorials illustrations (pictures, diagrams and apparatus) or materials illustrations. This

shows that instructional materials help to reduce students' difficulties in understanding the concepts and principles of refraction of light.

According to Olaitan (1994), instructional materials are normally used during instruction to enhance proper or effective learning and to encourage retention. They reduce the workload of the teacher in the classroom, reinforce and add clarity to learning.

The instructional materials identified for the study included the rectangular glass, identical pins, pencil, straight edge, white sheet of paper. These materials were used to explain the concept of refraction in terms of the angle of incidence, refraction, Snell's law and the laws of refraction of light to the students. Students were asked to explore, construct and describe a diagram of the light's path in their own groups. After effective discussions, the use of instructional materials made the lesson looked so real and helped them to understand the concepts better. The learning materials stimulated the awareness and thinking abilities of the learners. After the intervention, students understood the concepts of refraction of light when exposed to the use of instructional materials and this resulted in high academic performance, they performed better during the post test.

T-TEST

The Pre-test and Post-Test results were subjected to T- test to compare students' achievement on reflection alone and also that of refraction. All tests were regarded as statistically significant at $p < 0.05$. The calculations were performed using statistical software Excel

Table 4.5 : T-test results for Pre-Test and Post-test on the concept of reflection of light (Comparing students' achievement in reflection alone).

Test	n	Mean	p	df	tcal	tcri
Pre-Test	40	4.5410				
			0.009	29	6.565	1.966
Post-Test	40	6.7213				

tcal – Calculated value of statistic

tcri – Critical value

n – Sample size

Table 4.5 above showed that t-calculated (6.565) is far greater than t-critical (1.960) at the Degree of freedom 39, at 0.05 level of significance. This showed that there is a significant difference in the mean performance of students in both pre-test (4.5410) and post-test (6.7213) The mean gain being (2.1803) indicates the positive effect of the instructional materials on the performance of students during the post test. This was based on the decision rule as advocated by Sambo (2008) that, if the calculated value of the statistic (t) is greater than the critical value of (t) the null hypothesis is rejected for the alternative hypothesis. This is to say that students performed better and understood the concept of reflection of light during the post intervention exercise than the pre intervention exercise. Comparing the result of post intervention to that of the pre-intervention exercise, there is an indication of absolute improvement in students' performance. This unique performance of students showed that the use of the

instructional materials for assisting students effectively was appropriate during the intervention.

The findings indicate that students show low mean performance in the pre-test and therefore seem to have difficulty in the concept of reflection of light. For the tests to be regarded as statistically significant at $P < 0.05$, from the table above, p was (0.009), this shows that the tests were however significant. The influence of instructional materials in teaching the concept of reflection of light help students to have better conceptual knowledge, improve their performance level, encouraging them to full participation in classroom activities and arouse their interest in the study of reflection of light. This affirms the assertion of Onasanya and Omosewo (2010) that there was significantly difference between the students taught with standard instructional materials and those thought with improvised instructional materials, i.e., mean scores on the posttest (t =4.09, df 14, p = 0.05).

Table 4.6 : T-test results for Pre-Test and Post-test on the concept of refraction of light (Comparing students' achievement in refraction alone).

Test	n	Mean	p	df	tcal	tcri
Pre-Test	40	5.7410				
			0.02	35	7.565	2.966
Post-Test	40	8.9213				

Table 4.6 above shows that there is a significant difference in the mean performance of students in both pre-test (5.7410) and post-test (8.9213). The mean gain being 3.1803

indicates the positive effect in the performance of students during the post test. This is to say that students performed better and understood the concept of refraction of light during the post intervention exercise than the pre intervention exercise. Comparing the result of post intervention to that of the pre-intervention exercise, there is an indication of absolute improvement in students' performance. The findings indicate that students show low mean performance in the pre-test and therefore seem to have difficulty in the concept of refraction of light. The low performance of students may be attributed to poor teaching method, students' attitude and misconceptions towards the study of refraction of light and lack of instructional materials to arouse students' interest in the study of refraction of light. For the tests to be regarded as statistically significant $P < 0.05$, from the table above, p was 0.02, this shows that the tests were however significant. The relatively high performance of the students on the post-test items is true reflections of what is suggested by the literature that how much a student learns depend on whether the instructional experiences are linked to the learning styles. The rapid change in the performance of the students was as a result of the methods, strategies and the activities that students were engaged in during the intervention stage. The use of instructional material during the intervention helped the students to have better understanding on the concept of refraction of light. This shows that instructional materials help to reduce students' difficulties in understanding the concepts and principles of refraction of light

Research Question Three: What are the opinions of students' with the use of instructional materials on their conceptual understanding in reflection and refraction of light?

