AKENTEN APPIAH- MENKA UNIVERSITY OF SKILLS TRAINING AND ENTERPRENEURIAL DEVELOPMENT

MPHIL THESIS

EFFECT OF ETHNOSCIENCE-BASED INSTRUCTIONAL APPROACH ON THE ATTITUDE, INTEREST AND ACADEMIC PERFORMANCE OF SENIOR HIGH PHYSICS STUDENTS IN TECHIMAN MUNICIPALITY

JOHN SAMPANE

JULY, 2024

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BY

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A Thesis submitted to the Department of Integrated Science Education of the Faculty of Science Education, Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development in partial fulfilment of the requirements for award of a Master of Philosophy degree in Science Education

JULY, 2024

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree at this university or elsewhere.

John Sampane

Signature: ………………………………….. Date: ……………………………

Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the Akenten Appiah- Menka University of Skills Training and Entrepreneurial Development.

Dr. Isaac Owusu-Mensah (Principal Supervisor)

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Signature: ………………………………….. Date: ……………………………

ABSTRACT

This study investigated the effects of ethnoscience-based instruction on attitude, interest and academic performance of Senior High Physics students in Techiman Municipality. Four research questions and three hypotheses guided the study. The study adopted survey and Quasi- experimental pretest-posttest control group designs. Ten (10) people were randomly selected for the interview in addition to 196 physics students randomly sampled out of 400 total physics students' population in S.H.S 2. Physics Students Academic Performance Test (PSAPT), Attitude and Interest measurement Questionnaires and Semi-structured interview guide were used to collect data for the study. The PSAPT was tested with a reliability co-efficient r=0.834. The research questions were answered descriptively where the hypotheses were tested using paired samples and Independent Sample t-tests at 0.05 level of significance. The findings revealed that; there was a statistically significant difference in attitude and interest scores of students taught Physics concepts using ethnoscience-based instruction and their counterparts taught same concepts using conventional teaching method in favour of those taught using the ethnoscience-based instruction. Also, there was a significant difference between the academic performance of students taught physics concepts using ethnoscience-based instruction and those taught same concepts using conventional teaching method in favour of those taught using the ethnoscience based instruction. The indigenes outlined some ethnoscience practices that could be adopted into teaching some physics concepts.

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DEDICATION

I dedicate this thesis to my children; Lordina, Achiaa, Idun, Fidelia and Jewel

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

CHAPTER ONE

INTRODUCTION

1.0 Overview

The concept of ethnoscience-based instruction employed in teaching various subjects especially the science related courses has been a topic of research in various parts of the world most especially in Africa and West-Africa of which Ghana is not an exception. This study focuses on the effects of ethnoscience-based instruction on attitude, interest and academic performance of senior high Physics students in Techiman Municipality. The chapter one of this study highlights the following sub-topics; overview, background of the study, problem statement, objectives of the study, research questions, research hypotheses, significance of the study, justification of the study, delimitation, limitations of the study and organisation of the study.

1.1 Background of the Study

Connecting students' activities to the curriculum, incorporating practical issues into the curriculum, and deploying examples that are applicable to students' experiences are all essential elements of a more culturally responsive approach to science education (Mensah, 2021). Natural phenomena and particular components of the universe are the focus of science (Roth & Tobin, 2019). The manner in which a society educates its populace is significantly affected by culture, as it shapes the attitudes people have toward education. As referred to ethnoscience, culture comprises the objects, beliefs, histories, information, languages, symbols, and ethics of a group of people, in addition to their family traditions (Mensah, 2021). Establishing an approach that integrates scientific theories with the daily lives of students is critical. One such method is the application of a cultural or local science framework (Fasasi, 2017).

Integrating cultural elements with students' scientific knowledge constitutes ethnoscience-based learning (Nuralita, 2020). In a nation with a dense cultural fabric, studying science under the guidance of a native scientist is the most advantageous course of action. Notwithstanding the efficacy of these innovative strategies and endeavours, the younger demographic is experiencing a deterioration in comprehension of regional sciences, which consequently results in a diminished regard for cultural traditions in their vicinity (Fasasi, 2017). In order to arouse students' interest regarding science education, it is critical to employ instructional resources and media that mirror the learners' natural surroundings (Koirala, 2023). Additionally, to beef up students' interest in Science by searching for the panacea to students dwindling interest in Science education, there is the need to consider a better instructional approach in teaching the subject (Owolab & Omoniyi, 2019). According to Hiwatig (2018), the conventional approach to science education fails to adequately prepare students for scientific endeavours by neglecting the use of indigenous science materials, which in turn have a substantial impact on students' attitudes and level of involvement. Students are educated regarding their personal and cultural experiences, knowledge capacities, and previous accomplishments through the ethnoscience method.

In science education, ethnoscience is a method that emulates cultural aspects. African ethnoscience comprises a wide range of artifacts, concepts, and convictions that have their origins in the African environment. It is deeply ingrained in the people's historical and modern traditions, encompassing mythology, superstitions, and beliefs (Mensah, 2021). Local science and cultural activities should be incorporated into the science curriculum in order to pique students' interest in and proficiency with science subjects. This methodology entails the integration of science education with a regional understanding and indigenous knowledge that is particular to the students' region of living (Sudarmin et al., 2019). The existing approach to science education has resulted in insufficient development of concepts among beginning learners, a problem that endures throughout their academic careers, as indicated by their academic achievement in science-related courses and their enthusiasm for the subject (Sudarmin et al., 2019). Udofia (2019) observed that in the following ways, integrating science instruction into students' daily lives enriches and broadens the learning process: Enhancements in students' subject comprehension and creativity; facilitation of the connection between theory and practice; serving as an intermediary between the classroom and real-world scenarios. The conceptual essence associated with science is diminished.

The scientific field of physics investigates natural phenomena and interactions that have a significant impact on society (Novika & Fajar, 2016). This subject has attracted considerable scholarly interest due to historically consistent low enrollment rates. The subject has encountered student censure and is regarded as one of the least successful scientific disciplines on a global scale, especially in Ghana and Africa (Kola, 2017; Guido, 2013; Maguswi, 2011). The persistent substandard academic performance of science students and the inadequate enrollment rates, specifically in the field of physics, infuriate educators in Africa. A detrimental disposition among students has been observed towards the discipline, which ranks among the lowestperforming scientific fields worldwide, including Ghana and Africa (Guido, 2013; Kola, 2017).

A multitude of factors have been identified by researchers as contributing to the persistent apathy, negative disposition, and subpar academic achievement in the field of Physics. These factors encompass learners' challenges in effectively engaging with unfamiliar learning environments and materials, learners' negative perceptions of Physics, and educators' ineffective pedagogical approaches (Chongo & Baliga, 2019). To tackle the matter at hand, African leaders in the realm of science education have proposed pedagogical approaches that integrate the cultural heritage, natural surroundings, and way of life of the African people. Ethnoscience is one such approach. Regarding this topic, ethnoscience refers to the notions, materials, and beliefs that originated in Africa and are rooted in the people's historical and modern traditions; they have been shaped by mythology, supernatural forces, and ongoing acculturation. The potential consequences of incorporating ethnoscientific concepts, theories, and paradigms into conventional science education merit additional research. The ethnoscientific teaching approach is implemented in accordance with the United Nations Educational, Scientific and Cultural Organisation (UNESCO)-described 1991 Science for All Movement's recommendations for science education;

a. The principles, objectives, and daily experiences of the students ought to inform the curriculum's language, symbols, designs, and overall meaning.
b. theory should be connected to practice, human purpose, quality of life, and experiences both within and outside of school, and
c. the integration of theory with practical application, relevance to the human condition, life satisfaction, and extracurricular experiences is essential.

In conclusion, the rationale behind this study is to check whether or not the indigenes have ethnoscience practices which can be incorporated into teaching Physics and to find out whether ethnoscience-based instructional approach used to teach Physics concepts has effect on attitude, interest and academic performance of students.

1.2 Statement of the Problem

The achievement, mentality, and excitement of students in the field of science have become a subject of concern on a global scale. In Africa, atrocities in scientific involvement, mental state, and achievement predominate in comparison to other continents across the globe. According to Kola (2017), Physics has traditionally been an area in which student achievement has lagged short of initial expectations. Europe and other western continents, according to Kola (2017), performs best in the field of Physics. In contrast, Africa has the lowest performance. Kola, (2017) documented an absence of female students enrolled in physics courses, with their academic performance lagging that of males. According to Kola (2017), science education in Africa frequently engenders a sense of alienation among its citizens within their own scholarly milieu. It has been noted by him that the science curriculum, which is widely utilised by adults and children alike, fails to sufficiently incorporate teaching methods and materials that reflect African culture. Guido, (2013) adeptly grasped the situation by asserting that "both African society and its youth are currently beset by ambivalence." According to him, African children are nurtured exclusively in an African cultural and environmental context from the age of zero to five. They are exposed to a different form of education as they progress through school, which is in contrast to their early upbringing. They underwent a complete transition from one learning environment to another after being born in one. Nigerian secondary schools have experienced a notable deficiency in students' comprehension of scientific concepts due to a substantial absence of students enrolling in science courses (Eze, 2005). It has been argued that current science pedagogical approaches in Nigeria fail to establish a coherent link between newly acquired knowledge and the preexisting knowledge of the students.

According to scholarly investigations, Zambian students struggle to comprehend and exhibit little enthusiasm for science as a result of a disconnection between the subject matter and their everyday lives and the educational approach to science (Halubova, 2015). Based on the prescribed teaching methods, he believes that the Teacher Education Diploma Syllabus for Physics in Zambia does not include a method that takes into consideration learners' culture as prior knowledge for studying school physics. According to Mensah (2021), the instructional methods employed to teach physics to disadvantaged students in Ghana are the primary cause of their lack of interest and academic achievement in the subject. If a student fails to comprehend the subject matter despite our instructional approaches, it is possible that we could modify our methodology to correspond with their preferred learning style. The absence of recognition or incorporation of Ethnoscience-based Instruction in the authoritative frameworks governing Teacher Education in Africa, and Ghana in particular, is manifest. Furthermore, its application in the classroom as a means to improve student achievement, cultivate favorable dispositions, and arouse students' curiosity regarding the subject is uncommon. Conversely, it is considered an additional measure.

Many researches have been conducted in relation to student affairs in Techiman. Some of which incudes but not limited to: Sexual harassment against Female students in Senior High Schools in Techiman Municipality of Bono East Region (Muhammad 2017), Formative assessment Conceptions and Practices of Junior High School Social studies teachers in the Techiman municipality of Ghana (Ochour & Opoku-Afriyie, 2022) and Relationship Between Deficit Needs and Academic Performance of Senior High School Students in the Techiman North District (Acheampong, 2019). It is obvious, the application of Ethnoscience-Based Instruction in formal Physics education to increase students' interest, academic performance and positive attitude development toward Physics has been the subject of scant research in Techiman Municipality. This necessitates the study entitled "Effect of ethnoscience-based instruction on interest, attitude and academic performance of physics students in selected senior high schools in Techiman Municipality".

1.3.1 Objectives of the Study

The objectives of the study have been treated under general and specific objectives.

1.3.1 General Objective

The main objective of the study was to assess the effects of ethnoscience-based instructional approach on the interest, attitude and academic performance of physics students in senior high schools.

1.3.2 Specific Objectives

The objectives of the study were to;

1. identify some of the ethnoscience practices that have relevance on the teaching of physics.

2. assess whether there is a difference in attitudes between students taught Physics concepts using ethnoscience-based teaching and students taught same concepts using the conventional teaching approach.
3. assess whether there is a difference in interest between students taught Physics concepts using ethnoscience-based teaching and students taught same concepts using the conventional teaching approach.
4. assess the effects of ethnoscience-based teaching on the academic performance of Physics students.

1.4 Research Questions

The following research questions were formulated to guide the study;

1. What are some of the Ethnoscience practices that have relevance on the teaching of Physics in Techiman Municipality?
2. What is the difference in attitudes between students taught Physics concepts using ethnoscience-based teaching and students taught same concepts using the conventional teaching approach?
3. What is the difference in interest between students taught Physics concepts using ethnoscience-based teaching and students taught same concepts using the conventional teaching method?
4. What is the effect of ethnoscience-based teaching approach on the academic performance of Physics students?

1.5 Research Hypotheses

The following hypotheses were formulated for testing at 0.05 level of significance.

Ho1: There is no significant difference in the attitude scores of students taught Physics concepts using ethnoscience-based instruction and those taught same concept using conventional teaching methods;

Ho2: There is no significant difference in the interest scores of students taught Physics concepts using ethnoscience-based instruction and those taught same concepts using conventional teaching methods;

Ho3: There is no significant difference between the academic performance scores of experimental groups taught using ethnoscience-based instruction and the control group taught using conventional methods.

1.6 Significance of the Study

This study will provide information on the extent to which an ethnoscience-based instructional approach has impacted on the attitude, interest and academic performance of Senior High Physics Students. This will inform the policy makers of the education ministry and curriculum developers on the need for an ethnoscience-based curriculum and instruction. The study will make the understanding of physics topics easy for students and also increase the interest of students in the subject. Again, the study will discover new ways of teaching physics topics making the teaching of the subject simple and easy for teachers.

1.7 Justification of the Study

This study will apprise curriculum developers and policymakers of the education ministry of the necessity for instruction and curriculum grounded in ethnoscience. The investigation will enhance students' comprehension of physics concepts and pique their interest in the field. Once more, the research will uncover novel approaches to instructing physics subjects in a manner that simplifies and streamlines the task for educators.

This research endeavour is poised to instigate a significant revolution that will introduce a revolutionary aspect to curriculum innovation. By providing curriculum planners with insights on syllabus design and suggested pedagogical approaches, the study may necessitate a reassessment of the existing science curriculum in order to integrate fundamental ethno-scientific paradigms, theories, and concepts into the physics curriculum.

Ultimately, this research endeavour will generate knowledge regarding the efficacy of indigenous models in facilitating cognitive reorientation among children. That is to say, the research will investigate the degree to which ethnoscience-based instruction can facilitate the resolution of differences and disagreements between European and African cultures. As a result, this research endeavour shall establish a connection between the African child and science oriented toward the West, while preventing the development of any cognitive imbalance.

1.8 Delimitation

This investigation was restricted to the Techiman Municipality, located in the Bono East Region of Ghana, due to the utilisation of students who were acquainted with one another's surroundings. Additionally, the Techiman Municipality was selected due to the researcher's residence and place of employment in the vicinity. By conducting the study in this municipality, the researcher was able to routinely oversee and monitor the experiment. Additionally, the research was limited to the field of physics, which is notably underrepresented among the scientific courses taken by senior high school students.

A subset of physics topics was utilised for the investigation; specifically, only three topics were selected for the study. These consist of frictional force, motion under the influence of gravitation, and heat transfer modes including conduction, radiation, and convection. This is due to time constraints and once more, the fact that the subjects involve substantial culturally grounded concepts.

1.9 Limitations of the Study

The following constraints prevent the generalisation of this study's results:

1. The study was conducted within a municipality consisting of six senior high schools, enrolling 400 students who were enrolled in elective physics courses. The sample size of 196 and the four designated senior high schools constitute a significant underrepresentation of the total number of senior high schools in the municipality and the region at large. Therefore, the generalisability of the results of this study is somewhat constrained.
2. The predominant languages, cultures, and traditions of the Akan people are those of Techiman Municipality, where the research was carried out. Nevertheless, a subset of the study's participants (students from the chosen institutions) had to travel considerable distances to attend Techiman Senior High School. Certain pupils in this group adhere to ethnoscience practices that deviate from the prevailing local culture of the municipality in which the research was carried out. The subjects who are less affected by the

ethnoscience approach present a challenge in terms of extrapolating the research findings to a broader context.

3. The absence of an exact English translation for certain indigenous terms and items compelled the researcher to at times employ the native tongue in order to elucidate concepts.
4. Certain students were unable to finish the examination within the allotted time of thirty minutes to complete the items. This affected their performance as well.
5. A number of students voluntarily withdrew from class on the day of the sampling. Thus, the sample size utilised in the study was altered.

1.10 Organisation of the Study

The research was divided into five chapters. The initial chapter will comprise the following: Overview, Statement of the Problem, study's objectives, research questions, Delimitation, significance of the study, limitations of study and Organisation of the study. The second chapter dealt with the literature review pertinent to the study. In Chapter 3, the methodology that was utilised for this investigation was described. Chapter Four consisted of an analysis and discussion of the study's findings. Finally, the Chapter Five encompassed the study's summary, conclusion, recommendations and areas of further research.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

The literature was classified into three overarching domains: conceptual review, empirical review, and theoretical review. The domains of the review are presented as follows;

2.1 Conceptual Review

The researcher reviewed literature on various ways of making the concept of Science, Physics inclusive more understandable to learners as identified by earlier researchers.

2.1.1 Teaching of Science

Science is a human endeavour in which man investigates the environment for his own benefit. It forms the foundation for contemporary technological progress. Science is of paramount importance in both the technological and scientific advancements of a nation and the lives of its citizens (Alebiosu & Ifamuyiwa, 2018). It is widely and generally acknowledged that scientific literacy, which can only be attained through science education, is the key to a nation's technological and scientific survival (Olajiwola, 2020). Peni, (2016) aptly characterised the status of science in all societies by asserting that we live in a globalised era where science and technology have become indispensable components of cultural life; any nation that fails to recognise this fundamental fact does so at its own peril. As is customary, scientific principles are commonly implemented in the daily lives of individuals across all societies (Obidi, 2015). Cultural practices such as feeding, transportation, cookery, bride selection, viable seed selection for the subsequent planting season, catapulting, and so forth are influenced by these principles (Peni, 2017). Nevertheless, within African society as a whole and Ghanaian societies specifically, these practices were utilised by individuals to address problems; the scientific principles underlying them were never investigated. Africans experienced a period of intellectual "bankruptcy" as a result. As a result of the imperative to rectify this circumstance, science was incorporated into the academic curriculum. Since the 1800s, science education in Ghana has existed. It was originally designated Natural Study and Hygiene. Subsequently, it underwent a transformation into the field of natural science, and subsequently into integrated science, agriculture, chemistry, and physics.

Basic science encompasses fundamental instruction in the scientific proficiencies necessary for sustainable development, human survival, and societal progress (Dung & Udofia, 2010). Therefore, the thematic elements of Basic Science mirror the learner's connection to the environment and the fundamental concepts that need to be mastered. For instance, "You and Technology." The objective of this initiative was to familiarize students with the development of scientific and technological proficiencies that would empower them to make well-informed decisions, devise effective survival strategies, and contribute to and live harmoniously in the global community (Dung & Udofia, 2010). By considering the aforementioned goals, it becomes evident that the fundamental purpose of science education is to foster in children an inquisitive spirit that empowers them to perceive their surroundings through a scientific lens. A child who possesses scientific literacy should be capable of elucidating specific natural phenomena and indigenous practices that manifest in their immediate surroundings. As of now, the achievement of the aforementioned curricular goal remains distant.

2.1.2 Contemporary Teaching Strategies in Science

To instruct, as defined by Hornby (2006), is to facilitate the acquisition of knowledge by providing individuals with relevant information. Teaching, according to Agbulu and Idu (2008), is the discipline of an expert imparting classified information to the recipients. Bunkure (2013), defined teaching as the purposeful interaction among the three components—the instructor, the student, and the instructional materials—to guarantee that students benefit from the process of learning. Thus, it is evident from the definition above that teaching entails the imparting of expertise-based knowledge to the student.

