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RESEARCH ARTICLE

# Effect of practical teaching approach on physics students' achievement in the concept of reflection and refraction of light

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## Abstract

This study investigates the effect of practical teaching approach the achievement of physics students in the concept of reflection and refraction of light in senior secondary schools, typically encompassing students aged between 15 and 18 years. Employing a quasi-experimental design, a purposive sampling technique was used to select four schools in Ondo West, Ondo State. Data were collected from 100 students using a 40-item Physics Concept Test (PCT) questionnaire, with 20 items dedicated to each concept. Pre-test and post-test assessments were administered to both control and experimental groups before and after the intervention, respectively. Hypotheses were tested at the 0.01 level using Pearson product-moment correlations and an independent sample T-test. Results showed a significant effect of practical teaching methods on students' achievement in light reflection and refraction. Recommendations include integrating practical approaches alongside theory and introducing practical activities earlier in students' education to enhance understanding before external examinations.

## Keywords

practical teaching approach, reflection, refraction, students' achievement, t-test

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### State of the literature

- The importance of science in societal development and the need for scientific literacy.
- Students' attitudes towards science subjects and the importance of fostering positive perceptions.
- The significance of physics in driving technological advancements and societal progress.
- Challenges and prospects in teaching and learning physics, including the exploration of instructional techniques and methods.
- The value of practical approaches in physics education and their impact on student achievement.
- Factors influencing student achievement in physics and common misconceptions surrounding light and vision concepts.

### Contribution of this paper to the literature

- Investigates the effect of a practical teaching approach on the achievement of senior secondary physics students in the concepts of reflection and refraction of light.
- Aims to provide insights into the effectiveness of practical teaching methods in improving students' understanding of physics concepts and addressing common misconceptions.
- The findings of this study can inform the development of teaching strategies and instructional materials that enhance physics education in Nigerian schools.

## Introduction

Science education is a well-known unique field within education, and deals with teaching and learning of science and the discrete science disciplines. Science education is an integrated field of study which considers both subject matter of science disciplines like, biology, chemistry, and physics and so on along with a process involved in the teaching and learning of science (Okeke, 2007). Basic knowledge in science, especially physics is an essential condition for all forms of modern development. To be able to appreciate, control and effectively tap from and utilise the resources from our natural environment, it is imperative to acquire this scientific knowledge – a basic tool of all forms of industrial and technological advancement of any nation (American Physical Society, 2014).

Physics is a science subject that involves practical application in daily life activities if well taught and well understood by the student. National Policy on Education, Federal Republic of Nigeria (2013) stated that the objectives of physics education are to provide basic literacy in physics for functional living in the society; attain fundamental concepts and principles of physics as a grounding for further studies; acquire necessary scientific skills and attitudes as a preparation for technological application of physics and stimulate and enhance creativity. Thus, the broad aim of physics is to understand and explain various physical phenomena occurring in nature/laboratory through observation, experimentation and theoretical formulation. There are various concepts in physics such as simple harmonic motion, heat, electricity, light etc., yet the scientific concept of reflection and refraction of light (optics) are basic and important contents in physics education. Students need to acquire knowledge of this concept properly in order to comprehend the interrelated and advanced physics concepts such as interference of light waves, dispersion of light, light spectrum etc. Djanett (2013) believes that without understanding the concept of light and its properties, students may not understand many scientific domains. Unfortunately, researchers have reported that students hold alternative conceptions in science phenomena about refraction of light. This ascertains the statement of Clement (1982) that they are confused about the meaning


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of light reflection and refraction; the direction of propagation of light; how light refraction occurs at an interface; and how to determine a position of image. These alternative conceptions according to Galili and Hazan (2001) arise because of their pre-existing ideas and beliefs based on their everyday experience with the light. In order to correct these alternative conceptions, an appropriate teaching approach has to be adopted. The recent development on the emphasis in science curricula objectives on the student-centred method approach in teaching science subjects makes a radical shift from the traditional teacher-centred approach. Thus, it requires that students should be actively involved in the learning process through properly and meaningfully taking part in the activities during every classroom instruction in science subjects. Despite the demands in the new science curricula in Nigeria, research reports from my fellow 2021 teaching practice students show that science teachers still teach contrary to this. Practical activities are never attended until the last week to the public examinations. In accordance with Dewey (1938), educational philosophy, which emphasises the integration of theory and practice to facilitate genuine learning experiences, the separation of science into distinct practical and theoretical lessons creates a false dichotomy that undermines the essence of true scientific inquiry. This delay hinders students' opportunities to engage in authentic scientific exploration and experimentation, thus deviating from Dewey's holistic vision of education. It was observed that students find the concept of optics to be obscure and difficult, and teachers' help is often inadequate because of its complex and abstract relations (Galili & Hazan, 2001). The teaching and learning of the concept of light (optics) in senior secondary three (SS3) has been challenging, as a result, teachers focus more on electricity and mechanics thereby preventing many students from attempting practical questions on reflection and refraction of light in their external examinations. These learning difficulties according to Srisawasdi and Kroothkeaw (2014) can be significantly reduced by embedding essential process and content explanations within the classroom learning environment. In order to help students get a meaningful understanding of the reflection and refraction of light phenomena, students' alternative conceptions, therefore, must be established and removed. Thus, to promote this meaningful learning, problem-solving and critical thinking for a diversity of students, there is need for proper embedding of theory with intensive practical activities in teaching of the physics concepts on reflection and refraction of light. Consequently, the primary objective of this study is to investigate the effect of practical teaching approach on the achievement of physics students in the concept of reflection and refraction of light.