Responses from Students

1. **Was your teacher able to give you clear explanation of scientific concepts (reflection and refraction of light) using instructional material?**

Rhoda said that: "*My teacher was able to explain into details the various stages and scientific process involved in reflection and refraction of light. Because he used instructional materials, his explanations linked to the various complex processes were clearly understood."*

Yvonne also responded that: *the instructional materials enabled me to grasp the various terminologies in reflection and refraction of light and apply them effectively.*

Francis also responded that: *"In fact, the instructional materials have really helped to promote deeper and clearer understanding of the lessons especially, under reflection and refraction of lights.*

2. **Using instructional materials to support physics lectures. Do you think it will enhance your understanding on reflection and refraction of light lessons? Give reasons for your answer.**

Philip responded that: *"Yes! This is because physics has many complex processes which cannot be easily explained verbally to clarify concepts to students unless with the support of instructional materials.*

David also responded that: "*Yes! Our teacher should continue using it because; it made the learning of reflection and refraction of light very interesting and simple. This will enhance the understanding of the scientific concepts"*

Francis responded again that: "*Yes! This is because it will promote a good student-teacher relationship and will help teacher to easily identify and understand the challenges of the students and find appropriate measures of addressing such challenges."*

Although there were mixed opinions to the questions, majority of them said the use of instructional materials helped them to understand the concept of reflection and refraction of light and perform better in class exercise which was evident in the post intervention exercise they performed

Few of them said without the use of instructional materials they were able to understand the concept of reflection and refraction of light since they were used to rote learning. The researcher grouped the opinions as expressed by the students with the use of instructional materials on their conceptual understand in reflection and refraction of light as follows:

(i) A good instructional material can supplement spoken or written words.

(ii) It can bring teaching to life in a way that words cannot.

(iii) Words can describe people, places and objects but a picture immediately brings reality

(iv) A teaching aid can simplify and clarify what is complex and difficult to express in words.

(v) Instructional materials have motivational value to develop the interest of the student.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Overview

This chapter contains the summary of findings, conclusions and recommendations made in relation to the study.

5.1 Summary of the findings

The purpose of the study was to use instructional materials to help level "100A" students of Atebubu College of Education have better conceptual understanding on reflection and refraction of light. The population of the study was all students of Atebubu College of Education. The targeted population for the research was all the Level 100 students of Atebubu College of Education but the accessible population was the level "100A" students of the College. The class was made up of forty (40) students. The researcher used purposive sampling to select the students based on their peculiar problems. The instruments used for the research were observation, regular class exercises, interview, pre and post- tests.

From the analysis of the data in the study, the following major findings were observed

1. The Pre – test was administered with the aim of finding the knowledge level of students in understanding the concepts of reflection and refraction of light and as well as the instructional materials available to teach these concepts. During the pre-intervention exercise, it was revealed that most of the students were lacking

the basic knowledge and understanding about the concepts of reflection and refraction of light, and that; they performed poorly in their pre test questions.

2. Post – test was also conducted to determine the extent to which the intervention activities improved students' performance in reflection and refraction of light using appropriate teaching materials. After the implementation of the intervention activities, results from the post-test did indicate that about 85% improved in the conceptual understanding of reflection of light. Again, about 75% also improved in the conceptual understanding of refraction of light. These showed that a greater majority of the students have overcome their difficulties in the concepts of reflection and refraction of light. Thus students' conceptual understanding of reflection of light as well as refraction of light improved.
3. There were mixed opinions to the research question three, students' opinions showed that majority of them supported the use of instructional materials in the learning process. Majority of students said the use of instruction materials helped them to understand the concept of reflection and refraction of light and perform better in class exercise which was evident in the post intervention exercise they performed. Few of them said without the use of instructional materials they were able to understand the concept of reflection and refraction of light since they were used to rote learning

5.2 Conclusion of the Study

The purpose of the study was to seek how the use instructional materials could help level "100A" students of Atebubu College of Education have better conceptual understanding and improve their academic performance in reflection and refraction of light.

It was revealed that the use of instructional materials did improve students' conceptual understanding and academic performance in reflection and refraction of light.

Students' opinions showed that majority of them supported the use of instructional materials in the learning process. They said the use of instruction materials helped them to understand the concept of reflection and refraction of light. This was evident in the post-test. Few of them said without the use of instructional materials they were able to understand the concept of reflection and refraction of light since they were used to rote learning.