According to Gero and Ogunnade (2012), a variety of instructional approaches are utilised. The methods emphasised by the instructors range from the conventional teacher-centered approach to more modern approaches including discovery, computer-assisted, demonstration, and experimental methods. Instructors are required to select from a diverse array of pedagogical strategies in order to achieve their intended learning outcomes. This is due to the fact that, as stated by Obeka (2010), the instructional approach can have a significant impact on the academic achievement and subject retention of students. Thus, Olukemi and Agoh (2012), suggested that when selecting teaching methods, instructors must consider the age and background of the students, the subject matter to be covered, the time of day, the size of the class, and the resources at their disposal. An examination of several current pedagogical approaches implemented in Ghanaian classrooms is provided below.

Lecture method, otherwise known as expository, teacher centered or traditional method, is the teaching technique in which one person, usually the teacher, presents a spoken discourse on a particular subject to students or an audience (Atadoga & Onaolapo, 2008; Vikas, Prerna, Mushtaq, & Virendra, 2010). Lecture is used to elaborate, simplify, clarify and discuss new materials to learners. The materials may include facts or views on issues or problems related to the learner. Effectiveness of lecture method depends on the type of students, circumstances of the class, the subject, educational purpose, and teachers‟ own characteristics and skills (Bunkure, 2013). Adesoji (2009) observed that educators have accepted lecture method as a proper way of imparting knowledge. He observed that at least eighty percent (80%) of scientific information or principles are passed on to students through lecture method. (Adesoji, 2009) observed that our educational system puts so much premium on external examinations. Thus lecture method helps a science teacher to cover a large amount of material (syllabus) to a larger class size in a very short period. This is, however, a detriment to student learning, but the teacher may not have a choice being driven by the pressure to cover the syllabus and thus, prepare students for the external examination, which is the only qualifying measure to the next level or employment.

Lecture method places the authority of the subject matter and the control of the student behaviour on the teacher; making the learners redundant with limited opportunities to express their problems, conflicts, needs, etc. It is difficult to know if the teacher is being understood, there is little chance of correcting students' misgivings and thus the students are alienated (Kilickaya, 2007). Some other draw backs of lecture methods are enumerated thus:

1. Meaningful learning of science is never promoted as it appeals to only the sense of hearing. Similarly, students are not inspired as to indulge in independent thinking and self-exploration processes;

2. Disregard for the various ability categories that are present in a given class is evident. Consequently, those pupils who would benefit greatly from manipulating or managing instructional materials are entirely excluded. This may cause frustration among the students in question.
3. Students find it distressing to sit still while simultaneously listening and writing for extended periods of time. It may result in disruption of regular classroom procedures and restlessness.
4. The talk and chalk (lecture) method promotes memorisation rather than substantive comprehension. The comprehension of students is frequently transient, thereby impeding the intended retention.

Numerous studies have been undertaken to evaluate the efficacy of the lecture method. Nevertheless, the method's limitations have been consistently exposed by the outcomes of these investigations. Olorukooba, (2007) conducted a comparative analysis of the Lecture Method and Computer Aided Instruction (CAI). A noteworthy disparity was observed in the academic achievement and subject retention of pupils who were exposed to CAI, according to their findings. In a similar vein, a study conducted by Ademiluyi and Musa (2024) contrasted the traditional teaching method (lecture method) with the peer tutoring teaching approach and discovered a statistically significant advantage for the subjects taught via the peer tutoring approach. However, alternative studies propose expanding the teaching approach to encompass more advanced levels (Vikas et al, 2010). In an effort to improve academic retention and performance, scholars have investigated various strategies that may be utilized to elevate the academic standing of students.

As a result, numerous instructional approaches were devised to supplement and/or substitute the lecture method. A number of the pedagogical approaches are utilised, such as computer-assisted instruction (CAI), guided discovery, and problem-solving. While these approaches have received praise from scholars for facilitating the achievement of educational goals (e.g., academic achievement) (Olorukooba, 2007; Vikas, et al 2010; Bunkure, 2008; Bimbola & Oludipe, 2010), it is indisputable that these approaches contain foreign elements that may cause students to feel inferior. Their academic performance may be adversely affected by this (Okwelle & Wali, 2011). This is due to the fact that Africans have been socialized since colonization to perceive European cultures as superior and African cultures as inferior. Academic performance in science continues to decline as a result of this inferiority complex (Okwelle & Wali, 2011). The preponderance of western perspectives and methodologies in science education has been the cause of this John, (2004). Students struggle to comprehend science and establish its relevance to their everyday experiences as a result.

According to Fasehun (2012), the Nigerian education system has neglected indigenous education in its pursuit of scientific advancement. She reached the conclusion that this resulted in numerous societal issues, including corruption and examination malpractices, among others. This situation is not peculiar to African or Nigerian students only; as Matthews and Smith (2006) reported a study that revealed the low performance of Native American students, as measured by standardised tests. Among the many factors cited as contributing to the poor academic performance was the absence of culturally relevant curriculum materials incorporated into their lessons. Native American students in Bureau of Indian Affairs schools for Grades 4–8 who were instructed in science utilising culturally relevant materials demonstrated significantly higher academic achievement and a significantly more favourable attitude toward Native Americans and science than comparable students who were not exposed to such materials (pre-post test control group design). They recommended that educators instructing Native American science utilise materials that make frequent reference to the culture of western science and Native American culture (Matthews & Smith, 2006). Regarding this lack of scientific literacy and advancement, Fashiku (2008) cited Guru Maharaji lamenting the state of affairs as follows: in our current predicament, an individual is rendered powerless; if one were to strip him of his cultural heritage. We are incapable of producing or undertaking any action beyond adhering to European theories and philosophies. We are therefore creatively impoverished. Therefore, Africans should not neglect that to be educated is not to be Eurocentric, according to Fasehun, (2012).

She emphasized the need for complete integration and harmony between formal and traditional education in order to ensure that both educators and students are well-informed about every aspect of the world. In a similar vein, Fleer, (2003) posits that learning outcomes in Africa can be substantially improved by incorporating indigenous cultural practices alongside western science, as opposed to exclusively depending on western science. Additionally, he provided support for his position by referencing Cobern (1996), who argues that science educators must be cognisant of the culturally rooted, foundational beliefs that students bring to the classroom and how these beliefs are reinforced by the students' cultures. According to Cobern, the success of science education is contingent upon how well science can establish itself within the cognitive and socio-cultural context of the students. According to Fakudze

(2004), constructivists recognise that all learning occurs in a social environment and is mediated by the culture of the learners. The function of the social context is to support the learner, offer guidance, and encourage the generation of new knowledge. The speaker placed great emphasis on the profound influence that socio-cultural context has on the pedagogy and acquisition of scientific knowledge, underscoring its pivotal function in forging a solid foundation for scholastic achievement. Veal (2001) suggested that Africans should enhance their development and communication of science by decreasing reliance on Western research to avoid being used for economic exploitation. The request for universal access to science has prompted this. This is what Africans must do.

2.1.3 Science and Culture

As defined by Nakpodia (2010), culture is an all-encompassing concept that comprises knowledge, beliefs, arts, morality, conventions, and other competencies that are acquired by members of a given society. The culture of a given society is the result of its way of life being shaped by the prevailing circumstances and environment. This definition encompasses the extensive phenomenon known as enculturation. Enculturation refers to the systematic introduction of a youthful and unseasoned person to the societal norms, customs, and way of life. Culture comprises the enduring modifications that occur as a result of intergenerational transmission of the behaviours, values, and beliefs of a given social group (Nwegbu, Eze, & Asogwa, 2011). Scholars have established a correlation between culture and its impact on human development and growth, as well as the influence of socioeconomic and social class on children's learning, according to Nakpodia (2010). Understanding existing knowledge, interpreting information, comparing known facts to new experiences, and resolving inconsistencies between existing knowledge and new information are all components of science education, according to Igbokwe (2010). A discernible disparity exists in scientific education across Africa as a result of the influence of cultural concepts. A perceived dichotomy exists between the everyday experiences of students and the domain of science in Africa. As a follow-up to Igbokwe (2010), Adenyi (1987) argues that scientific explanation is not widely integrated into African society, particularly in Nigeria. In contrast, the mechanisms of malevolent spirits and the power of witchcraft serve to elucidate natural phenomena. The African child may hold the cultural belief that an infant who does not wail at birth is not complete.

2.1.4 Some Ethnoscience Practices of Scientific Relevance

The ethnoscientific significance of ethnoscience practices in Ghana and the surrounding approximately Four Hundred and Fifty-nine million inhabitants of West Africa. A diverse array of cultural heritage exists that holds scientific significance. In this geographical region, the subsequent exercises may be implemented to elucidate specific scientific principles. The practices are represented in the table 2.1 below.

Table 2.1: List of Ethnoscience Practices with Scientific Relevance

Ethnoscience practice	Area of scientific relevance
Addition of potash into sour soup	Neutralisation reaction
Addition of nails into pots when cooking animal skin	Catalysis
Fishermen floating on calabash	Density
Slicing of meat to enhance faster drying	Density
Soap making	Saponification
Addition of ash into pit latrine	Neutralisation reaction

2.1.5 Ethnoscience and Science Teaching and Learning

Ethnoscience, alternatively referred to as culturally pertinent science or indigenous knowledge, comprises the unique insights and understandings that are specific to a given civilisation, culture, and geographical area. It has been defined as group-specific cultural practices that are either directly associated with science or can be defined scientifically. Their expertise in botanicals, self-care practices, and categorisation methods are all included (Sutherland & Dennick, 2017; Hayatu, 2015).

The notion and discipline of ethnoscience originated within the realm of anthropological theory in the 1960s. Indigenous knowledge, colloquially referred to as "indigenous knowledge," presents an approach grounded in the indigenous peoples' perspectives. The intricate correlation between a culture and its surroundings is the subject of ethnological inquiry (Abonyi, 2018). Indigenous knowledge, which is alternatively referred to as ethnoscience, encompasses the understanding and information that native inhabitants employ to survive within a particular environment (Jerie & Matanga, 2017). This concept is referred to by a number of terms within the field of sustainable development, including rural knowledge, indigenous technical knowledge, and traditional environmental knowledge. The body of knowledge is distinguished by its capacity for innovation, creativity, and experimentation in order to accommodate changing circumstances.

The integration of ethnoscience with knowledge-based science and technology has the potential to augment scientific and technological pursuits by addressing challenges associated with the comprehension of scientific concepts. Udofia (2019) observed that in the following ways, integrating science instruction into students' daily lives enriches and broadens the learning process: Enhancement of students' comprehension and creativity, facilitation of the connection between theory and practice, serving as an intermediary between the classroom and practical applications, and reduction of the abstract quality associated with scientific concepts (Udofia, 2019).

2.1.6 Ethnoscience Instruction

a. In order to improve comprehension, George (1999) criteria for ethnoscience instruction include a methodical evaluation of prior cultural beliefs and ideas held by the students in relation to the scientific concept being taught. Based on the Science for All Movement's 1991 UNESCO-outlined proposals for teaching science, the ethnoscientific teaching approach is implemented; the curriculum's content, language, symbols, designs, and purpose should be relevant to the students' daily lives and goals.

b. Incorporating theory into practice, human intention, quality of life, and experiences both inside and outside of the classroom is essential. Education ought to commence by recognising and expanding upon students' thoughts, passions, and aptitudes for learning in order to augment and perfect their competencies and understanding (Hiwatig, 2018).

c. The Culture Responsive Curriculum for Indigenous People (CCIP) was developed in the Philippines in response to local circumstances. This initiative subsequently inspired the conception and implementation of the Third Elementary Education Project (TEEP). The research emphasised the significance of incorporating local elements and culture into the curriculum in order to foster a connection between learning and comprehension (Fassasi, 2017). Curriculum, fundamental instructional objectives, and evaluation methodology for ethnoscience training are strikingly similar to those of the modified lecture method. Educators in the ethnoscience instruction group foster connections between scientific concepts being taught and supplementary information derived from local beliefs and proverbs. In addition, they solicit additional student input and encourage them to develop their own perspectives on the concepts. Students shall be granted access to supplementary educational materials that embody indigenous customs and concepts.

2.1.7 Indigenous Students' Attitudes towards Science

To what extent does ethnoscience education (EI) influence the attitudes of students toward science? It is crucial because a number of academicians believe that students' attitudes toward science may be influenced by their beliefs and values concerning a particular object or circumstance. The relationship between Emotional Intelligence (EI), academic achievement, and enthusiasm for science was investigated by Fasasi (2017). Students who were instructed through EI demonstrated greater academic achievement and greater interest in science, according to the study, in comparison to those who were instructed through the lecture method. Participating in the research were American Indians. He recommends incorporating ethnoscience instruction into science curricula for students. What effect would it have on the attitude of students toward science? The subject of attitudes toward science education has been extensively examined in the literature, inspiring a multitude of research studies. Diverse perspectives on analysing students' attitudes toward science are outlined by Fasasi, (2017):

The following is discussed: the attitudes of students towards science as a discipline and as a school subject; the correlation between attitudes towards science and various instructional strategies; the connection between attitudes towards science in general and specific areas of school science; the correlation between attitudes towards science and student achievement; the impact of teachers' conduct on students' attitudes towards science. The correlation between science-related attitudes and extracurricular variables, including but not limited to age, gender, ethnicity, and grade level.

As a result, it is necessary to examine the relationship between training in ethnoscience and attitudes toward science. The significance of school geographic location has been examined in only a limited number of research papers that examine the variables that impact academic achievement. The disparity between urban and rural student populations, as well as the contrasting circumstances for students acclimated to Western thought, renders the choice of school location an attractive moderator variable. According to Bandele and Ogunmakin (2019), as well as Behrman (2019), the academic achievements of students are notably impacted by the attributes of the school. Distinction has been identified between rural and metropolitan educational institutions. In contrast to metropolitan areas, which have a high population density, rural regions have a low population density. The norm for rural institutions is to have smaller class sizes than their urban counterparts. According to research, academic achievement is substantially impacted by family history-related variables. The parental level of education is a determinant. Scholarly investigations suggest that children whose parents have attained advanced degrees tend to perform better academically than those whose parents have lower levels of education (Woßmann, 2010). In contrast to urban areas, a greater proportion of students reside in rural regions with parents possessing a comparatively lower educational attainment. In light of these concerns, this research examines the influence of school location and Parental Educational Status (PES) as moderating variables.

2.1.8 Students' Attitude and Academic Performance in Science

Attitude was defined by Akinbobola and Ikitde (2018) as a collection of beliefs and ideas that have the capacity to impact the conduct of an individual. Thompson defines attitude as a perspective, way of reasoning or behaviour that manifests an individual's mindset (Peni, 2018). Attitudes are associated with ones' beliefs and opinions, which have the potential to impact one's behaviour in particular ways. In essence, the aforementioned definitions imply that attitude is comprised of both cognitive and affective elements. According to Sola and Ojo (2017), attitudes significantly influence whether students embrace or reject particular situations. Learning and behaviour are both influenced by attitudes, as demonstrated by Muhammad's 2017 study's Kay. Significant indicators of successful learning are attitudes. (Akimbobola & Ikitde) 2018. Learning and academic achievement are profoundly influenced by a child's attitude. An offspring who cultivates a positive rapport with educators and derives pleasure from academic pursuits is more inclined to attain academic success and operate with greater productivity. The attitude associated with science has an effect on the academic achievement of students in the field of science.

Lakpini (2012) investigated the significance of self-perception and attitude in forecasting the academic achievement of collegiate students in Basic Science. Significant correlations were found between performance and high self-esteem, the perceived applicability of science, and contempt for the discipline, according to statistical analysis. Adesoji (2018) and Mcphee and Maria (2018) discovered that students' academic achievement in the subject was strongly correlated with their positive attitudes toward science. Adesoji (2018) raises an issue regarding the tendency of Nigerian students to develop a deteriorating attitude towards the Basic Sciences, specifically biology, chemistry, physics, and mathematics. It has been discovered by researchers that students harbor negative attitudes toward science and fields associated with it. According to Eze and Bunkure (2015), children have an ambivalent view of science. Certain students harbor preconceived notions regarding their capacity to comprehend scientific concepts and have even disseminated fallacies regarding the intricacy of the subject, potentially deterring others (Sola & Ojo, 2017). In addition, these perspectives have affected the way in which students perceive the study of science. It was underscored by him that a significant proportion of students perceive certain scientific concepts as difficult, thereby influencing their scholastic achievements (Akinbobola & Ikitde, 2018). Both Strutevant (1984) and Akinbobola and Ikitde (2018) concurred that the available evidence suggests attitudes are acquired rather than inherited, and thus can be modified through the use of diverse persuasion techniques. A multitude of factors, including prior experiences and societal influences, may exert an influence on the attitude of an individual (Akinbobola & Ikitde, 2018). Regarding science, attitudes may be shaped by particular science courses, prior scientific experiences, science instructors, and other pertinent factors. The attitude of a pupil towards science is of the utmost importance.

Strutevant, (1984) discovered that the declining interest of American students in science is a direct result of the instructional strategies employed by their instructors. Optimal performance is profoundly influenced by one's perspective on science. An association has been established between favourable dispositions towards science and enhanced scientific achievement, as Akinbobola and Ikitde (2018) provide. Not only academic achievement but also a student's attitude toward science can be significantly impacted by prior scientific experiences. Research findings have indicated that exposure to scientific knowledge can impact attitudes towards the field, with the extent of change being significantly influenced by the caliber of that exposure (Strutevant, 1984). A variety of factors, including peer pressure and domestic environment, may impact the attitudes of students. Negligent regulation of the impact that a peer group has on students' attitudes can result in a transformation of their dispositions toward any subject, including science. According to Ogunsola & Bandele (2019), the socioeconomic status of the parents has an impact on the selection of topics; for example, parents with higher levels of education are more inclined to encourage their children to pursue scientific disciplines. It is expected that the familiar environment in which a child develops will have an influence on their perspective and stance towards science. An additional societal effect that influences enrollment and attitudes toward science is gender stereotyping (Ogunsola & Bandele, 2019).

In several Nigerian communities, science is predominantly associated with males and females are discouraged from pursuing it. Certain behaviours are considered atypical by males but considered typical by females. Social perceptions of conventional and unconventional gender roles have an effect on the attitudes and participation of women in the scientific community. As defined by Akanbi (2014), gender role issues, stereotyping, gender division of labour, discrimination, glass walling, and slick floors have a substantial effect on female participation in science. The female student's academic performance in the field of science may be negatively impacted by issues such as shyness, low self-esteem, negative self-perception, and lack of initiative

(Ogunsola & Bandele, 2020). Ogunsola & Bandele observed that science is influenced by mathematics. According to her, the majority of women would prefer to evade mathematical elements (Ogunsola & Bandele, 2020; Olayiwola, 2020). It is common for young women to misjudge the capabilities of males and consider them to be superior (Anthonia, 2000). Scholars including Ogunsola & Bandele (2020) and Chimezie (2021) have observed that while females initially exhibit a positive disposition and enthusiasm towards science, this enthusiasm gradually diminishes as they advance through the academic curriculum. This transition took place due to the limited exposure that individuals have to science-related activities that resonate with their interests. Chimezie, (2019) underscored the importance of employing instructional materials and efficacious strategies to augment the engagement of young females in science, specifically when introduced via hands-on manipulative toys that are relevant to their everyday routines. The study conducted by Achor, Imoko, and Uloko (2019) investigated the effects of the Ethno-Mathematical Teaching Approach (ETA) on senior secondary students' academic achievement and retention locus. The findings of the research indicated that pupils who received instruction through the ETA method exhibited superior retention in comparison to those who were instructed using the conventional approach.

The superior performance of the ETA-taught group was ascribed to their adeptness in synthesising their indigenous knowledge and prior experience with the novel concepts they acquired. According to Chiansom et al (2018), student retention is enhanced through the use of innovative instructional strategies. According to the findings of Achor, Imoko, and Uloko (2019), the teaching method has an impact on both academic achievement and the propensity to persist in science and mathematics courses. The impact of ethnoscience-enriched education on students' academic performance, attitude, and retention of Basic Science topics in mathematics was examined by Achor, Imoko, and Uloko, (2019).