### *Research Questions*

The following research questions guided this study:

1. What is the effect of the use of a practical teaching approach on students' achievement on the concepts of reflection of light?
2. What is the effect of the use of a practical teaching approach on students' achievement on the concepts of refraction of light?

### *Research hypothesis*

This study was directed by the following null hypotheses:

H0: There is no significant difference between the performance of senior secondary three (SS3) physics students who were taught the concept of reflection of light using the practical teaching approach and those taught using the conventional method.

H0: There is no significant difference between the performance of senior secondary three (SS3) Physics students who were taught the concept of refraction of light using the practical teaching approach and those taught using the conventional method.

## REVIEW OF LITERATURE

The literature review for this study encompasses several crucial dimensions of science education. Firstly, it delves into the pivotal role of science in societal development, emphasising the need for widespread scientific literacy to address contemporary challenges. It also examines students' attitudes towards science subjects, underlining the importance of fostering positive perceptions to enhance engagement and learning outcomes. Furthermore, the review elucidates the significance of physics in driving technological advancements and societal progress, underscoring its relevance in various domains. Additionally, it addresses challenges and prospects in teaching and learning physics, including the exploration of instructional techniques and methods. Moreover, the review highlights the value of practical approaches in physics education, advocating for hands-on learning experiences to deepen conceptual understanding. Furthermore, it explores factors influencing student achievement in physics and common misconceptions surrounding light and vision concepts. Lastly, the review synthesises existing empirical research relevant to the study's focus, providing a comprehensive foundation for further investigation.

### *Importance of Science in Societal development*

Science, as the greatest collective discipline, has indeed had a tremendous effect on our society and continues to influence it today. It has changed what we believe in and how we live our lives. By improving our lives, science has given humanity the opportunity to take into account concerns such as education, justice and even morality; create civilizations and improve human living conditions. Science has dramatically improved society by dramatically changing our views on food, quality, or lifetime, and has even changed ethical principles and best philosophies that mankind has ever known. According to Vander Wolf et al. (2005), humanity is currently confronted with numerous social challenges, including the imminent demographic and energy crises, global warming, HIV and AIDS, among others. Ethics related to biotechnology require scientific knowledge if they need to be treated with reason. To face the challenges of sustainable development, Juan and Ruiz (2009) argue that governments and citizens must understand the language of science and absorb scientific knowledge. On the other hand, scientists need to clearly understand the problems facing policy makers and try to make their research results relevant and understandable to society. So, the nature of the modern world depends on scientific technology. For example, Harley and Orjuela (2010) note that the physical sciences have been, are and will continue to be the main conceptual and applied pillars for some professions such as engineers and technologists, as they contribute to their thinking and structural development of their minds. Science creates solutions to everyday life and helps us solve the great mysteries of the universe. In other words, the most important medium of knowledge has been proven to be science.

### *Students' Attitude towards Science Subjects*

According to Osborne et al. (2003), student attitudes towards scientific research have been a major feature of the work of the educational research community for the past 40 years. Trumper (2006) believes that the development of positive attitudes towards science, scientists and scientific learning, which have always been the foundation of science education, is of growing concern. But according to Oludipe (2008), what remains as a major concern of science education is prejudice and misconceptions about women and science. Hobbies are a kind of conscious predisposition to understand the world and acquire cultural and scientific knowledge (Xiuhong & Dongyi, 2005). Yan (2011) commented that when students are interested in a certain field, they can pay attention, observe closely, remember well and think positively. A survey by Akarsu and Kariper (2013) on the preferences and attitudes of high school students towards science topics based on gender, grades and parental education level found that students' attitudes towards science is strongly related to science preferences, gender, grades, and parental education. In addition, the study revealed the participants' preferences in different scientific fields and their relationship to factors such as gender, grades, education level, and parental occupation. It was also found that students were most interested in general science concepts with a popularity rating of around 50%. This could indicate that students enjoy science when they are first introduced to basic topics in science. It's possible that this has something to do with how they're presented, and the methods teachers use to teach them.

### *Importance of Physics to the Society*

Physics' broad goal is to use observation, experimentation, and theoretical formulation to understand and explain numerous physical processes that occur in nature and in the laboratory. The motion of planets around the sun, evaporation of water, sound emission from a tuning fork, reflection and refraction of light, attraction of iron by magnets, discharge of an electrical capacitor, and decay of the pi meson are all examples of physical processes, according to Agrawal and Menon (2010). Thus, careful development of Physics syllabi and their relevance to environmental challenges leads to meaningful learning of Physics. The goal of physics in secondary school should be to develop process skills that will allow students to apply their understanding of physics to real-world issues. According to Zdenek and Hana (2008), these skills aid in the acquisition of physics concepts and their application in daily life. Without a doubt, we cannot consider the development of any other natural scientific discipline by minimising the progress of any other field. Physics has played an important role in the development of other scientific fields such as chemistry, biology, mathematics, and so on. Lasers, semi- and superconductors, fibre optics, contemporary computers, and other technologies and discoveries arose as a result of advances in physics. Scientists in all fields of natural science use this sophisticated technology to collect experimental data. Furthermore, physics aims to comprehend the universe. Physicists use experiments to question nature in order to achieve this understanding. The goal of these experiments is to test existing ideas and point to new and exciting theories. Experiments are important not only for improving our understanding of our cosmos, but also for teaching physics (Chiaverina & Vollmer, 2005).