5.3 Recommendations

Based on the research conducted, the following recommendations were made:

1. Physics teachers should try as much as possible to utilise instructional materials for effective delivery and achievement of lesson objectives.
2. Due to the lack of adequate modern instructional materials at the physics laboratory, physics teachers should learn to improvise instructional materials to augment their lessons
3. School authorities should frequently organize workshops for physics teachers on improving their teaching methods to suit the modern trend of teaching and learning.

5.4 Suggestions for Further Research

The researcher therefore proposes the following:

i. Studies should be conducted in other aspects of Physics such as the concept of Electricity, electronics, waves and mechanics

ii. Future research in the reflection and refraction of light should be extended to cover more schools.

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APPENDICES

APPENDIX A

DIAGNOSTIC TESTS

Answer all Questions

Name of student…….

Sex (male or female)……

Index number ……

Q1. Explain the following terms as used in reflection of light**;** angle of incidence, angle of reflection and normal line

Q2. Explain the laws of reflection of light and support your explanation with diagrams

Q3. Identify three uses of instructional materials

Q4. Explain the laws of refraction and Snell's law of refraction.

Q5. Explain the term; angle of refraction

Q6. Identify any three types of instructional materials available to teach concepts of reflection and refraction of light.

Q7. Discuss the factors that affect the use of instructional materials

APPENDIX B

Pre-intervention test on reflection

Name.....

Sex (Male or Female).....

Index number.....

Fill in the blank space

1. The angle between the normal and the incident light ray is known as ……
2. The phenomenon by which the incident light falling on a surface is sent back into the same medium is known as.....
3. The phenomenon that light travels in a straight line is referred to as.....
4. A light ray has an angle of incidence of 34º. The angle the reflected ray will make with the reflecting surface is.....
5. Kofi is only 6.7m tall stands in front of a plane mirror. What will be the height of his image?.....
6. The type of reflection that happens on a smooth polished surface is referred to as.....

Indicate whether each of the following statements is True or False

7. According to the second law of reflection, <i = <r .....
8. The image formed by a plane mirror is always real.....

9. When light bounces off a smooth, shiny surface, we say refraction has occurred.....

10. A virtual image can be formed on a screen, a real image cannot.....

For each of the following questions, select from the options A - D, the option that answers the question

11. For each angle of incidence, corresponding value of angle of reflection is

    A. different
    B. same
    C. can be same or different
    D. none of above

12. A periscope helps a person to look over a high wall or obstacles by using to plane mirrors inclined at

    A. 30 °
    B. 120 °
    C. 60 °
    D. 45 °

13. Straight line in which light travels is called

    A. wave
    B. ray
    C. path
    D. light perimeter

14. Reflection obtained from a smooth surface is called a

    A. transmission
    B. irregular reflection
    C. regular reflection
    D. none of the above

15. The normal makes an angle of .....with the reflecting surface

A. 70^{o}
B. 80^{o}
C. 90^{o}
D. 45^{o}

16. For each angle of incidence, corresponding value of angle of reflection is

A. greater
B. different
C. can be same or different
D. none of above

17. An object becomes invisible when it undergoes ..... reflection.

A. normal
B. irregular
C. diffused
D. regular

18. Straight line in which light travels is called

A. wave
B. path
C. ray
D. light perimeter

19. Way of light is always in a

A. bend path
B. straight line
C. convergent path
D. divergent path

20. What is angle of reflection?

A. the angle between the incident ray and the normal
B. the angle between the reflected ray and the normal
C. the angle between the incident ray and the reflected ray
D. the angle between the reflected ray and the mirror surface

Post-intervention test on reflection

Name of student.....

Index number.....

Answer all questions

1. Light is a form of energy produced by a.....

A. luminous object
B. transparent object
C. non-luminous object
D. opaque object

2. For each angle of incidence, corresponding value of angle of reflection is

A. same
B. different
C. can be same or different
D. none of above

3. The phenomenon by which the incident light falling on a surface is sent back into the same medium is known as .....

A. polarization
B. reflection
C. refraction
D. absorption

4. When light is incident on a polished surface..... reflection takes place.

A. regular
B. irregular
C. diffused
D. normal

5. An object becomes invisible when it undergoes ..... reflection.
A. regular
B. irregular
C. diffused
D. normal

6. According to the laws of reflection,

A. $\angle i = \angle r$
B. $\angle i > \angle r$
C. $\angle r > \angle i$
D. $\angle i \neq \angle r$

7. The image formed by a plane mirror is always .....

A. real and erect
B. virtual and erect
C. real and inverted
D. virtual and inverted

8. A ray of light is incident on a plane mirror and the angle of incidence is 25^o. What is the angle of reflection?

A. 0^o
B. 50^o
C. 90^o
D. 25^o

9 An object placed 2m from a plane mirror is shifted by 0.5 m away from the mirror. What is the distance between the object and its image?