2.1.9 Parental Education Level and Students’ Attitudes towards Science

The impact of parental influence on an individual's learning attitude has been acknowledged (Oluwatelure, 2019). Parent Education Level is a metric that quantifies the parents' level of education. Parental Education Status (PES) is considered a stable component of socioeconomic status (SES), according to Fasasi (2017), because it is typically established early in life and tends to endure. According to Fasasi (2017), this factor significantly affects the academic performance of students as well as their attitude toward science. In light of Fasasi's (2017) assertion that parental education level influences academic performance and attitude towards a particular subject, it is critical to examine the influence of parental education level on students' attitudes towards science. The attitude of the learner, according to Lakpini (2012), plays a substantial role in determining whether they are attracted to or repulsed by science. A positive attitude toward science is likely to result in consistent and enhanced academic performance, according to Fasasi, (2017). Academic achievement is positively correlated with students' attitudes toward science, according to Osborne, (2018).

2.1.10 School Location and Students’ Science Learning

Research examining the effect of school location on scientific learning outcomes has produced contradictory results. According to the findings of Fasasi (2017), there was a notable disparity in verbal aptitude, English language proficiency, and overall score on the American National Common Entrance Examination between students hailing from rural and urban areas. Children in urban areas of Nigeria performed better in terms of environmental education, according to Akintunde (2004). On the contrary, Kannapel and Deyoung (1999) put forth an alternative viewpoint grounded in their research carried out in the United States. What is the impact of school location on students' scientific attitudes, specifically in regard to the notion that metropolitan areas possess a more diverse cultural milieu than rural areas?

2.2 Theoretical Review

Thus, two theories formed the basis of the research: Ausubel's (1972) theory of meaningful learning and Haskell's (2001) theory of transfer of learning.

2.2.1 Haskell’s Transfer of Learning Theory

According to the theory of transfer of learning proposed by Haskell (2001), all learning is transferable, implying that learning proceeds in a comparable fashion. Scholars who have investigated the process of learning transmission share a conceptual framework. Transfer of learning was defined by Gick and Holyoak (1987), as a modification in task performance resulting from prior experience with an unrelated task. Transfer of learning is defined by Perkins and Salomon (1992) as the effect of familiarity with a particular environment, set of materials, or situation on performance when confronted with similar circumstances or materials.

Thomas (2010) defines transfer as the ability to utilise knowledge and skills obtained in one context effectively in a different or comparable context. These academics possess similar attributes with regard to the learner, environment, instruction, and transfer assignment. With minimal barriers, students can efficiently comprehend physics concepts in the classroom when their indigenous knowledge is incorporated into the curriculum. Transfer of learning is the phenomenon where performance in another situation or with similar materials is influenced by what was learned in one situation or with one set of materials (Sommer, 2018). Sommer (2018) underscored the importance of the transfer process by stating that our educational system is predicated on the notion that knowledge obtained in the classroom is applicable in diverse settings, and that prior learning influences subsequent learning and performance. Enculturation is a dynamic process that acknowledges and builds upon students' pre-existing knowledge, facilitating their capacity to cultivate comprehension through the deft management of information gathering and skill acquisition.

2.2.2 Transfer of Learning -Why is it Important?

Despite the critical importance of transfer in the process of human learning, enhancing students' ability to apply recently acquired knowledge and skills constitutes a substantial obstacle in the field of education (Galoyan & Kristen, 2021). The complexity and multifaceted nature of the phenomenon pose challenges in comprehending the notion of transfer. The study emphasises notable obstacles in the process of transferring knowledge, including the complex characteristics of transfer, the multitude of factors that impact transfer, and the inadequate comprehension of instructional approaches to enhance transfer of learning across formats (Galoyan, 2019).

In this study, "transfer of learning" pertains to the practical implementation of skills and knowledge obtained from one's culture, environment, beliefs, or environment in a distinct context, namely the formal study of science. Educators expect students to attain knowledge at different points in their education and showcase their understanding in subsequent assignments. After conducting research on the transfer of learning for more than two decades, Haskell, (2001) concluded that the transfer process is the only means by which we attain historical knowledge. Failure and prior knowledge, according to Haskell, are significant determinants of the transfer of learning. He argued that novel discoveries and solutions are frequently the result of a lack of transfer. In the context of teaching and learning across subject areas, failure can foster the growth of critical thinking abilities, such as parsing and reasoning.

Moreover, the process of acquiring a new skill is accelerated and improved through the application of prior knowledge and experience (Haskell, 2001). Transfer has been identified as the principal aim of instructional duties and school innovation, according to a number of researchers (Kracke, 2017). Transferring is essential for the professional development of educators and has a significant impact on student achievement. In today's educational landscape, which prioritizes reform professional development strategies, educators are expected to possess robust subject matter expertise and effective instructional capabilities (Jennifer, 2018). It is believed that instructors are capable of rapidly acquiring and then effectively applying new information and skills in the classroom. Transfer is crucial for teachers to design or utilize tests that demonstrate knowledge transfer rather than merely initial learning, according to Dewitz and Graves (2014).

This is because teachers are expected to monitor students' progress more frequently. By virtue of constructing examinations, instructors must possess a thorough comprehension of the subject matter. Before a transfer can take place, a substantial amount of learning must take place in the initial environment. The pupil must demonstrate knowledge of the subject matter, including facts, methods, and concepts pertinent to a particular field (Jennifer, 2018). As claimed by Perkins and Salomon (2012), knowledge consumers have difficulty subsequently utilizing the information they have acquired. It is advantageous to identify successful strategies that improve transfer. The practices involve learners having ample time to acquire knowledge, opportunities for practice, feedback on their performance, clear expectations for future application of learning, mastery of the topic, and improved skill development. There are those who argue that the implementation of successful transfer procedures does not guarantee the occurrence of a transfer. There are still unexplored potential factors (Jennifer, 2018).

2.2.3 Factors Affecting Transfer of Learning

Classroom settings are dynamic environments in which students acquire knowledge. Educators are typically expected to implement in the classroom what they have learned during professional development activities Sudarmine (2017). For successful knowledge and skill transfer, teachers must have access to resources and recognise the applicability of prior knowledge to the current circumstance, according to Murrill et al., (2013). Multiple studies have demonstrated that specific professors failed to employ innovative approaches when instructing their pupils. The transfer of knowledge and skills between various contexts is influenced by both environmental and human factors (Pomerantz & Condie, 2017). After attending professional development sessions, educators are obligated to apply the knowledge and skills they have gained to their particular setting, including the classroom, where they instruct students.

Transfer of learning is influenced by a number of factors, including classroom relevance, the presence of a supportive network, and external pressures. A mixed-methods investigation provided practitioner perspectives on the environmental conditions and barriers that influence the transfer process. A number of factors that facilitated the transfer of literacy skills by special education instructors were identified in the study, alongside the challenges they encountered. At the outset, a comprehensive support network was formed, encompassing administrative assistance, peer discussions, and the program's integration as an enterprise-wide endeavour. According to the responses of educators in the survey, maintaining ongoing dialogues with fellow educators and the principal concerning the consistent application of literacy strategies enhanced their perception of importance and the value of their pedagogical efforts. A further element that facilitated the transition was the students' presence. Educators were more likely to maintain their commitment to implementing the approach when they witnessed students benefiting from it or successfully utilising it. Teachers placed significant emphasis on the ability to modify or personalise the approach in order to align with the needs of their students. The third element referenced was the provision of prepared materials or resources by the instructors.

1. **Environmental Barriers**

   These are barriers that impede or obstruct the process of learning transfer. In contrast to those working in a constrained environment, educators are more likely to exercise their instructional autonomy and make decisions regarding their circumstances when presented with options and choices. A strong emphasis on curriculum implementation, external pressures, limited time for planning and implementation, and a mismatch between professional development programs and the classroom environment are examples of environmental variables that teachers typically lack control over.

2. **Personal Circumstances**

Personal circumstances are internal processes that have the potential to impede or facilitate the application of knowledge by educators. Individuals' decision-making and capacity to transmit acquired knowledge were impacted by reflective practices and instructor effectiveness. Critical to the examination of our behaviours is reflection Arowolo (2010). By engaging in introspection, we are able to ponder ideas, assess our comprehension, and ultimately validate our decision to improve. Personal obstacles were found to be associated with instructors' effectiveness, which pertains to their self-perception and instructional capabilities, according to research on transfer of learning (Kleinsasser, 2014). Lack of early knowledge or readiness, neglecting information, reverting to previous behaviour, or a discrepancy between dispositional elements such as motivation and attitude were examples of such obstacles. The preceding segment examined the ways in which environmental conditions and personal circumstances can influence the capacity of educators to effectively transmit knowledge. Each study contributes to our comprehension of transfer of learning and raises substantial concerns, as the review unequivocally demonstrates. Situational barriers are the result of both personal and environmental circumstances. While certain attributes may remain constant across various settings, other details may be irrelevant in other domains, thereby increasing the intricacy and challenge associated with the transfer of knowledge.

2.2.4 Ausubel (1972) Theory of Meaningful Learning

Established in 1972, Ausubel's theory of meaningful learning posits that learning occurs via the interplay between the learner's pre-existing knowledge within the cognitive structure and the newly acquired material, leading to transformation and advancement. Learners are grounded in ethno-science knowledge, artifacts, and practices; the subject matter to be examined is school physics. A reflection of this correlation in academic achievement is that Ethnoscience-Based Instruction facilitates this connection.

2.2.5 Conceptions about Meaningful Learning

The theory of genetic epistemology, developed by Jean Piaget, influenced meaningful learning. According to this theory, the acquisition of knowledge occurs through a dynamic interaction between the learner and their surroundings. Piaget examined the cognitive development of children and the progression of their thinking towards mature reasoning, perceiving them as methodical beings incessantly in pursuit of knowledge. Although Piaget's theory centers on the development of children and incorporates insights into adult functional learning, the theory of Meaningful Learning by David Ausubel is more comprehensive in its examination of learning beyond age constraints. Eze and Bunkure (2015) stated that Ausubel focused on the learning process within the structure, an issue that had not been thoroughly explored by researchers before. In this scenario, the new ideas are not logically and explicitly connected to the student's existing cognitive framework. Instead, they are simply learned and repeated, which does not guarantee adaptability or long-term retention.

The indigenous student's study of Physics is hindered by the frequent usage of calculators, which is still promoted by the school. Rote learning in Physics instruction at indigenous schools leads to a lack of depth in understanding, hindering students from articulating new concepts using different terminology. Thus, the indigenous student will struggle to relate their culture and community experiences to the academic material both in the classroom and outside of it. Rote learning and meaningful learning are not distinct, as noted by Leonardo et al. (2020). Eze and Bunkure (2015) stated that the shift from rote learning to meaningful learning is not innate or spontaneous. The belief that students may only learn by rote memorisation is a delusion, as ultimately, true learning occurs when the knowledge is understood and meaningful. It may happen based on suitable subunits, student's inclination to learn, relevant content, and teacher's guidance

2.3 Empirical Review

2.3.1 Empirical Review on the Effect of Ethnoscience Instruction on the Interest and Attitude of Students towards Science

The effects of ethnoscience-enriched education on the attitudes, retention, and academic performance of rural and urban students in basic science were investigated by Hussain (2019). Pre-posttest quasi-experimental design was employed for this study. For the research, a sample of 213 students was selected at random from eight different institutions. The schools were allocated at random into control and experimental groups, which included both urban and rural schools, and comprised both male and female students. The instructional methods utilised in the experimental groups were informed by principles of ethnoscience, whereas the control groups were instructed through conventional lecture approaches. Following the intervention, post-testing was administered to evaluate the academic performance and attitudes of each cohort. A subsequent evaluation was conducted (post-posttest) in order to gauge the extent to which the acquired knowledge was retained. The students completed the Students Attitude to Basic Science Questionnaire (SABSQ), a 25-item multiple-choice assessment with a reliability coefficient of 0.66, and the Basic Science Performance Test (BSPT), a 25-item multiple-choice assessment with a reliability coefficient of 0.75. The data were assessed in order to investigate the research inquiries and verify the null hypotheses.

In order to achieve this, descriptive statistics were implemented. Students from both rural and urban areas performed better in the experimental groups than in the control groups, according to the findings of the study. The pedagogical approach served to enhance students' academic achievement and disposition towards Fundamental Science. Both urban and rural students in the experimental groups demonstrated a significant enhancement in their ability to recall previously learned concepts. The study posits that the instructional approach is a viable and efficacious innovation that enhances the academic achievements, conceptual retention, and disposition towards Basic Science of students residing in both rural and urban areas. Moreover, it promotes gender inclusivity. The study proposes that educators integrate instructional methods that are enriched with ethnoscience principles.

Fassasi (2017) conducted a research investigation to assess the impact of ethnoscience instruction on children's scientific attitudes. The study also considered the moderating influences of family educational status and school location. The study employed a quasi-experimental design that included a pretest, posttest, and non-equivalent control group. The research sample comprised Junior Secondary School 1 students aged three-fifths to twelve years, who attended two educational institutions located in rural and urban areas of southern Nigeria. A set of three null hypotheses was evaluated at a significance level of 0.05. Assessment of the data was conducted utilizing Analysis of Covariance. Students attending rural schools outperformed their urban counterparts academically, and those whose parents held lesser educational attainment levels succeeded more than those whose parents held higher educational attainment levels. An education in ethnoscience enhanced students' dispositions toward science. Consequently, the research suggests its implementation within the domain of education.

The advantages of integrating local science into scientific education for the benefit of both students and culture were investigated by Brown and Crippen (2016). Through the integration of local science into community cultural events, this study investigates the potential of such integration to enrich scientific education by exposing students to cultural values through the lens of science. The manuscript analyses indigenous scientific knowledge, records the deliberations conducted by the tribal council, and assesses the pedagogical approaches employed by five science instructors situated in the Nagekeo district of East Nusa Tenggara. In order to collect data, observation, identification, interviews, and evaluation sheets were utilised. By incorporating traditional unit and measurement systems, Newton's laws into traditional games, biodiversity into traditional hunting practices, heat transfer concepts into traditional house construction, and vibrations, waves, and sounds into traditional musical instruments, the data revealed that Nagekeo cultural activities can be integrated into science education. Incorporating local scientific knowledge into science education could provide students with beneficial learning experiences and prevent the extinction of indigenous culture for future generations, according to the research.

2.3.2 Empirical Review on the Effect of Ethnoscience Instruction on the Academic Performance Students in Science

The impact of Ethnophysics-Based Instruction on the academic performance and attitude of students towards Density, Forces, and Heat Transfer at Mufulira College of Education in Zambia was investigated by Chongo and Baliga, (2019). The research employed a quasi-experimental design, and 156 students were purposefully selected to serve as a control group for both the pre-test and post-test. In order to achieve this, descriptive statistics were implemented. The two hypotheses, academic performance and attitude, were assessed using a two-sample t-test with a 0.05 level of significance. The results of the study indicated that the experimental group exhibited superior performance compared to the control group. It was found that the experimental group experienced a more pronounced improvement in attitude when instructed using Ethnophysics-Based Instruction as opposed to the control group, which received instruction using the conventional method. Ethnophysics-Based Instruction is a gender-inclusive method of teaching students about density, forces, and heat transfer, according to the study. This teaching method does not exhibit any gender bias and appears to be a viable innovation for enhancing students' academic performance and attitudes toward the specified subjects, according to the study. The research indicates that educators should integrate Ethnophysics-Based Instructions into their pedagogical approaches. In physics courses, pre-service teacher preparation should integrate ethnophysics-based instruction. At the in-service level, seminars and workshops ought to be organised to provide guidance to practicing lecturers regarding the integration of Ethnophysics-Based Instruction into their pedagogical practices.

2.4 Conceptual Framework

After reviewing literature on previous studies, the researcher has coined the conceptual model for the study as shown below;

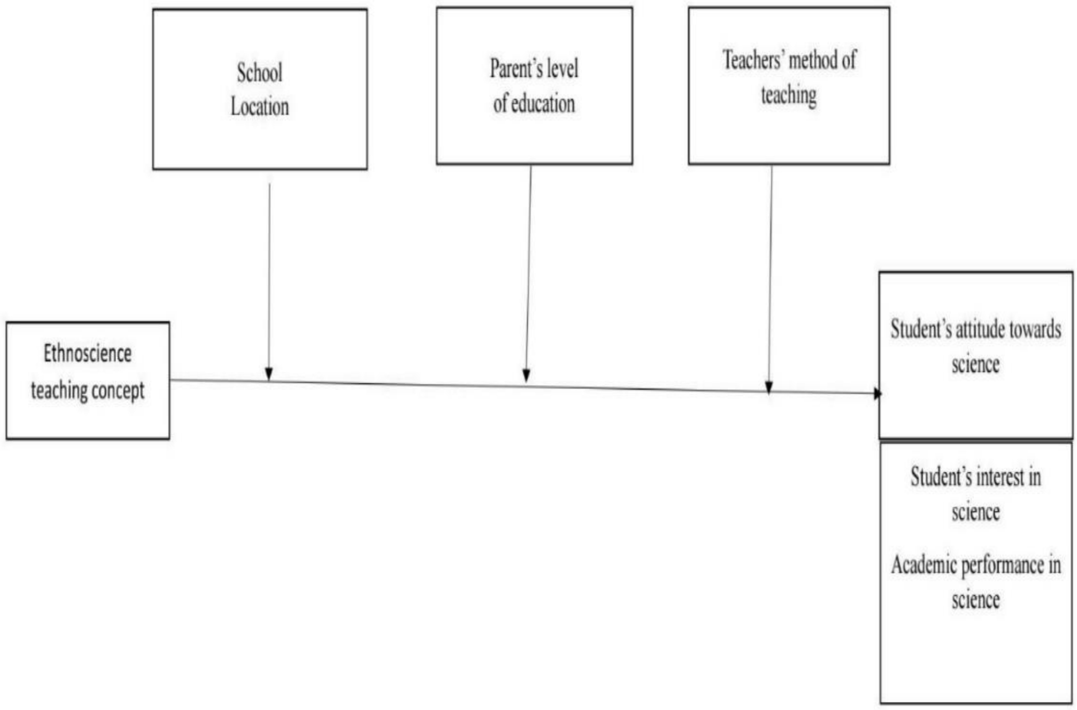

Figure 2.1 – Conceptual framework of the research
Source; researcher's conceptual model (2023)

Figure 2.1 above is the conceptual framework which defines the variables and their corresponding roles they perform in the study. The study comprises four main variables that the researcher intends to measure so as to achieve the set objectives. The variables include;

2.4.1 The Ethnoscience –based Instruction (Independent variable)

Ethnoscience in this context refers to the local wisdom, indigenous practices, materials and items found in the environment of a particular ethnic group which forms the cultural and historical background of the people. Hence the name "*Ethno-science*" literally means Science or wisdom in practices of a particular ethnic group. Some practices are generally common among many ethnic groups based in a country who share many cultural traits in common whiles there are other practices that are confined to a particular Ethnic group which defines the group of people by defining their way of life. Ethnoscience-based instruction has to do with the classroom activity that requires that the teacher bases, links, connects and centers the teaching and learning in the classroom on the culture, tradition and environmental practices of the local people. The teacher uses the local wisdom of the indigenous people as a basis to bridge the gap between the already existing knowledge (learner's Relevant Previous Knowledge) and the new information which is the content of the curriculum usually western scientifically oriented. The research seeks to measure the extent to which Ethnoscience-based Instruction (independent variable) has impacted on learners' interest, attitude and academic performance (dependent variables).