### *Teaching and Learning Physics as a Science Subject: Issues and Prospects*

Physics as a discipline has several important issues, including teacher training and conceptualization, student understanding, and physical resources such as laboratories, instructional aids, and textbooks. According to Schwerdt and Wuppermann (2009), traditional teaching methods that ignore students' perspectives are ineffective in dealing with students' misconceptions. This method has limitations in terms of assisting a learner in developing abilities (Tarekegn, 2009). The practical teaching approach, on the other hand, actively engages the student and leads to improved capacity to relate and comprehend concepts. According to this study, if the practical teaching technique is applied, students' achievement in the topic may improve. Hence, this study investigates the effects of a practical teaching approach to physics on students' achievement in the concept of reflection and refraction in physics. According to Chiu (2000), students at all levels of physics find it challenging to acquire physics concepts that are different from what they have already assimilated (Refik & Bahattin, 2008). One of the numerous challenges teachers encounter is the capacity to capture and retain information. Several studies undertaken have revealed that teaching of physics has the same problems in the whole world.

Juan and Ruiz (2009) discovered that since teaching has been primarily restricted to the classroom, teaching and learning physics has some obstacles: that instruction appealed more to the cognitive domain and little to the affective-emotional domain, and that teaching and learning physics faced some challenges. Instruction and learning physics were personalised, and learning was centred on making the individual fit into the environment rather than changing the individual to change the environment. As a result, it is critical to adapt the ways in which physics is taught in order to improve its relevance and application. Also, it is worth mentioning that there is a breakdown between the practices and the theoretical taught. The practical is taught separately from the theoretical, which does not help students learn concepts. Teaching should include a practical component, and theory should be generated from the practical (Juan & Ruiz, 2009). This aids in the development of the present study's design.

Another issue facing physics as a discipline is teachers' lack of content expertise. Fadaei (2012) conducted research to determine the teachers' level of knowledge acquisition using the Force and Motion Conceptual Evaluation (FMCE) for mechanics concepts. The survey discovered that the majority of physics professors did not fully comprehend kinematics and dynamics concepts. Furthermore, assessments utilising the FMCE show that when particular learning strategies are planned, teacher grasp of dynamics concepts improves. As a result, 1) teachers should self-evaluate their talents and be motivated to be more involved in the classroom; 2) it is critical to emphasise the importance of recognizing and preparing teacher training projects. According to Lyons (2006), due to the overburdened curriculum, science teachers do not have time to undertake practical exercises. He goes on to say that the overburdened science curriculum forces teachers to prioritise completing the syllabus for science teaching pedagogy. This, according to Osborne and Collins (2001), is why teachers utilise transmissive pedagogy. Ranade (2008) does not mention scientific curriculum overload as a motivation for teachers to utilise transmissive pedagogy, but she does highlight it as a burden on school science students.

Although evaluation is an important part of all teaching-learning processes, it normally necessitates significant preparatory work from both students and teachers. Teaching and learning activities in schools require support, monitoring, assessment, and supervision, according to Munshi and Bhatti (2006). It is suggested that curriculum and teaching practice approaches be updated to accommodate new teaching techniques.

According to Jumani and Iqbal (2006), a critical examination of the efficiency of teacher education, particularly in physics, is required. It is critical to align our teacher education with the realities of life and current school conditions. According to Halai (2008), science teachers are in low supply in schools, with the situation being even worse in rural areas. She also notes that due to a shortage of science professors, some teachers who never studied science in school are now teaching science courses. He also claims that the shortage of science teachers adds to teachers' burden, forcing them to teach a big number of classes with a huge number of students, and as a result, they prefer to focus on covering the syllabi for the examinations.

According to Ranade (2008), big class sizes make it difficult for teachers to adopt the activity method, and they end up teaching science through the lecture approach.

Gadoko (2001) outlines the following resources for communicating well in physics: (1) sufficient instructional materials; (2) practical apparatus; (3) well-trained and qualified physics teachers. According to Nivalainen et al. (2010), teacher education programs should provide well-designed practical work courses for physics teachers, with the goal of familiarising teachers with practical work and helping them comprehend its purpose. This is especially significant in educational systems where teacher candidates have not had much experience with practical work and hence may not understand the benefits of it.