A. 2 m
B. 1.5 m
C. 5 m

D. 3 m

10. Way of light is always in a

A. bend path
B. straight line
C. convergent path
D. divergent path

11. Angle between incident ray and normal ray is called angle of

A. reflection
B. refraction
C. transmission
D. incidence

12. Reflection obtained from a smooth surface is called a

A. regular reflection
B. irregular reflection
C. both a and b
D. none

13. When light bounces off a smooth, shiny surface, what process has occurred?

A. Refraction

B. Reflection

C. Transmission

D. Photosynthesis

14. In what way is a mirror different from a stop sign?

A. The light (and all colors) bounce off the mirror.

B. No light bounces off the mirror.

C. Light passes through the mirror.

D. Light is absorbed into the mirror

15. A light ray has an angle of incidence of 34º. The reflected ray will make what angle with the reflecting surface?

A. 0º

B. 34º

C. 56º

D. 66º

16. We can see objects because of .....

A. reflection
B. refraction
C. transmission
D. diffraction

17. The angle between a ray of light and the surface it strikes is 30º. Calculate the angle of incidence

A. 120 º
B. 140 º
C. 90 º
D. 60º

18. Ama stands 1.2m away from a plane mirror. What isthe distance between Ama and her image?

A. 1.2m
B. 2.4m
C. 2.6m
D. 4.2m

19. Which one of the following statements is correct?

A. A virtual image and a real image can both be formed on a screen.

B. A virtual image can be formed on a screen, a real image cannot.

C. A real image can be seen, a virtual image cannot.

D. Real images are formed by the actual intersection of rays.

20. Straight line in which light travels is called

A. wave
B. ray
C. path
D. light perimeter

APPENDIX C

Pre-intervention test on refraction

Name of student.....

Index number.....

Answer all questions

1.The bending of a beam of light when it passes obliquely from one medium to another is known as .....

A. reflection
B. refraction
C. dispersion
D. deviation

2. A ray of light travels from a medium of refractive index n_1 to a medium of refractive index n_2. If angle of incidence is i and the angle of refraction is r.

Then $\frac{\sin i}{\sin r}$ is equal to

A. n_1
B. n_2
C. n_{21}
D. n_{12}

3.The refractive index of a denser medium with respect to a rarer medium is...

A. 1
B. greater than 1
C. smaller than 1
D. negative

4. The refractive index of a rarer medium with respect to a denser medium is...

A.1
B. greater than 1
C. smaller than 1
D. negative

5. Total internal reflection will occur if the angle of reflection is...

A. 45°
B. 60°
C. 90°
D. 99°

6. Symbol for refractive index is

A. i
B. r
C. n
D. r_n

7. Total internal reflection occurs when

A. light passes from a denser to a lighter medium
B. light comes into air from vacuum
C. light goes to vacuum from air
D. light passes from denser to less dense medium

8. Difference in speed of light in air and in denser medium is termed as

A. reflective index
B. refractive index
C. transactional index
D. density index

9. Medium in which light rays get slower in speed is termed as

A. Rarely denser
B. Optical medium
C. Optically denser
D. Refractivity denser

10. When light travels from an optically denser medium into a less dense medium, it
A. bends towards the normal
B. bends away from the normal

C. bounces back
D. glows

11. In swimming pools they appear shallower than they actually are because of

A. reflection
B. refraction
C. both a and b
D. none

12. In refraction, the angle of incidence is

A. always equal to the angle of refraction
B. not equal to the angle of refraction
C. aways greater than the angle of refraction
D. always smaller than the angle of refraction

13. Which of the following occurs in two media?

A. reflection
B. refraction
C. transmission
D. emission

14. Mirages are formed because of ....

A. refraction
B. reflection
C. penetration
D. transmission

15. If the first medium is vacuum, then the refractive index obtained is referred to as

A. Initial refractive index
B. final refractive index
C. absolute refractive index
D. total refractive index

A coin is placed in a bucket of water at the depth of 10cm from the level of the water. An observer looking through the water sees the coin at a depth of 6cm from the water level.