2.4.2 Students' Interest in Physics (Dependent variable)

Interest as used in relation to this research refers to the feeling of wanting to learn or know about something or someone. For teaching and learning to be successful, learner's interest in the subject is crucial. The teacher cannot force the subject matter on the learner who shows disinterest in the lesson in class. It is therefore the professional responsibility of the teacher to arouse and sustain the 'wanting to know feeling' of the learner in the lesson or subject which motivates the learner to have the urge to read the subject even if the teacher is unavailable. Interest in subject reflects in the performance of learners in the subject during assessment. The research will finally reveal whether or not Ethnoscience –based Instruction (independent variable) has aroused and sustained learner's interest (dependent variable) in Physics.

2.4.3 Students' Attitude towards Physics (dependent variable)

The attitude of a learner refers to the manner of acting or thinking that shows the learners disposition or opinion on the subject. One's opinion or position about something defines how the person will act or behave towards it. It is vital for a teacher to help learners develop positive attitude towards the subject. Teaching and learning tends to be unsuccessful if the learner comes to class with poor attitude towards the subject. Good attitude towards the subject affects the general learning behaviour of the learner positively, which is manifested through the academic performance during assessment. At the end of the research, it is expected to be clearly stated whether or not Ethnoscience-based Instruction affected the Attitude of learners towards Physics.

2.4.4 Students' Academic Performance (dependent variable)

Academic performance in a School or learning setting is the extent to which short and long terms learning goals of an institution or learner has been achieved. The performance of the learner describes the extent to which the learner has imbibed and dissipated the content being exposed to. To improve the academic performance of learners, the teacher is professionally obliged to use varying efforts such as teaching pedagogies and motivation techniques appropriate to enable the learner adjust positively towards the material to which they are exposed. This research seeks to measure the extent to which students' Academic Performance is impacted by the Ethnoscience-based Instruction used as the intervention of the study.

2.5 Mediating Variables

Other variables contributed to the stronger effect of the independent variable on the dependent variables. They include;

2.5.1 School Location

Researches have revealed that the location of a School determines the perception of children on education. This therefore influences the attitude, interest and academic performance of the students towards the subjects. Akintunde (2004) found that children in urban areas in Nigeria outperformed those in rural areas in terms of environmental education. In contrast, Kannapel and Deyoung (1999) presented a different perspective based on their study conducted in America. In conclusion the location of a school environment affect students' attitudes, interest and performance towards science in relation to the belief that rural places have a richer culture than metropolitan ones. The School location is a mediating variable contributing to the effect the independent variable has on the dependent variables.

2.5.2 Parents' Level of Education

Parents Education Level is a metric that indicates the educational attainment of parents. Fasasi (2017) asserts that Parental Education Status (PES) is considered as an integral component of socioeconomic status (SES) as it is usually determined early in life and tends to persist over time. Fasasi (2017) has recognised it as an important element influencing students' academic performance and their perspective towards science. For instance, Parent Education level impacts achievement and attitude towards a subject. According to Fasasi (2017), it is important to investigate the role of Parent Education level on learners' attitude and interest towards science. The parents level of education is a contributory (mediating) variable that facilitates the effect of the independent variable on the dependent variables.

2.5.3 Teachers' Teaching Methods

To teach, according to Hornby (2006) is to help somebody to learn something by giving him/her some information about it. Agbulu and Idu (2008) see teaching as an art of disseminating classified information to the recipients by an expert. Bunkure (2013) viewed teaching as the meaningful interaction between the triads; the teacher, the learner and the materials that ensure students gain in the learning process. Thus from the above definition, one clearly sees that teaching involves the transfer of knowledge from an expert to the learner. Gero and Ogunnade (2012) observed that teaching is done through different methods.

These methods they stress vary from the traditional teacher-centered approach to the contemporary approaches such as demonstration, experimental, discovery and Computer Assisted Approaches. Teachers are expected to choose from the wide varieties of teaching approaches for the attainment of their instructional objectives. This is because, according to Obeka (2010), pedagogy can greatly influence students" academic performance and retention in school subject. Thus, Fasehun (2012) suggested that in selecting methods of teaching, teachers have to take into consideration learners' age, background, topic to be taught, timing, class size and the available resource at the teacher's disposal. It is therefore clear that the teaching methods teachers employ in lesson delivery is a mediating variable contributing to the effect of Ethnoscience-based instruction (independent variable) on the interest, attitude and performance (dependent variables) in this study.

2.6 Intercultural Factors to Pedagogical Facilitation

As their name implies, the substantive factors of pedagogical facilitation are those that encourage learning in action and are associated with the selection of the most pertinent topics on which students will be instructed. Therefore, it is critical to choose fundamental concepts so as not to overwhelm students with superfluous data, which could impede the development of a sound cognitive framework (Leonardo et al, 2020). In relation to the pedagogical facilitation process of the Meaningful Learning Theory and intercultural factors in physics education, the instructor must link the indigenous student to the routine cultural activities of the community. Put differently, individuals will be predisposed to engage in meaningful learning by utilising their prior knowledge (including rituals, cosmology, religious concepts, art, and various other facets of existence) to generate ideas and conceptions regarding new information (Leonardo et al, 2020). We believe that cultural context influences the development of human thought. Alternatively put, it is culture rather than the individual who defines it that imparts distinctive qualities to culture. The integration of this idea into the school environment, the creation of instructional materials, and the community is crucial for the intellectual growth and meaningful education of indigenous students.

According to Ausubel (1972), it is preferable to present concepts to students in a broad format, progressing from more general to specific ideas, as this facilitates individual learning through subordination rather than super ordination. Consequently, during the process of working on concepts, they can be linked in a subordinate manner; when apprenticeship takes place through subordination, the subordinators denote the essential concepts required for relevant learning. In this regard, general ideas or concepts selected by the instructor regarding particular subjects that are connected to the cultural context of the students will function as a foundation for subsequent apprenticeships. Conversely, should the instructor opt for novel ideas or concepts that are not connected to the students' culture, it is likely that the material will lack significance for the students as it would be devoid of prior concepts in their cognitive framework (Leonardo et al, 2020). One notable challenge frequently encountered by indigenous high school students during their physics apprenticeship is that their teachers only connect the material to examples from the textbook, which fail to incorporate the indigenous context or, alternatively, fail to represent their culture. An additional factor is the inadequate provision of information regarding indigenous and non-indigenous teachers in educational institutions, as mentioned earlier.

2.7 Chapter Summary

The chapter focused on a comprehensive examination of several key concepts: science education, current pedagogical approaches in the discipline, the intersection of science and culture, cultural practices that possess ethnoscientific importance, the correlation between teaching and learning and teaching and learning and ethnoscience, ethnoscience instruction based on UNESCO recommendations for science education, the perspective of indigenous students regarding science, and the correlation between students' attitudes and academic achievement.

The investigation was supported by a theoretical review that examined two main theories. Haskell's (2001) transfer of learning theory posits that local cultural knowledge should be transferred to the classroom to facilitate science learning; and Ausubel's (1972) theory of meaningful learning asserts that science learning becomes meaningful when new information interacts with an existing cognitive structure. The focus of the empirical review was to determine how ethnoscience instruction affected the attitudes and levels of interest of students in science. The study investigated the influence of ethnoscience education on academic performance. A substantial number of scholarly articles written by previous researchers were consulted to provide support for the study.

In the concluding section of the chapter, the conceptual framework was examined. This framework presented a module that depicted the subsequent relationships: the academic performance, attitudes, and interests of students (as the dependent variables), the location of the school, the educational attainment of parents, and the teaching method employed by the teachers (as mediators).

CHAPTER THREE

METHODOLOGY

3.0 Overview

The present chapter delineates the methodology that was implemented to conduct the study. Approach/strategy, research design, study population, sample and sampling techniques, data collection method, data source, validity and reliability, data analysis method, ethical considerations, and chapter summary comprise the contents.

3.1 Study Area

The study was conducted at Techiman Municipal in the Bono East Region of Ghana. Techiman is the capital of the Techiman Municipality. It is located in the central part of Ghana, approximately 160km north-west of Kumasi and 320km north of Accra. Furthermore, it is located within the Latitude 7.5833˚N and Longitude 1.9333˘ W. Techiman municipal has a population of approximately 147,554. The major ethnic groups includes Bonos who constitute the majority and the other Akan sub-groups, Mossi, Dagombas, Dagabas, Ewes and other ethnic groups. The majority people of the people of Techiman speak Twi (Bono) language and have rich cultural and traditional festivals such as Akwasidae, APO) and Yam festivals. The people in the area are predominantly farmers who cultivates Cocoa, Cashew, Maize, Cassava yams etc. Techiman is noted for trade activities because of its biggest food market in the sub-sahara region (Ayisaa et al, 2018).

Some notable landmarks includes the Techiman market, Bono Manso shrine (historic site) and the Tano river. The people of the area are noted for their rich customs culture and tradition.

3.2 Research Paradigm

The researcher operated within the pragmatic research paradigm. This was evident as the study focused on problem-solving. The ethnoscience –based teaching and learning sought to solve problems emanating from poor attitude towards Physics, negative interest in Physics and low academic performance in Physics during examinations. According to Robert (2018), the flexibility in the use of the research designs and methods characterizes the pragmatic research paradigm.

3.3 Research Design

This study utilised mixed methods approach, using the convergent parallel design with embedded components. According to Ngulube (2010), the convergent parallel design with embedded components comes into play when quantitative and qualitative data are collected simultaneously, analyzed, separately and then merged to form a comprehensive picture, whiles embedding both qualitative and quantitative components. Creswell and Creswell (2017) define quantitative research as the systematic gathering of data with the purpose of quantifying and statistically analysing information to substantiate or disprove claims of alternative knowledge whiles Qualitative research entails gathering data by examining the participants' perceptions of the situation and identifying recurring patterns, themes, categories, and regularities. This allowed for a more robust inference to be drawn compared to using either approach individually Misua and Garba (2023). It is worth noting that Subali et al. (2015) also utilised the convergent parallel design with embedded components in a study carried out in educational research. The researcher combined survey and quasi-experimental designs to collect data regarding the impact of an instructional approach based on ethnoscience on the academic performance, interest, and attitude of physics students in a some of senior high schools located in Techiman Municipality.

3.4 Population of the Study

The study's target population comprises all senior high school physics students in the Techiman Municipality. The population of the study consists of the four senior high schools in the municipality that offer general science programs, out of a total of six (6) in the municipality. The researcher conducted a comprehensive survey of schools offering general science courses, quantifying the number of students enrolled in physics at each institution. Four hundred (400) students constitute the target population. Table 3.1 below shows the population distribution of the four chosen institutions.

Table 3.1: Population of the study

School category	Population of physics students
Category B school 1	218
Category B school 2	102
Category C School 1	42
Category C school 2	38
Total	400

3.5 Sample and Sampling Techniques

Purposive sampling was utilised to select the four senior high schools for the study, as they are the only institutions offering physics among the six schools in the municipality. In the first phase, the schools to be included in the survey are chosen. In order to accomplish this, the institutions were categorised as B or C schools. Two schools were subsequently chosen from category B; one was allotted to the experimental group and the other was designated as the control group. Two additional category C institutions were chosen, with one being allocated to the experimental group and the other to the control group. This was done due to the fact that categories B and C contain only two institutions that offer physics. One hundred ninety-six students comprised the sample size for this investigation. The sample size was determined utilising the sample size determination matrix developed by Krejcie and Morgan (1970, p 26). A sample size of 196 was derived from the population of 400 students, as inferred from the table. The sample size for each school was calculated in accordance with sample size determination table provided by Krejcie and Morgan (1970, p 26).

Furthermore, a substantial sample size of ten (10) community members was selected at random to participate in interviews regarding cultural artifacts that impact the instruction of physics. Simple random sampling was employed to acquire the intact class samples from which participants would be selected for the research. Mishra and Alok (2011) define simple random sampling as the process by which every potential sample of a given size from a population has an equal and predictable chance of being chosen. Papers bearing the responses YES or NO are cut using this method, with consideration given to the sample size of each school. The responses are written on two distinct pieces of paper. In a lined-up configuration, representatives of intact classes are granted the freedom to select one of the papers bearing inscriptions that are not visible to the students. The students reached a consensus that participation in the research study would be limited to classes whose representatives selected YES.

Classes whose representatives selected NO would not be included in the study. This was implemented in order to establish a level playing field for all students to potentially be selected, thereby ensuring that the sampling procedure for the study was unbiased. Abonyi et al (2014).

Furthermore, a random sample of ten (10) community members was interviewed in order to gather information regarding cultural artifacts that impact the instruction of physics. The measurement is in accordance with the sample size determination table developed by Krejcie and Morgan (1970). Table 3.2 below illustrates the allocation of the sample size among the designated institutions and indigenous populations;

Table 3.2: Sample size of the study

S/N	Name of School	Sample size
1	Category A	120
2	Category B	40
3	Category C1	20
4	Category C2	16
5	Indigenous people	10
	Total	206

The researcher conducted an in-person interview with members of the Forikrom community in the Techiman municipality in order to gather information regarding the inhabitants' customs and culture. By doing so, the researcher will acquire primary data that can subsequently be incorporated into the intervention process. Table 3.3 is a summary of the sample size of the individuals who participated in the interview guide employed by the researcher.

Table 3.3: Sample size of indigenous people (respondents)

Ethnoscience practice	No. of indigene respondents
Story on struggle for supremacy between two gods.	2
Preparing cassava dough using kitchen grata	2
Stirring soup using metal ladle	2
Heating water until it boils	2
Family gathering around burning fire	2
TOTAL	**10**

3.6 Research Instruments

Primary sources of data were consulted for this study through the administration of a questionnaire, interview guide, and test items (PSAPT). The interview guide was utilised to gather data from the local populace, whom the researcher engaged in conversation with in order to obtain insights into their culture, traditions, and practices. The researcher will gain access to a wealth of cultural practices that are conducive to the instruction of physics (Adusei-Bonsu et al, 2021).

The researcher conducted a pre-test of the questionnaires and test items in a school distinct from the intended site of the study, prior to their administration. The results of the pre-test were subsequently compiled. This educational institution was selected due to the similarity in social characteristics between its students and those attending the schools where the research was conducted. Following the pre-test, the intervention plan, which was developed utilising teaching concepts grounded in ethnoscience, was executed across all institutions for a duration of five weeks. The researcher implemented rigorous protocols to control for extraneous variables that could potentially introduce bias into the study. To mitigate potential errors stemming from variations among teachers, the researcher initiated the investigation by convening a pre-experimental conference for the study's instructors. The conference assisted the instructors in establishing a unified set of instructional standards. Every aspect of the research was thoroughly addressed during the conference. Additionally, the researcher utilised the conference as a platform to identify potential errors in the study that could have been introduced by individual issues with the instructors (such as a lack of interest in the activities, contents, and objectives specified in the guide). At the conference, a consensus was reached that all participants in the research would rigorously adhere to the approach's specifications in order to guarantee consistency.

In addition, to ensure that instruction is consistent across all schools, the researcher provided instructors in all schools with an instructional guide and lesson plan in the format sanctioned by the Ghana Education Service. The intervention was implemented by the instructors in their respective schools. The researcher conducted routine monitoring of the study to ensure that instructors did not deviate from the established instructional procedure. The post-test was subsequently conducted utilising the identical test items that were employed in the pre-test. Furthermore, subsequent to the intervention, students were required to complete interest and attitude measurement scale questionnaires, which gathered data on their experiences following the intervention.

3.6.1 Development of Semi-structured Interview Guide

Interview guides were designed to answer the objective question one (1) which seeks some cultural practices that have relevance in the teaching of physics. The interview guide was semi structured which the researcher followed to obtain information from the respondents. Each guide has varying number of items depending on the depth of information the researcher needs.

3.6.2 Development of Questionnaires

The questionnaires were employed to address two of the research objectives of the study, namely objectives 2 and 3. Furthermore, one section of the questionnaires was designed to gather the bio-data of the participants **(Appendix F).** The initial component, designated as section (A), pertained to the respondent's biographical information, specifically their age and gender.

Components "B" and "C" were formulated in accordance with the second and third objectives of the research, respectively, and utilised a five-point Likert scale. On a Likert scale of five (5) ranging from (1-strongly Disagree (SD), 2-Disagree (D), 3-Neutral (N), 4-Agree (A) to 5-Strongly Agree (SA), respondents were asked to tick the variables. The purpose of this assessment was to evaluate the students' enthusiasm and perspective regarding the study of physics.

3.6.3 Development of Test Items

The research utilised test items from the Physics Students Academic Performance Test (PSAPT) to collect data for objective 4, which aimed to investigate the influence of ethnoscience-based instruction on the academic achievement of physics students. The researcher devised the twenty-five (25) multiple-choice questions based on the subjects (gravitational force, frictional force, and heat transfer modes) that were instructed utilising the ethnoscience teaching paradigm **(Appendix G).** Each of the 25 items consists of four options (A-D), requiring the respondent to choose the one option that most accurately addresses the query. The selection of these subjects was motivated by the fact that they are easily comprehensible when elucidated through the lens of indigenous cultural practices. There were two approaches taken to conducting the test. The initial assessment, known as the pre-test, was conducted as a pre-pilot test for the students prior to the implementation of the intervention, script grading, and results compilation. Following the intervention, an additional post-test was conducted, utilising the identical test items as the pre-test. The post-test scripts were subsequently graded, and the findings were compiled for subsequent analysis.

3.7 Validity

Face validation was performed on the Physics Students Academic Performance Test (PSAPT) by experts in education and research. Throughout the face validation process, items underwent careful examination with regards to their pertinence, overall test structure, appropriateness, clarity, and simplicity of language employed in their creation, with the aim of facilitating responses from the intended students. This was done in order for the instrument to accurately reflect the specialist's expert contribution. In addition, face validation was performed on the questionnaire and interview guide by education and research specialists. Given that both the questionnaire and interview guide are modifications of established, universally recognised and standardised formats in the field of construction, the researcher considered it superfluous to conduct additional factorial validation on the instruments. The format of the teacher's guide developed by Ghana Education Service was incorporated into the instructional guide authored by the researcher for classroom instructors. The science department head of one of the participating institutions reviewed the examination items. With over a decade of experience in the field of science, this educator has attained the esteemed position of Assistant Director II (AD II) within the Ghana Education Service.

3.8 Reliability

A pilot study was conducted to assess the reliability of the questionnaire and test items. Twenty students from Wiafe Akenten Presbyterian Senior High School participated in the study. Upon the conclusion of the pilot study, the collected responses were entered into the Statistical Package for Social Sciences (SPSS) software. Using the Cronbach's Alpha method, the reliability of the items was assessed at a significance level of 0.05. The Cronbach's Alpha coefficient is utilised to assess the internal consistency of a given instrument. The calculated coefficient of 0.834 indicates that the instrument possesses both validity and reliability for the research. This conclusion is supported by Mujis (2010), who states that in order for an instrument to be considered valid, its Cronbach's Alpha coefficient must be equal to or greater than 0.70.

3.9 Data Collection Procedure

The researcher handled collection of data under three broad stages namely; Pre-intervention, Intervention and Post-Intervention.

3.9.1 Pre-Intervention Stage

Prior to conducting the primary fieldwork study, it is critical to conduct a pretest evaluation of the questionnaire and test items draft, using a randomly selected school that will not be included in the main study. Such a mini-study has been conducted. A pilot study was conducted to assess the questionnaire's validity and reliability. Twenty pupils from Wiafe Akenten Presbyterian Senior High School participated in the study. Upon completion of the pretest of instruments, several typographical errors were identified and rectified. Additionally, certain inquiries were rephrased to facilitate comprehension. Data obtained from the pre testing phase was compiled and retained for subsequent analysis in conjunction with post-test data when it becomes available.