## *Physics Instructional Techniques/ Methods*

All natural sciences are founded on physics. It provides us with a clear picture of the world. As a result, we must devise the most engaging and ingenious technique of teaching physics. There are numerous ways for teaching sciences, particularly physics, which have evolved over time. Students' effective performance on the physics practical was aided by efficient teaching approaches. According to Zdenek and Hana (2008), any improvements in physics curricula should be made with the understanding that students will be more interested in addressing problems that affect their immediate environment. Alternative ways to physics teaching, according to Dykstra (2012), result in a far wider variety of students making considerably greater changes in their understanding of the phenomena than the traditional technique. However, the findings have not resulted in significant improvements in physics education (Fadaei, 2012). Effective teaching necessitates the development of complicated abilities that take years to master. According to Fadaei (2012), technical knowledge of teaching and learning is just as important as topic matter knowledge. The availability of conceptual tools to pupils and the teacher's facilitation are determinants of the construct's quality. Teachers allow pupils to develop their own knowledge of the material. Then, in the teaching of physics, the practical approach, which is a learner-centred method, allows students to acquire physics concepts through a process rather than rote learning, and encourages them to process the concepts in a methodical manner. Tesfaye (2012) conducted an experimental study in Nigeria to see how a question-and-answer strategy affected pupils' grasp of basic mechanics topics. Students exposed to the question–answer strategy with group discussion as a teaching intervention did better than those who were taught by the teacher lecture method on Mechanics Baseline Test (MBT). According to studies (Gamze et al., 2008), problem solving methods and practical work engage students in the learning process and help them become better problem solvers. They suggested that physics teachers employ problem-solving methods to help students acquire problem-solving skills. In light of students' poor performance in physics, Nwankwo et al. (2019) investigated the effect of an interactive and learner friendly Meta Conceptual Teaching Approach on students' achievement in physics, using a sample size of 68 SS2 physics students from two secondary schools in Awka South Local Government Area of Anambra State. The study's findings revealed a significant influence of the Meta Conceptual Teaching Approach (MTA) on students' physics achievement, implying that MTA can improve students' physics achievement. They proposed that MTA be used in science classes, particularly physics, in secondary schools. One strategy that prepares students with tools to address common challenges is the practical approach (Huffman, 1997). Furthermore, practical activities are teaching aids that assist students in solidifying concepts and comparing theoretical, practical, and real-world terms. These hands-on activities also spark students' curiosity. Practical work allows the teacher and student to bring the actual world into the laboratory and compare the two, resulting in a greater comprehension of the principles (Chiu & Lin, 2002). Many studies have been undertaken to investigate ways to improve physics teaching and learning, and it has been determined that science process skills assist students in understanding topics and other global challenges (Juan & Ruiz, 2009).

### A Practical Approach to Physics Education

Imagine someone teaching you how to swim or operate a car within the confines of a classroom. It's not feasible!! First of all, you must enter the water if you want to learn how to swim and to learn to drive, you must first be on the road. Some subjects are practice-oriented and skill-based. Theoretical knowledge of skill-based subjects must be backed up by practical experience. Physics and engineering are skill-based subjects. Practical knowledge is more significant than academic understanding in many disciplines. Experiments in laboratories, study visits, projects, and assignments are examples of practical work. Practical labour has unrivalled advantages. A science concept taught just theoretically is useless unless it can be applied by students in real-life situations. You recall more when you do something with your own hands (SRCOE pune, 2016). According to Prince (2004), a practical technique of teaching is one in which students are actively involved in the learning process. According to (Harfield et al, 2007), "students actively participate in the learning experience rather than sit as passive learners" in a practical way of teaching. On two aspects, the practical approach of teaching differs from the conventional/theoretical method of teaching. The first is students' active participation, and the second is student collaboration. Without practicals, scientific teaching and learning would never be meaningful. Practicals assist pupils in comprehending scientific concepts and acquire science process skills. "Manipulative items are commonly used" in practical teaching methods "Tell me, and I will forget, show me, and I will remember, involve me, and I will understand," Confucius famously said on student learning effectiveness. Learners can use practical teaching methods to 'build mental models that allow for higher-order performance such as applied problem solving and information and skill transfer.' In addition, rather than being a sage on a stage, the instructor in a practical class serves as a facilitator, motivator, guide, and coach (Stößlein, 2009).

Motlhabane (2013) explored the role and viability of effective practice in impoverished rural schools in South Africa in an interesting 'reflection.' He maintains the link between "hands on" and "minds on," and believes that a practical work-focused version of the Kolb experiential learning cycle could be useful in explaining why (McMahon, 1999; Knowles, Holton and Swanson, 2005). Musasia et al. (2012) make similar observations based on an empirical study of Kenyan girls learning physics. In their study, *Physics practical work and its influence on students' academic achievement in Kakamega South Sub-County-Kenya*, Amaldo et al. (2016) specifically sought to determine the difference in academic achievement in physics between students taught using intensive practical activities and those taught using traditional teaching methods, mostly theoretically. They discovered that the experimental group performed better than the control group after treatment, which aided in determining the value of experimentation in physics education and shaping policy on the nature and quality of practical work to be fostered in secondary school physics education. Learner-led practical work, according to the authors, enhanced interest and improved outcomes in both skills and broad goals. According to Zdenek and Hana (2008), in order to prepare students for further studies, they must think critically and apply knowledge gained in relevant ways. Experiments that allow students to observe events, test hypotheses, and apply their knowledge of the physical world have been demonstrated to be the most effective. Secondary school practical work Laboratory experiments, demonstrations, fieldwork, and excursions are all used to teach physics. Teacher creativity and innovation could potentially lead to new types of practical research. Recently, efforts have been made to use virtual laboratories that rely on computer and internet interaction (Scheckler, 2003). Clearly, every effort should be taken to excite students' interest in pursuing a degree in physics. Although the above efforts are commendable, this research will focus on the role that practical teaching approaches can play in developing interest in learning physics, particularly the concept of reflection and refraction of light, among students in government-owned secondary schools in Ondo west local government, Ondo state.

### Student Achievement and Its Influences

In today's Nigeria, a strong emphasis is placed on science and technical growth, as well as academic excellence in the sciences. As a result, students are encouraged to pursue science-related coursework. Physics is an important science subject. Physics is now a discipline that covers almost every sector of human activity and plays a critical role in educational growth. Unfortunately, throughout the last decade, pupils' performance in physics at the conclusion of secondary school has not been encouraging. The volume of work performed, students' task orientation and skill acquisition, students' personality and self-concept, feelings of inadequacy, motivation, self-confidence, anxiety, and a dearth of skilled teachers have all been linked to students' interest in physics (Aikens, 2006), large student-to-teacher ratio, overloaded curriculum (Okebukola, 2002), and poor content delivery are all factors that contribute to ineffective teaching (Odogwu, 2004). Science educators have continued to look for variables that could be used to improve students' overall learning outcomes in physics in order to obtain favourable academic results. As a result of this research, students' achievement in physics topics, particularly reflection and refraction of light, will improve with the application of practical work.