Use the information above to answer questions 16 and 17

16. Calculate the refractive index of the water
    A. 16.0
    B. 1.67
    C. 16.7
    D. 4.0

17. What is the displacement of the coin?
    A. 4cm
    B. 6cm
    C. 12cm
    D. 16cm

18. A light ray is incident on a glass surface at an angle of 30^{o} to the normal. Calculate the angle of refraction in the glass. (Refractive index of glass = 1.5)
    A. 16.60^{o}
    B. 19.45^{o}
    C. 21.00^{o}
    D. 23.00^{o}

19. Which of the following is true about refraction when the incident ray is at 90^{o} to the interface. It....
    A. refracts towards the normal
    B. refracts away from the normal
    C. does not suffer refraction
    D. bounces back into the same medium

20. In refraction, the ray that comes out of the second medium is referred to as....
    A. refracted ray
    B. incident ray
    C. emergent ray
    D. normal

POST-INTERVENTION TEST ON REFRACTION

1. The refractive index obtained for light ray moving from a vacuum as the first medium is referred to as.....
   A. Absolute refractive index
   B. initial refractive index
   C. final refractive index
   D. total refractive index

2. . In refraction, the ray that comes out of the second medium is referred to as....
   A. emergent ray
   B. incident ray
   C. refracted ray
   D. normal

3. Mirages are formed because of ....

   A. defraction
   B. reflection
   C. deflection
   D. refraction

4. Which of the following is true about refraction when the incident ray is at 90^{o} to the interface. It....
   A. refracts away from the normal
   B. bounces back into the same medium
   C. refracts towards the normal
   D. does not suffer refraction

A nail is placed in a bucket of water at the depth of 20cm from the level of the water. An observer looking through the water sees the coin at a depth of 6cm from the water level.

Use the information above to answer questions 5 and 6

5. Calculate the refractive index of the water
   A. 1.67
   B. 1.98
   C. 3.33
   D. 4.00

6. What is the displacement of the nail?
   A. 4cm
   B. 8cm
   C. 14cm
   D. 26cm

7. In refraction, the angle of incidence is.....
   A. always equal to the angle of refraction
   B. aways greater than the angle of refraction
   C. usually smaller than the angle of refraction
   D. not equal to the angle of refraction

8. A light ray is incident on a glass surface at an angle of 30^{o} to the normal. Calculate the angle of refraction in the glass. (Refractive index of glass = 1.5)
   A. 16.60^{o}
   B. 17.00^{o}
   C. 19.00^{o}
   D. 19.45^{o}

9. The bottom of a lake appears shallower than its actual depth because of....
   A. reflection
   B. revolution
   C. refraction
   D. imagination

10. Difference in speed of light in air and in denser medium is termed as

A. reflective index
B. refractive index
C. transactional index
D. density index

11. Which of the following phenomena occurs in two media?

A. reflection
B. refraction
C. transmission
D. emission

12. When light travels from an optically denser medium into a less dense medium, it....

A. bends towards the normal
B. bends away from the normal
C. bounces back
D. glows

13. Total internal reflection occurs when....

A. light passes from a denser to a lighter medium
B. light comes into air from vacuum
C. light goes to vacuum from air
D. light passes from denser to less dense medium

14. The angle between the refracted ray and the normal is called angle of.....

A. emergence
B. reflection
C. refraction
D. incidence

15. Which of the following symbols is the symbol for refractive index?

A. i
B. n
C. r
D. r_n

16. The bending of a beam of light when it passes obliquely from one medium to another is known as .....

A. reflection
B. refraction
C. dispersion
D. deviation

17. Total internal reflection will occur if the angle of reflection is...

A. 45°
B. 60°
C. 90°
D. 99°

18. The angle of incidence for which the refracted ray lies at the interface is called the..

A. absolute angle
B. critical angle
C. angle of refraction
D. total angle

19. Which of the following describes Snell's law?

A. angle of incidence is equal to angle of refraction
B. angle of incidence is equal to angle of reflection
C. ratio of sin(i) to sin(r) is constant for a given pair of media
D. ratio of sin(r) to sin(i) is constant for a given pair of media

20. A ray of light travels from a medium of refractive index n_1 to a medium of refractive index n_2.

If angle of incidence is i and the angle of refraction is r.

Then $\frac{\sin i}{\sin r}$ is equal to

A. n_1

B. n_2

C. n_{21}

D. n_{12}