3.9.2 Intervention Stage

The interview guide was employed to administer the survey to obtain more comprehensive information from the participants. Interviews were carried out by the researcher using question-and-answer format with several members of the Forikrom community, Techiman Municipality, who belonged to the Akan ethnic group. The researcher utilised the interview as a means to acquire crucial information that is culturally pertinent and can be implemented in physics instruction.

Additionally, a quasi-experimental treatment-control group design with a pre-posttest was implemented. The research comprised an experimental group that received instruction in physics concepts grounded in ethnoscience, while a control group was exposed to conventional teaching methods for the same subject matter. Male and female students from category B and category C schools comprised the student participants. Prior to the implementation of the treatment, pre-tests were conducted on both the treatment and control groups to record the students' initial academic performance. Similarly, the subjects' pre-treatment attitudes and levels of interest in science were assessed by pre-testing the groups' attitudes and levels of interest in science. In order to ascertain the efficacy of ethnoscientific processes, the researcher administered the treatment to the experimental group, which consisted of physics instruction infused with scientific principles. The treatment was administered over the course of five weeks, with each institution dedicating two contact hours per week. In this particular implementation of an ethnoscience-based teaching approach, students are encouraged to participate in culturally charged activities such as storytelling (a contest between gods for supremacy), heating water with fire or sunlight, stirring soup with a ladle, grinding or grating substances, and so forth. The researcher verified that the groups were instructed on the concepts for an equivalent period of time. Figure **3.1** shows the flowchart, giving general steps comprising the instructional procedure as highlighted below;

Stage 1 □ **Introduction:** The teacher presents the topic, assesses prior knowledge, organize students to conduct a certain cultural activity and /or go out to observe a certain cultural activity e.g. grating Cassava into dough

↓

Stage 2 □ **Presentation of the ethnoscientific activity to the students:** The teacher makes the students to study the process of grating cassava

↓

Stage 3 □ Analysis of ethnoscientific activity and identification of relevant principles. Nature of surfaces of the cassava and the kitchen grata.

↓

Stage 4 □ Relating the ethnoscientific activity with the concept. The teacher relates the phenomena the concept of Frictional force

↓

Stage 5 □ The teacher asks, allow and respond to students questions as to why the 'surface of the cassava peels off' into a smooth paste. Compare the two surfaces that are in contact sliding against each other.

Figure 3.1: Flow chart of Ethnoscience-based instruction adapted from Peni (2017)

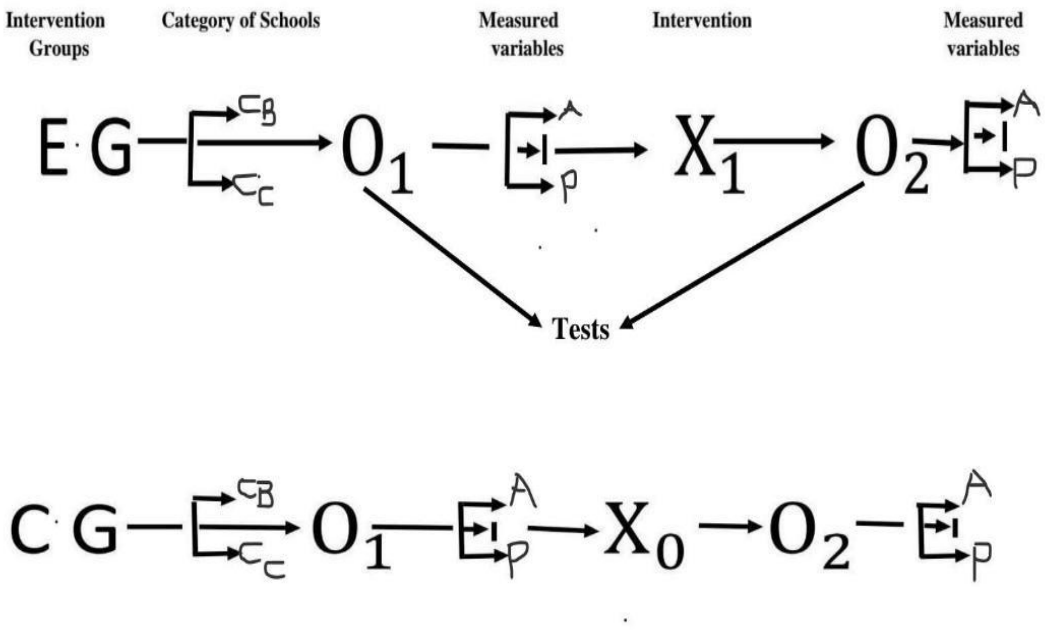

Fig ; 3.2 Schematic research design adapted from Peni (2011)

Where;

E.G - Experimental group

C.G – Control group

C_c – Category C school

C_B – Category B school

0_1- pretest

O_2- posttest

X_1 – Ethnoscience based Instruction

X_0 – Conventional teaching method

A - Attitude

I- Interest

P - Performance

Figure 3.2: Schematic design of the study

Fig.3.2 shows the path through which the entire study on the two groups were taken through. The pretests were initially administered in the two groups after which the dependent variables (Attitude, Interest and Performance) were given initial recording. The intervention (Ethnoscience-based approach) was implemented in the Experimental group whiles the control group was taken through the conventional teaching.

3.9.3 Post-Intervention Stage

The researcher administered the posttest in both groups after which the independent variables were recorded again. The data gathered from pretest and posttest were subjected to statistical analysis using SPSS software. The researcher interpreted the output of the tests from the SPSS and discussed them accordingly.

3.10 Data Analysis Procedure

The information gathered for this study through questionnaires and examinations was analysed and processed utilising version 20 of the Statistical Package for the Social Sciences (SPSS). Responses to the encoded questions in SPSS were entered manually into the database. In order to provide the necessary explanations for the results that require additional analysis, the research employed thematic analysis, descriptive statistics, paired sample t-tests, and Independent Samples t – test.

Moreover, with regard to the cultural practices that are pertinent to the instruction of physics, specifically objective 1, thematic analysis of responses were employed to ascertain these practices in the senior high schools of the Techiman Municipality. The differences in mean scores regarding students' attitudes and interests in physics between an ethnoscience-based method of instruction and a conventional teaching approach were also examined using paired samples t-test analysis. The effect sizes (eta squared) of the different items on the attitude and interest measurement scale questionnaire were computed for the experimental groups in accordance with the effect size calculation and interpretation guidelines established by Cohen (1988). The calculation was performed manually using the equation given below;

Eta squared = $\frac{t^2}{t^2+N-1}$ (where the t =the t-Value on the analysis table, N= Number of sample size)**.** Refer to Tables 4.7 and 4.10.

Thus objective 2 and 3. In the case of objective 4, Independent sample t-test (see Appendices J & K) was adopted by the researcher for the analysis. The effect sizes were also calculated.

3.11 Ethical Consideration

The present study conducted research in accordance with the following ethical principles: honesty, objectivity, integrity, diligence, transparency, confidentiality, regard for colleagues, social responsibility, non-discrimination, competence, and protection of the human rights of survey participants. This was achieved by providing them with information regarding the data collection instrument's foundation, the study's purpose, the significance of the research, and more. Respondents were granted complete autonomy to choose whether or not to divulge information, abstain from participation, or exercise other freedoms within the study's sample frame. Participants were provided with a consent form ensuring privacy and confidentiality.

Furthermore, the researcher acquired an introductory letter dated January 16, 2023, from the head of the Department of Integrated Science Education at Akenten Appiah-Minka University of Skills Training and Entrepreneurial Development (AAMUSTED)-Mampong. This letter bore the reference number M/DISE/ADM/STU/01/09 **(**See Appendix H**)** and was duly signed by the researcher. Prior to commencing the study, authorization was sought from the schools' head masters/mistresses, instructors, and students through the utilization of this correspondence.

3.12 Chapter Summary

The present study's research methodology was thoroughly examined in this chapter. The methods that contributed to the successful completion of this study's objective were thoroughly examined. The approach/strategy for the research (qualitative and quantitative research) that supported the survey design was judicious. The sample for the study was obtained using simple random sampling. Primary data for this research were collected using a questionnaire consisting of a five-point Likert scale, a semi-structured interview guide, and test items. A pilot study was conducted in advance of the data collection to ascertain the dependability of the survey instrument and test items. Utilising the Cronbach's Alpha test, the instruments' reliability was assessed. The pair sample t-test and the independent sample t-test were utilised in the data analysis to identify differences between variables. The treatment's effect sizes were computed. All ethical considerations pertaining to the research were duly acknowledged and delineated in this segment of the study.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Overview

The preceding chapter provided a concise overview of the methodology utilised in the research. The results of the data analysis, as well as a discussion of those results, are detailed in this chapter. The chapter is structured and categorised as follows: Results and analysis of data; synopsis of findings; discussion of results.

Four types of data were collected from this study. The data include:

i. Data of some Ethnoscience practices relevant to the teaching of Physics
ii. Pretest and Posttest scores of students' attitude towards Physics, using Physics Students Attitude Questionnaire (PSAQ)
iii. Pretest and Posttest scores of students' interest in Physics, using Physics Students Interest Questionnaire (PSIQ)
iv. Pretest and Posttest scores of students' academic performance, using Physics students' performance Test (PSAPT)

The information on some ethnoscience practices relevant to the teaching of Physics were compiled from the indigenes interview guide. The performance scores of pretest and posttest were compiled and recorded for experimental and control groups. The pretest data were obtained by the administration of the PSAPT, PSAQ and PSIQ before the commencement of the study. The administration of the PSAPT, PSAQ and PSIQ immediately after the treatment generated the posttest data. The data were analyzed using Statistical Package for Social Sciences (SPSS) version 20 at 0.05 level of significance to answer the research question.

4.1 Profile of Respondents

The respondents of instrument used to collect data are described here. The respondents include; respondents of Semi – Structured interview guide and respondents of both questionnaires and test items.

4.1.1 Respondents to the Semi-structured Interview Guide

Major respondents of the interview guide were inhabitants of the Forikrom community in the Techiman Municipality. Different people of varying age groups mainly between (15 and 60) years were contacted to provide information regarding some of the cultural practices relevant to the teaching of Physics. The respondents, composed of both males and females were mostly people from the Akan ethnic group whose major language is Twi precisely Bono. The data regarding certain cultural practices that are pertinent to the pedagogy of physics were extracted from the interview guide with indigenous individuals. The pre-test and post-test performance scores of the experimental and control groups were compiled and documented. Preliminary data were collected through the administration of the PSAPT, PSAQ, and PSIQ prior to the study's initiation. The posttest data were generated through the administration of the PSAPT, PSAQ, and PSIQ immediately following the treatment. In order to address the research question, the data were analysed utilising Statistical Package for the Social Sciences (SPSS) version 20 with a significance level of 0.05. Some of them were mature and elderly people who have plethora of life, work, cultural and traditional experiences giving them the opportunity to give in-depth explanation to the indigenous information the researcher sought from them.

4.1.2 Respondents to the Questionnaires and the Test Items

Participants were selected from the four senior high schools in the Techiman Municipality that offer physics courses. They were requested to complete questionnaires and assessments both prior to and following the researcher's intervention. They essentially comprised form two pupils, ranging in age from 15 to 19, who had attended the institution for a duration of two years. A minority of them speak other local languages but are fluent in Twi. The majority of them speak Twi as their native dialect. The interaction between students of ethnicities other than the Akan and the indigenous students piques the interest of non-Akans in the traditions and culture of the community in which they receive their education. The classes consist of varying proportions of both males and girls. The students' age and years of community experience would have enabled them to provide a general overview of the locality's environmental, cultural, and traditional practices. They would then be able to apply this knowledge in the Physics class, facilitating their comprehension of the new material.

4.2 Results for Research Question 1

Research Question 1: What are some of the ethnosciece practices that have effects on teaching of Physics?

4.2.1 Ethnoscience Practices that are Relevant in the Teaching of Physics

To accomplish the first research objective of the study, the investigator conducted interviews with ten individuals residing in the researcher's community. Through these interviews, the investigator identified five (5) ethnoscience practices that have a direct bearing on the instruction of physics. The corresponding physics content for these practices is detailed in Table 4.1. Plates 1 through 5 depict various ethnoscientific practices that occur within the community.

Plate 1 - A man telling stories to young children

Plate 2 - A woman grating cassav tuber into dough (paste)

Plate 3- A pot of water on fire

A woman grating Cassava tuber into dough (Paste)

Plate 4 - A laddle found in boiling soup

Plate 5 - Young children increasing their body temperature using heat from fire

Table 4.1: Ethnoscience practices and their related concepts in Physics

Ethnoscience practices	Related Concepts in Physics
God-god competition over supremacy	Force of gravity
Boiling of water	Heat transfer by convection
Grinding/grating of things	Frictional force
Using naked fire/sun to increase one’s body temperature	Heat transfer by radiation
Stirring hot food with ladle	Heat transfer by conduction

Source: researchers’ field survey (2023)

Two people were randomly sampled and interviewed on each of the ethnosience practices in the community which was relevant in the teaching of physics.

4.2.1.1 God-god Competition for Supremacy

Two distinct respondents utilised the "God-god competition for supremacy" as a cultural practice involving narrative to instruct a group of young individuals on the "force of gravity" in a local vernacular.

"Onyankopon" and "Tano" engaged in a struggle for supremacy, according to the narrative provided by the first respondent (R1). Tano, the lesser deity, is revered in our community, whereas Onyankopon is regarded as the creator of the earth and all its inhabitants (including Tano, the lesser god), as stated in R1. After being endowed with powers by his creator 'Onyankopon,' Tano developed an inflated sense of pride and began to conduct itself as if it were more powerful than the deity 'Onyankopon'. Onyankopon made the decision to administer punishment to Tano. The entire earth was commanded by Onyankopon to settle on Tano's cranium. By virtue of his abilities, Onyankopon compelled Tano to transport the entire planet and its contents as a form of punishment. R2 additionally stated that any object that attempted to flee the earth was compelled to return to it by the power of Onyankopon. This is to ensure that Tano can continue to sustain the weight of the earth. This is because Onyankopon utilised his powers to draw the object back into the earth in order to maintain its mass, whereas Tano experiences a lighter burden when an object departs from the earth. The following conclusions are drawn by the researcher after conducting a meticulous and comprehensive examination of the account provided by the two respondents regarding the rivalry between two supreme entities;

- The earth serves as a conduit through which the two supreme entities negotiate their actions. All 'powers' manifested by supreme entities occur on the earth, which gives the planet a crucial function.
- The "Powers" of the greater God have the capability and fortitude to cause objects that have escaped the earth's surface to return to it.
- The 'powers' emanating from the greater God are used to target objects that have a propensity to escape from the surface of the earth.
- The narrative reveals two migrations of objects in distinct directions. These phenomena consist of the upward motion of objects striving to escape the surface of the earth and the downward motion of objects influenced by the greater God's forces and directed to return freely to the earth's center.
- The objects that descend contribute to the earth's mass (heaviness).

The researcher conducts a critical analysis of the responses following the interview and identifies parallels between the narrative and the subject matter of "motion under the force of gravity" in physics. For objects in motion under the influence of gravity, the following scientific principle can be deduced (Attakora, 2020, page 110);

i. A gravitational force is present on Earth, which has the tendency to attract all bodies towards its center.

ii. Conventionally, the gravitational force of the earth is directed vertically downward. Conversely, a body in motion along a horizontal axis is not affected by the gravitational attraction of the earth.

iii. A body in vertical motion experiences motion in the opposite direction of gravity and under gravity.

iv. Angled body propulsion into the air induces motion due to the force of gravity.
v. A body propelled vertically into the air is slowed down (or decelerated) by the gravitational pull of the earth.
vi. A body that is allowed to descend unrestrictedly does so due to the gravitational pull of the earth. The body accelerates in the direction of the planet.
vii. When gravity acts upon an object, that object will acquire weight.
viii. The earth's massive masses exert a compelling force that attracts the masses of organisms in the air towards its center. This is referred to scientifically as the gravitational force of the earth.

As the researcher juxtaposes and contrasts the narrative's content with scientific principles governing the earth's gravitational pull, certain parallels emerge, including the following:

a. The earth is a factor in both the narrative and the scientific theory.
b. In both instances, an object induces the organism in flight to descend.
c. Both scenarios involve the existence of a body that is affected by an action and subsequently falls.
d. Vertical motion encompasses both upward and downward movements in both situations.
e. Weight is applied to a descending body as a result of the pulling action.

With these commonalities in occurrence associated with both the story and the scientific principles of motion under force of gravity, the researcher concludes that the story ‘God-god competition over supremacy’ is appropriate for use by Physics teachers as a strategy or approach to teach the topic ‘Motion under force of gravity’ to effectively impacts knowledge to learners.

4.2.1.2 Boiling of Water

As with the scalding of water in local households, two more respondents were questioned. R3 was observed boiling water in a bucket on fire. When the researcher inquired as to how the respondent would determine whether the water was hot, R3 replied, "I would use my hand to feel it." R4 elucidated that as the fire temperature increases, the lower portion of the vessel undergoes thermal expansion, causing certain bubbles to ascend to the water's surface. Further clarifying, R4 stated that "hot water rises to the surface of the water in the form of bubbles from the bottom of the pot." After a period of time during which the water's surface has been subjected to numerous bubble movements, the temperature of the water also increases. Furthermore, R3 elaborated on the method for determining whether water is hot: "To begin with, the presence of vapor on the water's surface indicates that the water is heating up." Additionally, I occasionally remove my finger from the water in order to determine its temperature.

The researcher after the interview noted some facts from their responses, which includes the following;

a. The transfer of heat from the lower portion of a container containing water over a hot flame to its outer surface is visually apparent through the ascent of water bubbles.

b. Before heat is transferred from the interior to the surface, the lowermost water temperature increases.
c. A number of bubbles circulating from the bottom to the top of the container heat the surface water.
d. The presence of water vapor on the water's surface indicates an increase in temperature at the water's surface.
e. Typically, the temperature of surface water is determined by touching it with the fingertips. Thus, determining whether the temperature of water is suitable for a specific purpose.

The locals' assertions of these facts are in complete accordance with the scientific principles governing heat transfer via convection. The foundational tenets of this type of heat transmission are exposed in the publication by Asiedu and Baah (2018, pages 245-247). They consist of;

a. The process by which heat is transferred through liquids is called convection.
b. For convection to occur, heated liquid from the bottom of hot container, moves up carrying heat along whiles cold liquid moves down to takes it's place.
c. Convection is a continuous process ensuring heat is transferred to all parts of the liquid.
d. The movement of liquid carrying heat along is known as convectional current.
e. Convection takes place in fluid (liquid and gas)
f. Convection occurs due to changes in fluid's density.
g. During convection movement of heat is vertical.

Comparing these basic scientific principles of convection with the observations made in the responses from local people. The research identifies a true practicality of the scientific principles in local practices and hence concludes that "boiling of water" as a local practice can be used by Physics teachers to teach the concept of 'heat transfer by convection' to successfully impart knowledge.

This group of the respondents were explaining the concept of convection in some home activities like the boiling of water where by the water at the bottom of the pot get hotter and got replaced by a denser cold water on the surface the practice continues till the entire water get uniformly hot.

4.2.1.3 Grating Cassava into Dough

In furtherance, the data shows that, some respondents were applying the concept of frictional force in some home activities like grinding and grating of substances. Respondent R5 was seen grating cassava on a plastic device and was interviewed what was the rationale, she *responded "I intend to scratching the surface of the cassava into a smooth dough".* The researcher asked why not on the smooth surface, but she responded, "*already, the surface of the cassava is smooth. Therefore, I need a rough surface to rub against it in order to get the paste. Also, two smooth surfaces are slippery, hence it cannot produce small particles".* Another respondent R6 was seen grinding tomatoes in an earthen pot and was asked why she prefer the inside of the pot to be rough and not smooth. R6 responded "*the rough one will help hold the tomatoes firmly and grind them well but the smooth one cannot".*

The researcher after taking the responses of the interview made the following observations from the responses of the local people interviewed. These include;

1. Comparing the rough surface of the plastic plate to the silky surface of the cassava. Two surfaces are therefore in contact.
2. The plastic plate and the cassava both move in the opposite direction.
3. The earthenware grinding dish's rough surfaces effectively secured the tomatoes' clean surface during the grinding process.
4. Grinding or grating substances becomes uneasy when they come into contact with two smooth surfaces.