### Students' Ideas about Light and Vision

Students in the scientific field of light, in particular, find the subject perplexing and difficult to grasp, and as a result, they develop profound and hard to change misconceptions (Heywood, 2005). The speed of light, for example, is impossible for the human mind to comprehend, but light is taught to be stationary in scientific classes (Hazan & Galili, 2010).

Blizak et al. (2009) conducted research and discovered that students have misconceptions about optical principles. According to the findings, students believed that the image of an object is generated by light rays travelling from the eye to the object. The students were unable to articulate the connection between the eye and the item seen during picture creation. The students in the study similarly believed that light beams could not travel through space. Furthermore, the students stated that a ball placed in front of a point size light source prevented all light emission; a screen positioned in that experiment set up (a screen, a ball, and a light source) was completely black. When a larger light source was employed in the same experiment, the students assumed the screen would be completely brilliant. The students assumed the image of an object on a plane mirror would form on the mirror's surface, according to the same study. Students' attitudes regarding this topic were investigated by Ayodele and Anyaegbuna (2012), who discovered the following non-scientific beliefs:

**Light as an object** - The effects of light as an object are instantaneous. Light does not travel at a constant rate. Only the source or the area of illumination is related to light. Only a source or its effects are related to light. Light is not thought to exist independently in space; therefore it is not believed to be 'travelling.' Like clouds, light bends around objects. The 'glow' surrounding a light bulb is represented by lines drawn outward from the bulb. A shadow is an object that exists independently. Light causes the shadow to be pushed away from the item and onto the wall or the ground, creating a 'dark' reflection of the object.

**Vision** - The only way to see something is to have it lit by light. The eye does not get light from the item. Something comes out of your eye when you stare at something. For the observer to see the thing, only the object and the observer must be bathed in light. The lens forms an image on the retina (picture). The brain then 'looks at' this image, which is how humans see. The only organ that can see is the eye; the brain can only think.

**Isotropic emission of light from luminous objects** - Light does not have to be conserved. It could go away or get stronger. A bulb's light only extends a set distance before stopping (or fades away). The length of time it lasts is determined by the brightness of the bulb. Smooth mirror surfaces reflect light, whereas non-shiny surfaces do not. When looking at an object through a transparent solid or liquid substance, you can see it exactly where it is.

## *The Concepts of Reflection and Refraction of Light*

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

The two laws of reflection are stated as follows by Ayodele and Anyaegbuna (2012); the incident ray, the reflected ray and the normal are all in the same plane and the angle of incidence is equal to the angle of reflection. He also 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 two important laws of refraction- The reflected ray, incident ray and the normal to the interface of the two media at the point of incidence all lie on the same plane and the ratio of the sine of the angle of refraction to the sine of the angle of incidence is a constant, which is also known as Snell's law of refraction.

## *Examining Related Empirical Research*

Akano (2018) conducted a study on how to teach refraction using a guided inquiry-based approach: An experience with college students. Teachers of science should make their scientific lectures more stimulating and student-centred by integrating science process skills such as observing, generating hypotheses, testing hypotheses, and explaining. Some of the implications of this approach to science teaching and learning include textbook authors emphasising detailed observation in practical lessons, adequate teacher preparation before practical lessons, and teachers' openness in dealing with students' questions, particularly when the teacher does not have a quick answer. This study examined the effect of a practical teaching approach on the achievement of reflection and refraction of light by senior secondary three (SS3) physics students.

Through mixed research methodology, Srisawasdi and Kroothkeaw (2014) supported students' conceptual development of light refraction through simulation-based open inquiry with dual-situated learning models. Clearly, the research found that combining a simulation-based open inquiry mechanism with a dual situated learning model of conceptual change induced students to develop in their scientific conceptual grasp of light refraction. However, this research looked into the impact of practical teaching approach on the achievement of senior secondary physics students on the concept of reflection and refraction of light. Nwankwo and Madu (2014) investigated the effects of analogy teaching on students' conceptual understanding of the concept of light refraction in physics. She developed and implemented a 20-item Physics Concept Test (PCT) to collect pertinent data from 111 physics students in Akure, Ondo State, Nigeria, utilising a pre-test and post-test design. According to the findings, using an analogous teaching model has a favourable impact on SS2 Physics students, and female students outperform their male counterparts regardless of the teaching technique utilised. Although their study focused solely on refraction and employed an analogous teaching strategy with a similar design, this current study focused on SS3 physics students in Ondo west on both the concept of reflection and refraction of light using the practical teaching approach. Tesfaye (2012) conducted an experimental study in Nigeria to see how a question-and-answer strategy affected students' understanding of basic mechanics topics. On the Mechanics Baseline Test, students who were taught using a question–answer approach with group discussion as a teaching intervention did better than students who were taught using a teacher lecture (MBT). The purpose of this study was to look into the impact of a practical teaching style on physics students' understanding of reflection and refraction of light.