Following these discussions and observations from the interviews, the researcher concluded that the practical aspects of the topic "Frictional force" in physics are consistent with the local practices described by the respondents. As stated by Ohanian (1985, p. 129), the fundamental scientific principles that underpin the notion of frictional force are as follows;

i. Relative motion describes the friction that occurs between two solid bodies in contact that are moving in opposite directions.
ii. The magnitude of friction is greater when the surfaces in contact are abrasive and decreases when they are smooth.
iii. Whether the velocity between two surfaces in contact is minor or large, the friction between them remains constant.
iv. The direction of action of friction is invariably antithetical to that of the motion.
v. The force with which two surfaces are pressed together determines friction.
vi. Weight is a determinant of friction on the upper surface. Increased friction results from decreased weight, conversely.

After identifying the applicability of the concept of friction in local practices, the researcher concludes that physics instructors can effectively impart knowledge to students by employing the method of "grinding/grating substances using earthenware dish."

4.2.1.4 Increasing the Body Temperature Using Heat from Fire

Early in the morning, a group of individuals was observed congregating around a bare fire. In an attempt to determine why they were there, the researcher addressed them and engaged in conversation with two individuals: "We wish to experience heat." Yet, how? There is no link between the conflagration and your end. The fire's heat radiates towards our location from a considerable distance (R7 and R8). It is evident that the heat of the fire percolates to the people via radiation, thereby warming them. Following interviews with indigenous individuals discovered to be elevating their body temperature with fire, the researcher derived the subsequent observations from their responses:

1. No tangible entity establishes a connection between the fire and the individuals in its vicinity.
2. Individuals are exposed to the fire's heat from great distances.
3. By installing a barrier between the heat source and the individuals, the thermal energy emanating from the fire becomes undetectable.

After collecting the locals' responses, the researcher contrasted these facts to the fundamental scientific principles underlying the concept of heat transfer by radiation, which are analogous to the methods employed by the locals.

The book authored by Attakorah, (2020, pages 662-663) delineates the subsequent scientific principles that underpin the notion of radiation heat transfer mode;

i. Radiation-based heat transfer occurs in a vacuum.
ii. Heat is directed in every direction.
iii. The transfer of heat through radiation exhibits characteristics of electromagnetic radiation.
iv. Raised heat that is transmitted via radiation is referred to as radiant energy. Polarized, refracted, diffracted, absorbed, and reflected.

The researcher deduces that physics instructors may employ the local people's practice of "using fire/sun to increase one's body temperature" to effectively instruct students on the subject of "mode of heat transfer by radiation" after recognizing parallels between fundamental scientific principles and its implementation.

4.2.1.5 Stirring Soup using Metal Ladle

After that, the researcher conducted distinct interviews with each of the two women after observing their cooking techniques. The researcher inquired as to the composition and justification of the spoon used to stir the broth. R9 responded with metal due to its market prevalence. The researcher inquired as to why she always removes the ladle rather than leaving it in the broth. Retaining the metal in the broth at its boiling temperature will result in an increase in temperature beyond its safe limit, rendering it unmanageable (R9). As an additional response (R10), I employ a ladle featuring a wooden handle while stirring the broth in order to safeguard my hand from potential burns.

Following the interview, the researcher discerned several significant facts exemplified in the local populace's way of life. These consist of;

a. From one end of the solid ladle to the other, heat transfers.
b. At one end of the metal ladle, a wooden insulator prevents the transfer of heat that would otherwise come into contact with the hand.
c. The metal remains immobile while the heat passes through it.
d. The heat that is supplied to the broth is transmitted via metallic components.
e. An energy transfer occurs along a specific distance, namely from one extremity of the metal to the other.

Upon analyzing the interview responses, the researcher discerned the regional applicability of heat transfer through metals in the context of food preparation. The researcher formulates the subsequent scientific principles regarding the mode of heat transfer by conduction by comparing the interview data to the scientific principles of "heat transfer by conduction." As stated in the publication by Asiedu and Baah (2018, pages 243-247), the subsequent scientific principles governing conduction heat transfer are delineated;

i. Heat is transferred from the heated end to the cold end via metals (solids) in order for conduction to occur.
ii. Despite the transmission of heat through the metal rod, the rod remains stationary in relation to the heat.
iii. Specific substances that impede the conduction of heat are referred to as insulators.
iv. A quantity determines the rate of heat conduction passing through the material.
v. At various locations along the conductor, temperatures vary.

The researcher reaches the conclusion that physics instructors would effectively impart the intended knowledge to students if they incorporated the local expression "stirring soup with a ladle" into their lessons on heat transfer by conduction, after identifying the parallels between these scientific principles and local customs.

It is evident that the participants utilized the principle of heat transfer via conduction. To mitigate heat transfer from the heated soup to the metal ladle, they opted for a ladle featuring a wooden handle or consistently extracted the ladle from the hot soup subsequent to stirring.

4.3 Research Question Two (2)

Research Question 2: What is the difference in attitude towards Physics between students taught physics concepts using ethnoscience-based teaching and those taught same concepts using the conventional approach?

To answer research question 2, the descriptive statistical analysis technique was employed where mean and standard deviation units were utilised. The interpretation of the means was done using Alton and Miller (2010) interpretation of the Five Point Likert Scale as shown in Table 4.4.

Table 4.2: Interpretation of Means using Alton & Miller (2010) Five Point Likert Scale interpretation

Threshold(Range)	Interpretation
1.0 - 1.99	Strongly Disagree
2.0 - 2.99	Disagree
3.0 - 3.99	Neutral
4.0 - 4.99	Agree
≥ 5.0	Strongly Agree

Source : Alton and Miller (2010) interpretation of Likert scale

Table 4.2 shows the range and magnitude of the five Point Likert Scale used to rate the responses by the respondents to the questionnaire. The scale was used and published by Alton and Miller (2010).

Table 4.3: Paired Sample t-test analysis of Pre-test scores of Control and Experimental groups

S/N	ITEM	CONTROL		EXPERIMENTAL		N	(df)	t	Sig
		MEANS	(S.D)	MEANS	(S.D)				
1.	I am scared of Physics because people say it is difficult.	2.08	0.74	2.02	0.71	196	195	0.70	0.48
2.	I like Physics because my parents are scientists.	2.03	0.71	1.88	0.78	196	195	1.42	0.16
3.	My major problem with Physics is the calculation it contains.	2.23	0.76	2.07	0.71	196	195	1.46	0.15
4.	In my opinion, Physics is meant for the most intelligent student.	4.25	0.65	4.23	0.54	196	195	1.09	0.28
5.	I think that Science is about understanding how the natural world works.	2.2	0.86	2.05	0.72	196	195	1.29	0.23
6.	I heard that those who study physics do not relate well with people.	1.73	0.82	1.65	0.73	196	195	1.70	0.32
7.	I will not do Physics because it changes one's faith.	4.18	0.77	4.22	0.78	196	195	0.35	0.73
8.	I see Physics as the magic of the white man.	4.17	0.69	4.35	0.66	196	195	2.03	0.15
9.	I do not see anything Physics in what I do everyday.	4.2	0.68	4.26	0.66	196	195	0.54	0.59
10.	My teachers do not relate Physics to my everyday activity.	4.07	0.76	4.15	0.76	196	195	0.71	0.48

NB » (S.D) = Standard Deviation

* = items with statistically significant difference in Pretest and mean scores.

At $p < 0.05$ (significant)

Table 4.4: Paired Sample t-test analysis of Posttest scores of Control and Experimental groups

S/N	ITEM	CONTROL MEANS	(S.D)	EXPERIMENTAL MEANS	(S.D)	N	(df)	t	Sig
1.	I am scared of Physics because people say it is difficult.	1.35	0.69	4.73	0.54	196	195	-31.8	0.000*
2.	I like Physics because my parents are scientists.	1.86	0.71	4.39	0.50	196	195	-35.8	0.000*
3.	My major problem with Physics is the calculation it contains.	1.87	0.69	4.18	0.68	196	195	-28.5	0.000*
4.	In my opinion, Physics is meant for the most intelligent student.	4.44	0.58	1.29	0.59	196	195	49.9	0.000*
5.	I think that Physics is about understanding how the natural world works.	1.26	0.68	4.77	0.42	196	195	-35.2	0.000*
6.	I heard that, those who study physics do not relate well with people.	1.60	0.67	4.35	0.64	196	195	-33.6	0.000*
7.	I will not do Physics because it changes one's faith.	4.42	0.66	1.39	0.56	196	195	42.8	0.000*
8.	I see Physics as the magic of the white man.	4.29	0.72	1.48	0.57	196	195	34.5	0.000*
9.	I do not see anything Physics in what I do every day	4.32	0.77	1.18	0.44	196	195	40.5	0.000*
10.	My teachers do not relate Physics to my everyday activity.	4.38	0.62	1.68	0.63	196	195	34.9	0.000*

NB » (S.D) = Standard Deviation

* = items with statistically significant difference in Posttest mean scores.

At $p < 0.05$ (significant)

Table 4.5: Effect sizes of the independent variable (ethnoscience-based approach) used in experimental group

S/N	Item	Effect Size (eta squared)	Interpretation
1.	I am scared of Physics because people say it is difficult.	0.88	large effect
2.	I like Physics because my parents are scientists.	0.90	large effect
3.	My major problem with Physics is the calculation it contains.	0.86	Large effect
4.	In my opinion, Physics is meant for the most intelligent student.	0.95	large effect
5.	I think that Science is about understanding how the natural world works.	0.90	large effect
6.	I heard that, those who study physics do not relate well with people.	0.89	large effect
7.	I will not do Physics because it changes one's faith.	0.93	large effect
8.	I see Physics as the magic of the white man	0.90	large effect
9.	I do not see anything Physics in what I do everyday.	0.92	large effect
10.	My teachers do not related Physics to my everyday activity.	0.90	large effect

Source: Researcher's own calculation based on Cohen (1988) effect size calculation and interpretation guidelines

4.4 Discussion of Findings for Research Question 2

Table 4.3 shows the result of the paired sample t-test analysis conducted to evaluate difference in attitude scores of students pretest scores for both Control and Experimental groups before they were taught Physics concepts using conventional and ethnoscience-based methods of instruction respectively. Table 4**.**4 shows the output of a paired sample t-test analysis conducted to assess th**e** difference in mean scores of students posttest scores for both control and experimental groups after they were taught Physics concepts using conventional and ethnoscience-based methods instruction respectively. Lastly, Table 4.5 shows the effect sizes, the treatment (ethnoscience-based instruction) had on the respondents in the experimental group. The researcher classified the ten items on the attitude measurement scale into three broad headings for easier understanding and also to reduce excessive repetitions of the item analysis. The items are put under the following headings:

1. Students Opinion on Physics
2. Parents/teachers opinion on Physics
3. Effect of Religion/faith on Physics

The difference in mean scores as shown on the Tables 4.4 and 4.5 is discussed below;

4.4.1 Students' Opinion on Physics

The researcher classified five items under this heading. The items include:

Item one (1) "*I am scared of Physics because people say it is difficult.* ".

Item four (4) "*In my opinion Physics is meant for the most intelligent student*".

Item five (5) "*I think that science is about understanding how the natural world works*".

Item eight (8), "*I see Physics as the magic of the white man*".

For item nine (9) "*I do not see anything physics in what I do everyday'.*

According to Table 4.3 (Pretest table)**,** there are no statistically significant differences between the pretest mean scores in all the five items (1,4,5,8 and 9) above. This is because the p-value is greater than the cut-off 0.05. ($p>0.05$) significance level in all the five items. On the other hand, considering Table 4.4 (Posttest table), there are statistically significant differences between the posttest mean scores in all the five items (1,4,5,8 and 9) above. This is because the p-value is less than 0.05 ($p<0.05$) significance level in all the five items.

According to the interpretation of the five point likert scale propounded by Alton and Miller (2010), the means in both the control and experimental groups for item one (1), (Table 4.3) shows respondents disagree with the item ""*I am scared of Physics because people say it is difficult.* ". ". This shows that the attitude of the respondents in control and experimental groups towards Physics was negative. For the same item (1) on the Table (4.4), the posttest mean shows respondents in control group still disagreed after being exposed to conventional teaching method whiles those in experimental group agreed with the item "*I am scared of Physics because people say it is difficult"* after being exposed to the treatment (ethnoscience-based instruction). Table 4.5, the effect size (0.88) is large enough to cause change in attitudes of respondents. This indicates that there is change in attitudes of respondents in experimental group towards Physics caused by ethnoscience-based instruction used as treatment.

In similar instance, the means of both Control and Experimental groups for item (4) on Table 4.3 show that before intervention, respondents agree with the item "*In my opinion*, *Physics is meant for the most intelligent student*". This shows negative attitude towards Physics is seen on members of the control and Experimental groups as shown by the means of Pretest scores. On contrary, the Posttest means of same item four (4) on Table 4.4 shows that respondents in the Control group still agree with item "*In my opinion, Physics is meant for the most intelligent student*". The posttest mean shows that respondents in Experimental group strongly disagree with the item. This is an indication that respondents (in the experimental group) attitude has changed towards Physics after treatment. This is due to the fact that respondents were exposed to ethnoscience-based instruction. From Table 4.5 the effect size was large enough to cause change in respondents' attitudes.

Also, according to Table 4.3 the means of both Control and Experimental groups of item five (5) indicates that before intervention, respondents disagree with the item "*I think that, science is about understanding how the natural world works*". This shows the attitude of the respondents in both groups was towards Physics. Table 4.4 presents the Posttest scores of the same item five (5) which shows respondents in Control group still disagreed with the item "*I think that, science is about understanding how the natural world works*". However, the respondents later agreed with item five (5) above after treatment. This is an indication that there is a change in respondents' attitude towards Physics. This happened after respondents in the experimental group were exposed to treatment (ethnoscience-based instruction). Table 4.5 shows the effect size of the treatment which is large enough to cause change in respondents' attitude.

Furthermore, the means of the Control and Experimental item eight (8) on Table 4.3 shows that before intervention, respondents in both groups agree with the item "*I see Physics as the magic of the white man*". This shows that respondents' attitude towards Physics was negative as shown by the means for both groups. On the other hand, considering Table 4.4 the Posttest mean for the same item eight (8) shows that respondents in Control group agree with the item "*I see Physics as the magic of the white man*" meanwhile, respondents in the Experimental group strongly disagreed with the item after being exposed to the ethnoscience-based instruction. This shows that respondents in the experimental group has experienced change in attitude towards

Physics. Table 4.5 presents the effect size of the treatment which is large enough to cause change in respondents' attitude.

Lastly, the means of both Control and Experimental groups for item nine (9) on Table 4.3 show that respondents in both groups agreed with the item "*I do not see anything physics in what I do everyday"*. Therefore, negative attitude of respondents in both groups towards Physics is seen. Table 4.4 shows a Posttest mean of the item nine (9) shows that respondents in Control group still agree with the item "*I do not see anything physics in what I do everyday".* However, the posttest mean of the item nine (9) for the Experimental group shows that respondents strongly disagree with the item after treatment. This shows that respondents in the experimental group have changed their attitude towards Physics which is noticed after respondents were exposed to ethnoscience-based instruction. Table 4.5 shows the effect size of the treatment which is large enough to cause change in respondents' attitude towards Physics. The interpretation of the means of the items 1,4,5,8 and 9 shows that conventional method used in the control group has failed to cause positive change in attitude of respondents towards Physics.

Also, the pretest means of the experimental group which were similar to both pretest and posttest means of the control group, were significantly different in the posttest after the experimental group were taught Physics concepts using ethnoscience-based as a treatment. The findings agree with Fassasi (2017), who conducted a study on the effect of Ethnoscience instruction and the moderating effects of school location and parental educational status on students' attitude to science. It was found that, Learners in experimental group performed better and developed positive attitude towards science than those in control group. Similar results were obtained by researchers (Hussain 2019). The researcher investigated the Impact of Ethnoscience-enriched-instruction on Attitude, Retention and Performance in Basic Science among Rural and Urban Students. The study found that Urban and Rural students in the experimental groups performed better than those in the control groups. It was also found that the instructional process used in the experimental group had enhanced the performance and attitude of students to Basic Science than the instruction used in the control group.

Parents/teachers opinion on Physics

The researcher classified three items under this heading. They include;

item two (2), "*I like Physics (science) because my parents are scientists*".

item three (3), "*My Parents regularly advise me to study physics*".

item ten (10) "*My teachers do not relate physics to my everyday activity*".

Table 4.3 shows there are no statistically significant differences in Pretest scores between the Control and Experimental groups S in the analysis of the three items above ($p>0.05$).

Table 4.4 shows there are statistically significant difference between the pretest mean and posttest means of the three (3) items. ($p<0.05$).

The means of the items are interpreted using the Five point Likert Scale. Considering the means in Pretest of the Control and Experimental groups for item two (2), on Table 4.5, it is found that, the respondents in both groups disagreed with the item "*I like Physics (science) because my parents are scientists*". The response to this item "*I like Physics (science) because my parents are scientists*" by both groups in the Pretest is an indication that respondents attitude towards Physics negative before intervention. Table 4.3 shows Posttest mean score of the same item two (2) "*I like Physics (science) because my parents are scientists*", which suggests respondents in Control group, strongly disagree with the item. The posttest mean score for the Experimental group show that respondents agree with the item after being exposed to ethnoscience-based instruction. This indicates a positive change in attitude of respondents in the experimental group towards Physics. Table 4.4 shows effect size which was large enough to cause change in respondents' attitude.

Similarly, the means of Control and Experimental for item three (3) "*My Parents regularly advise me to study physics*" on Table 4.3 show that respondents in both groups disagreed before the intervention. This shows negative attitude towards Physics is realized in the respondents in both groups. Considering Table 4.4, the Posttest mean of the same item three (3) "*My Parents regularly advise me to study physics*", shows that the respondents in Control group strongly disagree with the item. However, after the respondents in Experimental group were exposed to the ethnoscience-based instruction, the posttest mean shows they agree with the item. This indicates positive change in attitude of respondents in the experimental group as a result of being exposed to the treatment (ethnoscience-based instruction). Table 4.5 shows the corresponding effect size of the treatment which is large enough to cause change on respondents' attitude toward Physics.

Lastly, on Table 4.3 the means of the Control and Experimental groups for item ten (10) "*My teachers do not relate physics to my everyday activity",* show that respondents in both groups agree with the item, indicating respondents in both groups have negative attitude towards Physics. For Table 4.4, the Posttest means of the same item ten (10) "*My teachers do not relate physics to my everyday activity*" shows that respondents in the Control group agree with the item. However, the posttest mean of the same item shows respondents in Experimental group strongly disagree with the item after treatment. This shows respondents' attitude towards Physics has changed positively as a result of being exposed to Ethnoscience-based instruction. Table 4.5 shows the effect size of the treatment which is large enough to cause change in the attitude of respondents towards Physics.

Effect of religion/faith on Physics

The researcher classified two items under this heading. The items with their respective scores include;

item six (6) *"I heard that, those who study physics do not relate well with people.*

Item seven (7) "*I will not do Physics (science) because it changes one's faith*".

According to Table 4.3 There are no statistically significant differences between the pretest means for both Control and Experimental groups. For item six (6) "*Scientists can believe in God or supernatural being and still do well at physics*", the pretest means show that both respondents in Control and Experimental groups disagreed with the item before intervention. Table 4.4 shows the Posttest means of both Control and Experimental groups where respondents in the Control group still disagreed with the item. Meanwhile, respondents in the Experimental group agreed with the item in the posttest as indicated by the mean, after they were exposed to Ethnoscience-based instruction. Table 4.5 shows the effect size of the treatment which is large enough to cause change in the attitude of respondents towards Physics.

4.5 Research Question Three (3)

Research Question 3: *What is the difference in students' interest in Physics between students taught Physics concepts using ethnoscience-based teaching and students taught same concepts using the conventional teaching method?*

To test hypothesis 2, thus, what is the difference in interest of students taught Physics concepts using ethnoscience-based teaching and those taught same concepts using conventional approach, paired sample t-test showing the descriptive statistical analysis technique was employed where mean and standard deviation units were utilized. The results of the analysis is shown on Table 4.6. (Pretest Scores) and Table 4.7 (Posttest Scores). Table 4.8 shows the effect sizes of the treatment calculated for individual items in the experimental group. The interpretation of the scores for both groups was done using Alton and Miller (2010) Five Point Likert scale guidelines.

Table 4.6: Paired Sample t-test analysis of Pretest Scores of Control and Experimental groups

S/N	ITEM	CONTROL MEANS	CONTROL (S.D)	EXPERIMENTAL MEANS	EXPERIMENTAL (S.D)	N	(df)	t	Sig
1.	I easily understand physics because I am interested in it.	1.75	1.06	1.80	0.99	196	195	1.22	0.23
2.	I lose interest whenever it is time for Physics lessons.	4.95	0.87	4.16	0.85	196	195	-1.21	0.26
3.	My major problem with Physics is the calculations it contains which kills my interest.	4.88	1.01	4.05	0.85	196	195	-1.15	0.26
4.	I heard that Physics involves the use of complex machines which reduces interest of learners.	3.77	0.93	3.85	1.05	196	195	-0.53	0.60
5.	My interest in Physics is diminished because people say it is difficult.	3.65	0.85	3.83	1.12	196	195	0.81	0.20
6.	In my opinion, those who study Physics do not encourage others to develop interest in the subject.	3.76	0.93	3.85	1.05	196	195	1.31	0.60
7.	I think that most of what is taught to us as Physics are things we have never seen with our eyes.	4.13	0.83	4.37	0.85	196	195	-0.81	0.42
8.	I always encourage my friends to study Physics.	1.23	0.89	1.75	0.65	196	195	-3.68	0.07
9.	I always happily prepare for Physics lessons	1.60	1.96	1.80	0.98	196	195	1.22	0.23
10.	Most Physics inventors are "white men" therefore I do not think black people must show interest to learn Physics.	4.08	0.88	4.37	0.61	196	195	3.22	0.20

NB » (S.D) = Standard Deviation

* = items with statistically significant in Pretest and Posttest mean scores.

At $p < 0.05$ (significant)

Table 4.7: Paired Sample t-test analysis of Posttest interest scores of Control and Experimental groups

S/N	ITEM	PRE-TEST MEANS	PRE-TEST (S.D)	POST-TEST MEANS	POST-TEST (S.D)	N	(df)	t	Sig
1.	I easily understand physics because I am interested in it.	1.61	0.63	4.49	0.58	196	195	39.58	0.000*
2.	I lose interest whenever it is time for Physics lessons	4.30	0.62	1.39	0.55	196	195	41.37	0.000*
3.	My major problem with Physics is the calculations it contains which kills my interest.	4.32	0.69	1.57	0.64	196	195	33.26	0.000*
4.	I heard that Physics involves the use of complex machines which reduces interest of learners.	4.43	0.61	1.40	0.57	196	195	41.49	0.000*
5.	My interest in Physics is diminished because people say it is difficult.	4.37	0.54	1.47	0.69	196	195	41.54	0.000*
6.	In my opinion, those who study Physics do not encourage others to develop interest in the subject.	4.15	0.51	1.27	0.57	196	195	40.69	0.000*
7.	I think that most of what is taught to us as Physics are things we have never seen with our eyes.	4.38	0.66	1.43	0.70	196	195	41.51	0.000*
8.	I always encourage my friends to study Physics	1.93	0.74	4.49	0.79	196	195	29.35	0.000*
9.	I always happily prepare for Physics lessons	1.08	0.83	4.23	0.57	196	195	21.86	0.000*
10.	Most Physics inventors are "white men" therefore I do not think black people must show interest to learn Physics.	4.38	0.55	1.22	0.05	196	195	46.7	0.000*

Table 4.8: Effect sizes of the independent variable (ethnoscience-based instruction) used in the experimental group

S/N	Item	Effect Size (eta squared)	Interpretation
1	I easily understand physics because I am interested in it	0.92	large effect
2	I lose interest whenever it is time for Physics lessons	0.93	large effect
3	My major problem with Physics is the calculations it contains which kills my interest.	0.89	large effect
4	I heard that Physics involves the use of complex machines which reduces interest of learners.	1.04	large effect
5	My interest in Physics is diminished because people say it is difficult.	0.93	large effect
6	In my opinion, those who study Physics do not encourage others to develop interest in the subject.	0.93	large effect
7	I think that most of what is taught to us as Physics are things we have never seen with our eyes.	0.93	large effect
8	I always encourage my friends to study Physics.	0.87	large effect
9	I always happily prepare for Physics lessons.	0.78	large effect
10	Most Physics inventors are "white men" therefore I do not think black people must show interest to learn Physics.	0.94	large effect

Source: Researchers calculation based on Cohen (1988) effect size calculation and interpretation guidelines.

Table 4.6 represents the t-test analysis of the Pretest scores of data collected from both Control and Experimental groups. Table 4.7 shows the t-test analysis of the Posttest data collected from the respondents in the Control and Experimental groups in the study. Lastly, Table 4.8 shows the respective effect sizes for the independent variable (ethnoscience based instruction) showing the magnitude of effect it caused on the dependent variable (students' interest in physics). The means of the tests for both groups are compared and discussed with reference to the five-point Likert scale used in the interest measurement scale (questionnaire). To avoid excessive repetition, the researcher grouped the ten items under two broad headings namely;

- Students Opinion on Physics learning
- People and laboratory influence on Physics learning

The discussion of the items is shown below;

4.5.1 Students Opinion on Physics learning

Item eight (8), "*I always encourage my friends to study physics*".

Item nine (9) "*I always happily prepare for physics lessons*"

According to Table 4.6 (Pretest table), there are no statistically significant differences between the pretest scores of the ten items on the table, thus ($p>0.05$). Meanwhile Table 4.7 (Posttest table) shows there are statistically significant differences between the Posttest scores of the items on the table. ($p<0.05$).

4.5.2 People and Laboratory influence on Physics Learning

Item four (4) *"I heard that Physics involves the use of complex machines which reduces interest of learners.*

Item Five (5) "*My interest in Physics is diminished because people say it is difficult"*

Item six (6) "*In my opinion those who study Physics do not encourage others to develop interest in the subject".*

Item seven (7) "*I think that, Most of what is taught to us as physics are things we have never seen with our eyes*".

Item ten (10) *"I think that, most Physics inventors are "white men" therefore I do not think black people must show interest to learn Physics*".

There are no statistically significant differences in the four items (4, 5, 6, 7 and 10) between the pretest and posttest scores. The p-values for all the items are greater than the alpha (0.05) level of significance. This is a clear indication that conventional teaching approach has failed to cause respondents to develop interest in Physics in the study.

4.6 Discussion of Findings for Research Question 3

The means of the items are interpreted using the Five point Likert Scale.

According to Table 4.6, the means of the Pretest of item four (4), *"Physics involves the use of complex machines which reduces interest of learners"* indicates that, the respondents in the control and experimental groups gave neutral response to the item before the intervention. The response to this item was neither negative nor positive towards Physics, which is an indication that respondents' interest in Physics is uncertain. On contrary, Table 4.7 shows the Posttest mean of the item four (4) "*Physics involves the use of complex machines which reduces interest of learners*" which suggests that respondents in the Control group still gave a neutral response whiles respondents in the Experimental group disagreed with the item after treatment. This however means that after being taught using ethnoscience –based instruction, the respondents developed interest in the Physics. This shows that respondents in the experimental group's interest towards Physics has been developed positively. Table 4.8 shows the effect size (1.04 eta square) of the treatment, which is large enough to be able to cause change in respondents' interest in Physics.

Similarly, Table 4.6 shows the mean of pretest of item five (5) "*My interest in Physics is diminished because people say it is difficult*." show that respondents in both groups agree with the item in the pretest before the treatment. Also, Table 4.7 shows the mean of the Posttest scores shows that respondents in the Control group still agreed with the of item (5) "*My interest in Physics is diminished because people say it is difficult*" whiles respondents in the experimental group strongly disagreed with the item five after treatment. This shows that respondents in the experimental group have developed interest in Physics as a result of being exposed to the ethnoscience-based instruction. Table 4.8 shows the effect size (0.93) of the treatment which is large enough to cause change in the respondents' interest in Physics.

Table 4.6 shows pretest scores for item six (6) "*Those who study Physics do not encourage others to develop interest in the subject".*

shows that respondents in both groups were neutral to the item, meaning that interest of respondents in Physics received no positive development. In other case, Table 4.7 shows the posttest mean of same item (6) "*Those who study Physics do not encourage others to develop interest in the subject"* sugests that respondents in the Control group agrees with the item. However, the posttest mean shows that respondents in Experimental group strongly disagreed with the item six (6) after they were taught using ethnoscience-based instruction. This is an indication that there is a positive development of respondents' interest in Physics. Table 4.8 shows the effect size (0.93), which is large enough to be able to cause arousal of respondents' interest in Physics.

The case is similar for item seven (7) "*Most of what is taught to us as physics are things we have never seen with our eyes*" on Table 4.6 shows the pretest means which indicates that respondents in both groups agreed with the item. This is an indication that respondents' interest in Physics has been negative. Table 4.7 shows the pretest mean of same item seven (7) "*Most of what is taught to us as physics are things we have never seen with our eyes*", which suggests that respondents agree with the item before treatment. However, they strongly disagreed with the item after being exposed to the ethnoscience-based instruction. This shows that the respondents' interest in Physics have been developed positively. Table 4.8 shows the effect size (0.93) is large enough to be able to cause change in respondents' interest in Physics.

Lastly, considering item ten (10) *"Most Physics inventors are "white men" therefore I do not think black people must show interest to learn Physics*" on Table 4.6 shows that respondents in both Control and Experimental groups agree with the item. There is no positive development of respondents' interest in Physics. Table 4.7 shows the posttest scores of both groups which indicates that respondents in Control group agrees with item. Meanwhile, respondents in the Experimental group strongly disagreed with the item showing that respondents' interest in Physics has been developed positively.

In conclusion, the t-test analysis conducted reveals that all the ten items were insignificant in their mean differences. This is an indication that in general, conventional teaching approach does not lend itself to arousing the interest of students in physics. It is therefore inappropriate for teaching high school physics. This finding is supported by similar findings of a study conducted by Fasasi (2017) who assessed the effects of Ethnoscience Instruction (EI) on academic achievement and interest in science. The result of his study reveals that students taught using EI had higher academic achievement and greater interest in science than those taught using the lecture method.

In conclusion, the result of testing of the hypothesis three shows that the subjects in the experimental group taught Physics concepts using ethnoscience-based instruction developed greater interest in Physics than their counterparts in the control group who were taught same concepts using conventional method. This could be because ethnoscience instruction involves practices that learning are familiar with. The introduction of such activities in the classroom interaction generated a novel situation that influenced learners' inquisitiveness towards learning. Similarly, the students' familiarity with the practices provided them with the required link to which they anchored their learning. Thus, the practices served as 'prior knowledge' which Ausubel (1972) stressed, was necessary for meaningful learning. This finding is supported by Fasasi (2017) who assessed the effects of Ethnoscience Instruction (EI) on academic achievement and interest in science. The result of his study reveals that students taught using EI had higher academic achievement and greater interest in science than those taught using the lecture method. They argued that the development of greater interest by the EI taught group was because the group was able to link their background/indigenous knowledge to new concept they were taught. The relative low interest in science by learners in the control group is a vivid indication of ineffectiveness of lecture teaching method, despite the fact that it has been the most adopted among teachers.

The low interest in science attributed to the conventional teaching method was because it only appeals to learners' auditory sense (Paris, 2014). Students, when taught using conventional teaching method learn little or will not acquire the desired skills; hence they will resort to rote learning. The ethnoscience-based method of teaching on the other hand involved the use of practices in the locality the learners never expected to be scientifically relevant. The use of such practices had influenced the inquisitiveness of learners and had motivated them to learn. Koirara understood the issue quite well when he said to increase students' interest in science learning, there is the need to use learning resources and learning media from the environment of the learner (Koirala, 2023).; The result of this finding has in respect of students' interest in Physics in experimental group showed that there was no significant difference in the students' interest in Physics. This shows that Ethnoscience based instruction has effectively caused learners to develop greater interest in Physics.

4.7 Research Question Four (4)

*Research question four: What is the effect of ethnoscience-based teaching approach on students' academic performance***?**

Ho3 There is no significant difference in academic performance between students taught using ethnoscience-based instruction and those taught using conventional method.

To test this hypothesis, independent sample t-test was conducted on the study's data, which was gathered from the schools using test items after assessing the effectiveness of the conventional and the ethnoscience-based teaching approaches on students' academic performance. It was revealed that, there was no statistically significant difference between the pretest scores of both groups and this was the reason why independent Sample t –test was used for the analysis of the posttest data. The output of the analysis of the pretest is located at Appendix J whiles that of the posttest is located at Appendix K.The results of the analysis of the posttest scores in its summary form is shown on the Table (4.9)

Table 4.9: Independent t-test analysis of posttest scores on academic performance of Control and Experimental groups

Group	Mean (SD)	t-value	df	Sig (2 - tailed)
CONTROL	7.20 (2.1)			0.000*
EXPERIMENTAL	20.39 (1.8)	45.128	194	0.000*

Control = 60, Experimental =136 P < 0.005 Significance denoted by *

4.8 Discussion of Results for Research Question 4

The hypothesis three (3) assesses the differences between the academic performance of experimental group taught Physics concepts using ethnoscience-based instruction and control group taught same concepts using conventional teaching method. The findings of the study (Table 4.11) revealed that there was statistically significant difference between the Scores of academic performance of experimental group and that of the control group in the posttest scores collected after administering the intervention. According to table 4.11 the experimental group had a mean score of (20.39) whiles the mean score of the control group was (7.20). A t-value of 45.13 at 194 degree of freedom gave a p-value of 0.000. Since the p-value of 0.000 is less than the set alpha level of 0.05 statistical significance, it was concluded that there was a statistically significant difference between control and experimental groups in favour of the experimental group in the study. This is an indication that the ethnoscience-based teaching method used to teach Physics concepts in the experimental group, improved the academic performance of learners whiles the conventional teaching approach caused no significant difference in the performance of the learners in the control group.

In conclusion, the ethnoscience- based instruction has caused high academic performance of learners in the experimental group. This finding agrees with similar research finding by Achor, Imoko, & Uloko (2019) who also studied the effects of Ethno-mathematics Teaching Approach (ETA) on senior secondary students‟ performance and retention of locus. The results revealed that students taught using ETA had higher retention than those taught with the conventional approach. They argued that the higher performance by the ETA taught group was because the group was able to integrate or link their background knowledge/indigenous knowledge to the new concepts they were taught. The study concluded that academic performance and retention in science and mathematics depend on the approach of instruction. Similarly, Mari and Peni (2010) studied the effect of improvised instructional materials on male and female students' academic performance and attitude to volumetric analysis. The findings revealed that there was no difference in the academic performance of male and female students in the concept.

However, the female mean was persistently observed to be higher than that of the male. They attributed the difference to be due to the local/domestic nature of the improvised materials which are more familiar to the girls than the boys. Thus instructional materials obtained from the child's home environment is capable of enhancing the learners interest especially girls. This suggests the efficacy of the ethnoscience-based instruction at improving academic performance of learners over the conventional method. Furthermore, the finding of this study is supported by, Fasasi (2017) who assessed the effects of Ethnocsience Instruction (EI) on academic achievement and interest in science. The result of his study reveals that students taught using EI had higher academic achievement and greater interest in science than those taught using the lecture method. It also agrees with the findings by Ayua (2023) who studied the effect of the ethno-science teaching on performance among upper basic science students with diverse reasoning in Makurdi, Benue State. Based on the findings it was concluded that ethno-science teaching enhances performance of students with diverse reasoning ability without gender disparity. They further emphasized that Ethno-science Teaching should be used for science teaching at the upper basic education level. Nwankwo (2021) who studied the effects of ethno-science instructional strategy on Junior Secondary School Students achievement in basic science also found that there is a significant difference in the mean achievement scores of students in the experimental and control groups in favor of the experimental group taught using ethnoscience instructional strategy. Nwankwo (2021) therefore recommended that basic science teachers should relate learning and instruction to students' cultural practices and other indigenous knowledge by adopting ethno-science instructional strategy.

4.9 Chapter Summary

The chapter focused on data collection, Analysis and Presentation. Two main tests analysis were conducted on the data collected. They include; the Paired sample t-test and the Independent sample t-test. The quantitative data obtained from respondents were analysed descriptively. The qualitative data obtained in the research was analysed thematically. The findings and results of data analysis were thoroughly discussed drawing inference from similar findings of other researchers' work. At the end of the data analysis, it was revealed that;

i. The indigenous people interviewed in the study showed clearly that they have cultural, environmental and traditional practices that a teacher can base on to teach Physics.

ii. The Ethnoscience-based instruction used to teach Physics concepts to students in the experimental group led to the development of positive attitude towards Physics concepts in the study than the conventional teaching approach used to teach Physics concepts to students in the control group.

iii. Ethnoscience-based instruction used to teach Physics concepts to students in the experimental group, aroused and sustained the interest of students in Physics concepts in the study than the conventional teaching approach used to teach Physics concepts to students in the control group.

iv. Students in experimental group recorded high academic performance when taught Physics concepts using Ethnoscience-based instruction than their counterparts in the control group taught Physics concepts using conventional teaching approach. The effect sizes of the treatment were calculated using Cohen (1988) effect sizes calculation principle (For objectives 2, 3&4).

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

The chapter is presented under the following headings; summary of findings, conclusion, contribution to knowledge, recommendation and suggestion for further studies

5.1 Summary of the Study

The objective of this research was to examine the impact of ethnoscience-based instruction on the academic performance, interest, and attitude of physics students enrolled in a subset of senior high schools within Techiman Municipality. 196 students from four senior high schools in the Techiman Municipality comprised the sample. The four educational institutions were intentionally chosen and categorized into control and experimental groups; the intact classes that participated were selected at random.

Three instruments were utilized in the study's data collection. Data were collected from the local populace using the Physics Students Academic Performance Test (PSAPT), which consisted of 25 multiple-choice items, the Students Attitude and Interest towards Physics Questionnaire, which comprised 20 items, and the interview guide. The researcher devised and validated the instruments, which were determined to be reliable with coefficients of $r=0.658$; $p<0.05$ for the PSAPT and $r=0.617$; $p<0.05$ for the Questionnaire.

Pre-testing of both instruments was conducted on the institutions to ascertain that the respondents possessed comparable academic aptitude and inclination towards the field of physics. A random assignment was made to the institutions into experimental and control groups. An instructional approach grounded in ethnoscience was utilized to teach physics concepts to the experimental groups, whereas the control groups were instructed in the same concepts through lectures. The duration of the treatment was five weeks.