Duku (2017) did research on the usage of instructional materials to enable level "100 A" students at Atebubu College of Education in Ghana understand reflection and refraction of light more conceptually. The utilisation of instructional materials to help increase students' conceptual knowledge of reflection and refraction of light was shown to be beneficial when the intervention activities were implemented. The purpose of this study was to see how a practical teaching approach affected students' understanding of the concepts of reflection and refraction of light. The present one differs from the previous one in that the locations are different: the former was held in Ghana, while the latter was held in Nigeria. Furthermore, the current concentration was on a practical teaching approach.

After reviewing the relevant literature for this research, it was clear that several studies had been undertaken to determine the best teaching approach for students' understanding of light, particularly the concepts of reflection and refraction. Despite this, students continue to struggle with understanding the concept. However, there is no published research on the effects of a practical teaching approach on the achievement of physics students in the concepts of reflection and refraction of light in Ondo west local government area, Ondo state. The current study was created to fill this void.

## METHODOLOGY

This study was a quasi-experimental design in which the purposive sampling of the SS3 students into experimental and control group was used for the study with the consent of both the school head and the participants.

**Table 1.** Rubrics for the design

| | | |
|---|---|---|
| $T_P$ | $O_1$ | $O_2$ |
| $T_T$ | $O_1$ | $O_2$ |

Symbolic representation:

$O_1$ = Observation before treatment (pre-test)

$T_P$ = Treatment using practical approach (Experimental group)

$T_T$= Treatment using traditional method (Control group)

$O_2$ = Observation after treatment (post-test)

### *Conceptual Framework*

Figure 1 is the conceptual framework that guided the design of this study. It presents the activities that were engaged in the two groups in the study, namely, the experimental group that is exposed to the practical teaching approach and the control group that was taught using the conventional method.

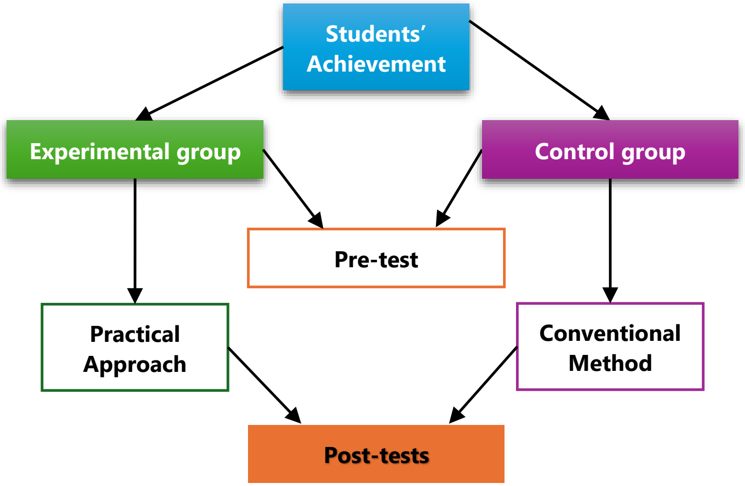


**Figure 1.** Conceptual framework (Ilomuanya & Ikusika, 2022)

### *Population*

The target population of this study is all public senior secondary class three (SS3) physics students in Ondo West local government area, Ondo State. There are 32 secondary schools in the local government area; 27 are classified as co-educational, meaning they enrol both male and female students, while 5 are designated as single-sex schools, with 2 schools exclusively for males and 3 exclusively for females.

### *Sample and sampling technique*

A purposive sampling technique was used to select four schools (A, B, C, D) which have two streams of SS3 students offering physics. In each of the schools, students were randomly selected from one intact class and a group was given the experimental treatment while the second class was given the conventional treatment. A total of 100 students were used for the study, with 50 assigned to the control group and 50 to the experimental group. Among the control group, there were 12 male students and 38 female students, while the experimental group comprised 11 male students and 39 female students.

**Table 2.** Sampling grid

| Selected schools | Control group | Experimental group |
|---|---|---|
| A | 17 | 17 |
| B | 10 | 10 |
| C | 10 | 10 |
| D | 13 | 13 |
| Total | 50 | 50 |

### *Research Instrument*

The instruments utilised in this study is the quasi-experimental design invented by Campbell and Stanley (1963) which encompasses observation, pre-test and post-test assessments. Observation was employed by the researcher to collect data on students' interactions, encompassing their questions, responses, and engagement with teachers throughout the teaching, learning, and evaluation processes. This qualitative approach provided valuable insights into the dynamics of classroom interactions and student-teacher engagement before and after the intervention. Additionally, the pre-test and post-test assessments were conducted using a Physics Concept Test (PCT), consisting of 40 multiple choice and short-question items. Specifically, 20 questions were dedicated to assessing students' understanding of reflection, while the remaining 20 focused on refraction, with both sets of questions drawn from selected topics within the senior secondary three (SS3) physics curriculum. These tests served to gauge students' comprehension and mastery of the concepts of reflection and refraction both before and after the intervention activities. The PCT was chosen as an appropriate assessment tool due to its alignment with the learning objectives and curriculum content targeted by the intervention, facilitating the measurement of changes in students' knowledge and understanding over the course of the study.

### *Validity and reliability of the instrument*

The test items and model answers were face and content validated as shown in **Table 3** to ensure that it measures what it intends to measure. To measure the consistency of the test, the test items were pre-tested to establish the reliability and internal consistency of the instrument using Cronbach Alpha and the value was calculated to be 0.77.

**Table 3.** The table of specification from which the PCT was drawn

| Content | Knowledge 40 % | Comprehension 30 % | Application 30 % | Total |
|---|---|---|---|---|
| Concept of reflection 20% | 3.2 | 2.4 | 2.4 | 8 |
| Laws of reflection 15% | 2.4 | 1.8 | 1.8 | 6 |
| Application of reflection 15% | 2.4 | 1.8 | 1.8 | 6 |
| Concept of refraction 20% | 3.2 | 2.4 | 2.4 | 8 |
| Refractive index 15 % | 2.4 | 1.8 | 1.8 | 6 |
| Application of refraction 15% | 2.4 | 1.8 | 1.8 | 6 |
| Total 100% | 16 | 12 | 12 | 40 |

### *Data Collection Procedure*

At the beginning of the study, the teachers who were involved in the study underwent training exercises to familiarise themselves with the practical approach. In selecting 40 Physics Concept Test (PCT) questions, 20 questions each for both reflection and refraction, the researcher aimed to comprehensively assess students' understanding of the concept of reflection and refraction of light. This number of questions was deemed necessary to cover a broad range of topics within the SS3 physics curriculum related to reflection and refraction. By including 20 questions for each concept, the researcher sought to ensure a balanced representation of both aspects of the topic. Additionally, the utilisation of a sufficient number of questions enhances the reliability and validity of the assessment, providing a more accurate measure of students' basic knowledge and comprehension of the subject matter.

Marks were awarded to students according to their responses during the pre-tests. The students were taught the concept of reflection and refraction of light using the practical approach for the experimental group and the conventional method for the control group for a period of two hours each. Practical activity was conducted as the major interventions implemented before the post-test exercises were done using similar 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 was made on the data and was collected using mean/ standard deviation, t-test and Pearson correlation method and thus, represented on tables for interpretation.

### *Challenges with the implementation of the treatment*

- Absence of some students' due lack of interest and conclusion of school term examination.
- Change in the agreed time by school administrators due to sport activities which encroached upon the researcher's lecture periods.
- Students' inattentiveness due to distractions from these activities.
- Lack of laboratory attendance for easy and quick access to the apparatus.

## RESULTS

To answer the research questions the researcher not only used mean and standard deviations to provide information about how closely the scores are clustered around the mean but also utilises a t-test and Pearson correlation coefficient to test the relationship in the performances and determine significance of difference of the means from the groups.

**Research question 1**: What is the effect of the use of practical teaching approach on students' achievement on the concepts of reflection of light?

**Table 4** below indicates the results of experimental and control groups on the pre-test and post-tests on the concept of reflection of light.

**Table 4.** Overall mean scores of the students on the concept of reflection of light

| | Test | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Experimental | Post-test | 50 | 13.34 | 3.474 | 0.491 |
| | Pre-test | 50 | 6.58 | 3.465 | 0.490 |
| Control | Post-test | 50 | 10.78 | 3.241 | 0.458 |
| | Pre-test | 50 | 6.36 | 3.538 | 0.500 |

Analysis of the pre-test results on the concept of reflection of light showed that the difference in mean scores between experimental and control groups were bleak (0.2). The mean score of the experimental group was slightly above that of the control group. The post test results show that the experimental group with mean (13.34) and standard deviation (3.474) performed better than their control group with mean (10.78) and standard deviation (3.241) by having a higher mean gain of 2.560 compared to 0.22 respectively. Thus, the practical teaching approach was effective.

**Hypothesis 1:** There is no significant difference between the performance of senior secondary three (SS3) physics students taught the concept of reflection of light using the practical teaching approach and those taught using the conventional method.

For the overall comparison of post-test results on reflection of light, the Pearson correlation and t-test were used to test the relationship in the performances and determine significance of difference of the means from the groups.

**Table 5.** Pearson correlation coefficient on the overall students' post-test performance on the concept of reflection of light

| | Correlations | Experimental | Control |
|---|---|---|---|
| Experimental | Pearson correlation | 1 | 0.521** |
| | Sig. (2-tailed) | | 0.000 |
| | N | 100 | 100 |
| Control | Pearson correlation | 0.521** | 1 |
| | Sig. (2-tailed) | 0.000 | |
| | N | 100 | 100 |

** Correlation is significant at the 0.01 level (2-tailed).

Table 5 shows that there was a positive high linear relationship between the experimental and control group which is statistically significant at $r_{(98)} = 0.521$, p value of (0.000) less than α value of (0.01). Thus, the null hypothesis is rejected, and the alternative hypothesis is accepted which implies that there is significant difference between the performance of senior secondary three (SS3) physics students taught the concept of reflection of light using the practical teaching approach and those taught using the conventional method.

**Table 6.** Independent samples t-test on the overall post-test scores on reflection of light

| Group | N | Mean | Std. Dev. | df | t-test | p value | Remark |
|---|---|---|---|---|---|---|---|
| | | | Independent samples test | | | | |
| Experimental | 50 | 13.34 | 3.474 | 98 | 9.743 | 0.000 | Significant |
| Control | 50 | 10.78 | 3.241 | | | | |

Table 6 is the independent t-test conducted on the overall post test score on reflection. It shows that there was a significant difference in the mean performance of both groups at $t_{(98)} = 9.743$, p value (0.000) less than α value (0.05). This certifies the decision to reject the null hypothesis.

**Research question 2**: What is the effect of the use of practical teaching approach on students' achievement on the concepts of refraction of light?

Table 7 below indicates the results of experimental and control groups on the pre-test and post-tests on the concept of refraction of light.

**Table 7.** Overall mean scores of the students on the concept of refraction of light

| | Test | N | Mean | Std. Dev. | Std. Error Mean |
|---|---|---|---|---|---|
| | | | Group statistics | | |
| Control | Post-test | 50 | 9.22 | 2.964 | 0.419 |
| | Pre-test | 50 | 6.40 | 3.104 | 0.439 |
| Experimental | Post-test | 50 | 11.62 | 3.251 | 0.460 |
| | Pre-test | 50 | 5.40 | 3.270 | 0.462 |

Analysis of the pre-test results on the concept of refraction of light showed that the difference in mean scores between experimental and control groups were bleak (0.17). The mean score of the control group was slightly above that of the experimental group. The post test results show that experimental group with mean (11.62) and standard deviation (3.251) performed better than their control group with mean (9.22) and standard deviation (2.964) by having a higher mean gain of (2.40) compared to (1.00) respectively. This implies that the practical teaching approach was effective.

**Hypothesis 2:** There is no significant difference between the performance of senior secondary three (SS3) physics students taught the concept of refraction of light using the practical teaching approach and those taught using the conventional method.

For the overall comparison of post-test results on refraction of light, the Pearson correlation and t-test were used to test the relationship in the performances and determine significance of difference of the means from the groups.

**Table 8.** Pearson correlation coefficient on the overall students' performance on the concept on refraction of light

| | Correlations | Experimental | Control |
|---|---|---|---|
| Experimental | Pearson correlation | 1 | 0.323** |
| | Sig. (2-tailed) | | 0.001 |
| | N | 100 | 100 |
| Control | Pearson correlation | 0.323** | 1 |
| | Sig. (2-tailed) | 0.001 | |
| | N | 100 | 100 |

** Correlation is significant at the 0.01 level (2-tailed).

**Table 8** shows that there was a positive moderate linear relationship between the experimental and control group which is statistically significant at $r_{(98)} = 0.323$, p value of 0.001 less than α value (0.01). Thus, the null hypothesis is rejected and the alternative hypothesis is accepted which implies that there is significant difference between the performance of senior secondary three (SS3) physics students taught the concept of reflection of light using the practical teaching approach and those taught using the conventional method.

**Table 9.** Independent samples t-test on the overall post-test scores on refraction of light

| Independent samples test | | | | | | | |
|---|---|---|---|---|---|---|---|
| Group | N | Mean | Std. Dev. | df | t-test | p value | Remark |
| Experimental | 50 | 11.62 | 3.251 | 98 | 4.646 | 0.000 | Significant |
| Control | 50 | 9.22 | 2.964 | | | | |

**Table 9** is the independent t-test conducted on the overall post test score on refraction. It shows that there was a significant difference in the performance of both groups at $t_{(98)} = 4.646$, p value of (0.000) less than α value (0.05). This confirms the decision to reject the null hypothesis.

### *Discussion of findings*

The study aimed to assess the effect of a practical teaching approach on the achievement of physics students in the concepts of reflection and refraction of light. Results showed that experimental groups consistently outperformed control groups in both pre-test and post-test phases, indicating the efficacy of the practical teaching approach. Statistical analyses, including mean performance (with mean gains of 2.560 for reflection and 2.400 for refraction), Pearson correlation ($r = 0.521$, $p < 0.01$ for reflection; $r = 0.323$, $p < 0.01$ for refraction), and independent t-tests ($t = 9.743$, $p < 0.05$ for reflection; $t = 4.646$, $p < 0.05$ for refraction), confirmed significant differences in performance between experimental and control groups. Hypothesis testing supported these findings, with null hypotheses being rejected in favour of alternative hypotheses, signifying a significant difference in performance favouring practical teaching. This is in line with previous research by Muchai (2016), who concluded that practical approaches result in higher student achievement in physics and improved attitudes towards the subject. Additionally, it supports the assertion of Usman (2016) regarding the importance of learning materials in practical teachings, as well as Bell's (2004) statement emphasising that practical work fosters both experiencing phenomena and cognitive activity. Overall, the study highlights the effectiveness of practical teaching methods in improving students' comprehension and achievement in physics education, particularly in the areas of light reflection and refraction.

## CONCLUSION

From the study, it was observed intensive practical activities have a positive influence on student's achievements in physics. It improves physics academic performance of the learner which can be achieved if the learners fully and actively participate in the practical learning process. This was confirmed from post-test results in both experimental and control groups. At the beginning of the study respondents from both groups scored low grades. By the end of the study, the experimental group improved by more than the control group. The influence of practical activities in teaching the concept of reflection and 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 reflection and refraction.

### *Recommendations*

1. The study has shown that practical approach improves knowledge, comprehension, application and performance, in the concept and improved acquisition of science process skills. It is therefore recommended that teachers should use the practical approach in the teaching of the concept because it enhances students' understanding and eventually better students' performance in the concept. In addition, the practical approach to the teaching of this concept and physics in general help to simplify complex concepts, make it real, improve skills and promote the interest of the learners.
2. It is observed that many teachers engage the students in practical activities only just a few weeks before the external examination and due to the complexity of the concept of light/ optics focus more on electricity and mechanics thereby making students not to attempt practical questions on light. I therefore recommend that teachers should endeavour to engage the students in practical activities with theories earlier before the inception of external examinations.

3. The study recommends that the school administrators and the boards of management should equip physics laboratories since the practical approach to teaching the subject demands such facilities.
4. The study also recommends employment of experienced personnel as a laboratory technician/ attendance for proper care of the equipment and accessibility.

School authorities should frequently organise workshops for physics teachers on improving their teaching methods to suit the modern trend of teaching and learning.

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