After five weeks of instruction, both the PSAPT and the questionnaire were distributed to the students as posttests. The findings were analyzed statistically using SPSS version 20 software with a significance level of 0.05. Descriptive statistics were applied to the data for both the test elements (PSAPT) and the questionnaire, with the primary purpose of calculating the means and standard deviations of the scores. The analysis of the means and standard deviations was conducted utilizing the Five Point Likert Scale. A discussion of the results and a synopsis of the findings were provided.

The following are the major findings of the study.

1. The academic performance of physics students was significantly impacted by ethnoscience-based instruction, as students who were taught the same concepts using this method achieved superior results compared to those who were taught the same concepts using conventional methods.
2. The learning outcomes of students who were exposed to ethnoscience-based instruction in physics were more favorable in comparison to those who were taught using the lecture method.

3. Students were more engaged and maintained their interest in physics when they were exposed to concepts through ethnoscience-based instruction as opposed to when the same concepts were taught using conventional methods.
4. As a result of their cultural and traditional practices, some physics concepts are practically understood by the local populace.

5.2 Conclusion

From the findings of this study the following conclusions are drawn: -

1. Teachers' instructional strategies have a substantial effect on the academic performance of their students.
2. An effective innovation, ethnoscience-based instruction improves the academic performance of students in physics concepts.
3. A positive impact of ethnoscience-based instruction on students' attitudes toward physics concepts is observed.
4. Ethnoscience-based instruction possesses the capacity to stimulate and maintain the interest of students in scientific principles;
5. When ethnoscience and local knowledge are integrated into physics-related lessons, they do engender disagreements among students and are not primitive in nature.
6. Due to the positive correlation between cultural knowledge and advanced scientific knowledge, it is essential to incorporate cultural knowledge into physics concepts in the curriculum.

5.2.1 Contributions to Knowledge

Determining the impact of ethnoscience-based instruction on the academic performance, interest, and attitude of senior high school physics students in Techiman Municipality was the purpose of this research. The following are the contributions to knowledge and implications for educational practices that this study generated;

1. The research has demonstrated that the ethnoscientific method is a viable instrument for enhancing the academic performance of physics students.
2. It was determined that the employed instructional method was more effective for the learning of adolescents (senior high school students).
3. The persistent disparity in academic achievement between schools in categories B and C can be addressed through the implementation of suitable pedagogical approaches, such as ethnoscientific processes that offer students culturally and academically enriching experiences.
4. The researcher modified the Physics Students Academic Performance Tests (PSAPT) and the Students Attitude to Physics Questionnaire (SAPQ) to evaluate students' academic achievement and interest in physics concepts, respectively. Other researchers may utilize these instruments as a template to construct their own instruments that assess pertinent variables of interest.
5. This research investigation into the impacts of ethnoscience-based instruction is unprecedented in the specific context of senior high schools located in Techiman Municipality, Bono East Region. Therefore, additional scholars could conduct comparable investigations either in the identical setting or in different locations in order to validate the effectiveness of the instructional process.

5.3 Recommendations

The present study has compiled empirical evidence regarding the positive impacts of ethnoscience-based instruction on the academic performance, interest, and attitude of senior high school physics students. Hence, it is advisable to consider that:

1. In senior high schools, teachers as curriculum implementers should identify ethnoscience practices in the immediate environment of the learners and integrate them into the teaching of Science related fields especially Physics.
2. Teachers ought to employ effective and innovative pedagogical approaches that takes into account ethnoscience practices enabling learners arouse interest in physics education. This will result in enhanced academic performance and the cultivation of a favorable attitude towards the subject.
3. At the pre-service level, methodology courses offered by student teachers should emphasize the use and implementation of ethnoscience-based instruction in the classroom; at the in-service level, the ministry of education, metropolitan/municipal/district education officers, and school administration should organize seminars and workshops to educate teachers on how to implement ethnoscience-based concepts.
4. In a systematic and clearly communicated manner, science curricula should be reevaluated with regard to instructional strategies to integrate ethnoscientific or culturally significant materials and practices that assist students in gaining confidence and an appreciation for emerging modern scientific concepts.

5.4 Suggestion for Further Studies

The extant body of literature has demonstrated that the application of ethnoscientific knowledge and concepts in Africa has not garnered the level of recognition and acceptance that it merits among scientists. This circumstance explains why a significant portion of the population continues to consider science to be "white man's magic"! In order to dispel this misconception, research should be undertaken in pertinent disciplines that aim to alter perspectives and attitudes toward science while also enhancing academic achievement. Consequently, the following areas are suggested as potential future research directions in the field:

1. Further research should be undertaken to investigate ethnoscientific processes beyond those that were identified and utilized in this study, with the intention of augmenting the catalog of such practices.
2. The ethnoscientific concepts that have been identified possess the potential to inform research in other domains of physics, as well as in related fields of science, biology, and mathematics.
3. While the research focused exclusively on two (2) physics students from senior high schools in Techiman Municipality, replication of the study at other levels (SHS 1 and SHS 3) could provide broader generalizable insights. Similarly, the study can be conducted using pre-service Physics teachers at the B.Sc. and B.Ed levels;
4. There is the need to assess the efficacy of ethnoscience-based instructional approach relative to other instructional strategies like demonstration method, discovery method etc.

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APPENDICES

APPENDIX A

Interview guide for collecting information on cultural practices relevant to the teaching of force of gravity.

Please am I permitted to join your gathering?

My name is …….. A post graduate student of AAMUSTED Mampong Campus. I want to interact with you to learn more about your culture and traditional practices in this community.

Please can you introduce to all who are part of this gathering?

Please can you tell me why you have gathered here with your grandchildren at this time?

Fantastic! Please, how many times do you meet in a week?

What is the topic for this evening's gathering?

Interesting, I can't wait to listen. Please who are Onyankopon and Tano?

Ok, could you tell us what ensued between the two?

What did Onyankopon do then?

What happened after Tano was made to carry the earth and everything in it?

What is the moral lesson of this story for the children to learn?

Great, that is a good lesson for us all to learn.

Thank you very much for your educating me and availing yourself for this important interview.

APPENDIX B

Interview guide for collecting information from a local woman on cultural practice relevant to the teaching of frictional force.

Good evening Mummy

Thank you Mummy. Can you give me few minutes of your time to interact with you?

Thank you Mummy. Please my name is John Sampane, a student of AAMUSTED-Mampong campus. I am here to learn more about the cultural practices of the people in this community especially concerning the use of kitchen grader to prepare cassava dough as you are doing while preparing Banku?

Thank you. Please may I know the reason you are rubbing the cassava over the plastic device?

Why don't you use the smooth side of the device rather?

What do you think makes the rough surface able to produce the dough more than the smooth surface?

Fantastic! I'm happy to learn a lot from you today. Thank you very much for your time to share this rich experience with me.

Thank you, too for making time to learn from our culture.

APPENDIX C

Interview guide for collecting information culturally relevant for teaching mode of heat transfer by conduction.

Good evening, Madam.

Please my name is John, a postgraduate student of AAMUSTED.

For the purpose of a research, I want to find out some few information about some of the traditional practices in your culture. It is my plight to learn more about your culture.

Firstly, I can see you are cooking. May I ask, what is the spoon you use for stirring the soup made of? Wood, metal, ceramic or plastic?

Why did you choose a metal spoon as compared with other materials?

Oh I see. Why don't you leave the spoon in the soup after stirring?

What happens if the spoon becomes hotter?

Please why do you think so?

Great, observation. So can you conclude that heat can move through metals?

I must be frank, I am happy to learn more about your culture. Thank you so much for your time. Relocation was in transition

APPENDIX D

Interview guide for collecting data for teaching heat transfer by convection

I am fine. Please my name is John, a student of AAMUSTED-Mampong Campus. I am here to learn about some practices in your culture and traditions.

I can see water in a black pot placed on fire.

Great, how do you want the water to be, before you can use it bath?

Please how do you determine that the water is hot or warm?

Great, and what does the bubble movement mean?

How do you know that the surface is also hot?

So can you conclude that heat has moved through the water?

Please how?

This is an interesting observation. I am very happy to learn a lot from you today.

Thank you and bye for now

APPENDIX E

Interview guide for collecting information to teach heat transfer by radiation

Good morning Mummy and children

Thank you Mummy. Please my name is John a student of AAMUSTED- Mampong campus. I am here to study your culture and see those aspects of your culture we can use in teaching and learning.

Please do you feel the hotness of the fire at the distance you and the children are sitting around the fire?

What makes you think causes the hotness of the fire to reach that distance?

By what means did it get to your end? What connects the fire to your end?

Do you conclude that the heat from the fire reaches you through no physical object or substance?

Good observation. Thank you for your time to explain things to me. I am happy to learn a lot from this practice.

APPENDIX F

Tool for data gathering

Questionnaire for the students' Attitude and Interest towards Physics

Student Code……………………………………………………

School…………………………………………………………

Dear respondent, Please tick the appropriate box as to the level you agree with the statements, taking note of the following:

Strongly Agree (**S A**) Disagree (D)

Agree (**A**) Strongly Disagree (S **D**) Neutral (**N**)

SN	ITEMS	SA	A	N	D	SD
	. Attitude towards Physics					
1	I am scared of physics because people say it is difficult.					
2	I like physics (science) because my parents are scientists.					
3	My major problem with physics is the calculation it contains.					
4	In my opinion, Physics is meant for the most intelligent students					
5	I think that, science is about understanding how the natural world works					
6	I heard that, scientists can believe in God or a supernatural being and still do good					

	at physics					
7	I will not do Physics (science) because it changes one's faith					
8	I see physics as the magic of the white man.					
9	I do not see anything physics in what I do every day.					
10	My teachers do not relate Physics to my everyday activity					
	Interest towards Physics					
11	I easily understand physics because I am interested in it.					
12	I lose interest whenever it is time for physics lesson.					
13	My major problem with Physics is the calculations it contains.					
14	I heard that, physics involves the use of complex machines and they are dangerous to use.					
15	I am scared of physics because people say it is difficult.					
16	I heard that, those who study physics do not relate well with people.					
17	Most of what is taught to us as physics					

	are things we have never seen with our eyes.					
18	I always encourage my friends to study Physics.					
19	I always happily prepare for Physics lessons.					
20	Most Physics (science) inventors are “white men” therefore I do not think black people can be good scientist					

APPENDIX G

Answer all questions by choosing the right answer from the alternatives A- D by circling the right answer. All questions carry equal marks.

1. The earth's gravitational force pulls all bodies ……………
    a. Horizontally down
    b. Horizontally up
    c. Vertically up
    d. Vertically down
2. The following are thermal conductors **except**
    a. Alcohol
    b. Copper
    c. Mercury
    d. Water
3. Which of the following forces does not cause a change in the velocity of a body moving in a horizontal plane
    a. Air resistance
    b. Frictional force
    c. Gravitational force
    d. None of the above
4. Which of the following metals have very high thermal conductivity
    a. Copper
    b. Iron
    c. Lead
    d. Zinc
5. The following are classes of motion under gravity EXCEPT
    a. A body moving vertically up or down in air
    b. A body moving on an inclined plane

c. A body moving in a leveled horizontal plane

d. Projectile motion

6. Which of the following is a determining factor for convectional current in fluids

   a. Changes in fluids volume

   b. Changes in fluids density

   c. Changes in fluids mass

   d. Changes in fluids expansivity

7. The collective term used to refer to the motion of a body in the air at an angle that describes a parabolic and hyperbolic path is known as

   a. Periodic motion

   b. Projectile motion

   c. Brownian motion

   d. Simple harmonic motion

8. In the absence of air resistance, different objects of different masses held at the same height and left to fall will hit the ground simultaneously. This was a discovery of a physicist called……….

   a. Albert EIstein

   b. Isaac newton

   c. Galelei Galeleo

   d. Blaise Pascal

9. The equation V = U – gt shows that ………………

   a. The velocity of a body accelerating vertically in air.

   b. The velocity of a body decelerating vertically in air

   c. The velocity of a body accelerating horizontally on the leveled ground.

   d. None of the above

10. All the following statements about radiant energy are correct EXCEPT

a. It can be reflected
b. It can be refracted
c. It can be polarized
d. It can be reversed

11. Measuring the inertia of a body is equivalent to measuring its…………

a. Weight
b. Centre of gravity
c. Mass
d. None of the above

12. The following factors affects the amount of heat radiated from a hot body EXCEPT

a. State of the body
b. Temperature
c. Surface area
d. Nature of the surface

13. Which of the following changes when part of the body is either removed or added?

a. Center of mass
b. Mass of the body
c. The gravitational pull on the body
d. All of the above

14. A 20kg of a bag of maize has a weight of

a. 169 N ($g= 9.8m/s^2$)
b. 29.8 N
c. 196 N
d. 20 N

15. If a body is shot vertically up into the air the earth's gravity causes it to

a. Accelerate

b. Decelerate

c. Change in speed

d. Become stationary

16. Which of the modes of heat transfer does not obey the kinetic theory.

a. Conduction

b. Radiation

c. Convection

d. None of the above

17. Acceleration due to gravity is a ……

a. Vector quantity represented by the symbol G

b. scalar quantity represented by the symbol G

c. Vector quantity represented by the symbol g

d. Scalar quantity represented by the symbol g

18. Which of the following equations represents temperature gradient of a conductor (where the symbols have their usual meaning)

a. T_{em}gradient = $\frac{KT_1 \quad -T_2}{L}$

b. T_{em} gradient = $\frac{KT_2 \ - \ T_1}{L}$

c. T_{em} gradient = $\frac{L}{KT_{2-T_1}}$

d. T_{em}gradient = LK ($T_2 - T_1$)

19. The S. I unit of temperature gradients is

a. $K\ \mathrm{C}m^{-2}$

b. $K\ m^{-1}$

c. $K\ m^{-2}$

d. $K\mathrm{m}m^{-1}$

20. At what distance can one determine the centre of gravity of 15cm ruler.

a. 7cm

b. 10cm

c. 7.5cm

d. 15cm

21. When heat is lost through the sides of the objects as it flows from one end of the object to other end, it is termed as

a. Laminar heat flow

b. Streamline heat flow

c. Turbulent heat flow

d. Regular heat flow

22. If the force between two bodies is 20 N. what would be the attractive force each one exerts on the other

a. 20 N each

b. 10 N each

c. 5 N each

d. 15 N each

23. Which of the following objects can best enjoy free fall due to gravity

a. Piece of paper falling from sky

b. Leave detached itself from tree

c. Mango fruit detached itself from tree

d. Feathers of birds

24. According to the experiment on free fall, if air resistance is neglected, two objects of different masses (or densities) in a free fall have

a. The same acceleration

b. The same velocity

c. Different acceleration

d. Different velocity

25. The Following impacts are as a result of friction EXCEPT

a. Foot of Ladder hold firmly on the ground

b. Matches sticks catches fire when it is struck against the box

c. Car suddenly stops as it's brake is applied

d. Rubber plastics attract pieces of paper after rubbing against dry hair

APPENDIX H

AKENTEN APPIAH-MENKA UNIVERSITY
of Skills Training *and* Entrepreneurial Development

FACULTY OF SCIENCE EDUCATION
DEPARTMENT OF INTEGRATED SCIENCE EDUCATION

P.O. Box 40, Asante Mampong   0270001890, 0502972415

M/DISE/ADM/STU/01/09   **JANUARY 16, 2023**

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

INTRODUCTORY LETTER FOR MR. JOHN SAMPANE

We write to introduce Mr. John Sampane, who is an M.Phil. (Science Education) student of this Department. Mr. Sampane is working on a project titled "***Effects of enthnoscience-based instructional approach on academic performance of physics students in some selected senior high school in Techiman municipality***" and would like to collect data from your institution for a period of six (6) months to enable him complete his thesis, which is a requirement for graduation.

We would be grateful if you could offer him the needed assistance. We count on your usual cooperation.

Thank you.

Yours faithfully,

DR. EBENEZER E. MENSAH
(AG. HEAD OF DEPARTMENT)

APPENDIX J

Independent sample t-test output of pretest

Warning # 849 in column 23. Text: en_GH

The LOCALE subcommand of the SET command has an invalid parameter. It could not be mapped to a valid backend locale.

```
GET DATA
  /TYPE=XLSX
  /FILE='D:\Academia\StudentsThesis\Masters\MPhil
Thesis\ScienceEduc\Sampana\Data\ArrangedForAnalysisForAssumptions.xlsx'
  /SHEET=name 'ForANCOVA'
  /CELLRANGE=FULL
  /READNAMES=ON
  /DATATYPEMIN PERCENTAGE=95.0
  /HIDDEN IGNORE=YES.
EXECUTE.
DATASET NAME DataSet1 WINDOW=FRONT.
T-TEST GROUPS=Group(1 2)
  /MISSING=ANALYSIS
  /VARIABLES=PreTest
  /ES DISPLAY(TRUE)
  /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		21-JUL-2024 08:18:32
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	196
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=Group(1 2) /MISSING=ANALYSIS /VARIABLES=PreTest /ES DISPLAY(TRUE) /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.01

[DataSet1]

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
PreTest	1	136	7.15	2.688	.231
	2	60	7.08	2.573	.332

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
PreTest	Equal variances assumed	.206	.650	.173	194
	Equal variances not assumed			.176	117.602

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
PreTest	Equal variances assumed	.863	.071	.411
	Equal variances not assumed	.861	.071	.404

Independent Samples Test

		t-test for Equality of Means	
		95% Confidence Interval of the Difference	
		Lower	Upper
PreTest	Equal variances assumed	-.740	.882
	Equal variances not assumed	-.730	.872

Independent Samples Effect Sizes

		Standardizer[a]	Point Estimate	95% Confidence Interval Lower	Upper
PreTest	Cohen's d	2.654	.027	-.277	.331
	Hedges' correction	2.664	.027	-.276	.329
	Glass's delta	2.573	.028	-.276	.331

a. The denominator used in estimating the effect sizes.

Cohen's d uses the pooled standard deviation.

Hedges' correction uses the pooled standard deviation, plus a correction factor.

Glass's delta uses the sample standard deviation of the control group.

APPENDIX K

Independent sample t-test output of posttest

Warning # 849 in column 23. Text: en_GH

The LOCALE subcommand of the SET command has an invalid parameter. It could not be mapped to a valid backend locale.

```
GET DATA
  /TYPE=XLSX
  /FILE='D:\Academia\StudentsThesis\Masters\MPhil
Thesis\ScienceEduc\Sampana\Data\ArrangedForAnalysisForAssumptions.xlsx'
  /SHEET=name 'ForANCOVA'
  /CELLRANGE=FULL
  /READNAMES=ON
  /DATATYPEMIN PERCENTAGE=95.0
  /HIDDEN IGNORE=YES.
EXECUTE.
DATASET NAME DataSet1 WINDOW=FRONT.
T-TEST GROUPS=Group(1 2)
  /MISSING=ANALYSIS
  /VARIABLES=PostTest
  /ES DISPLAY(TRUE)
  /CRITERIA=CI(.95).
```

T-Test

Notes

Output Created		21-JUL-2024 08:06:35
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	196
Missing Value Handling	Definition of Missing	User defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on the cases with no missing or out-of-range data for any variable in the analysis.
Syntax		T-TEST GROUPS=Group(1 2) /MISSING=ANALYSIS /VARIABLES=PostTest /ES DISPLAY(TRUE) /CRITERIA=CI(.95).
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.01

[DataSet1]

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
PostTest	1	136	20.39	1.785	.153
	2	60	7.20	2.098	.271

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
PostTest	Equal variances assumed	2.510	.115	45.128	194
	Equal variances not assumed			42.399	98.352

Independent Samples Test

		t-test for Equality of Means		
		Sig. (2-tailed)	Mean Difference	Std. Error Difference
PostTest	Equal variances assumed	.000	13.190	.292
	Equal variances not assumed	.000	13.190	.311

Independent Samples Test

		t-test for Equality of Means 95% Confidence Interval of the Difference	
		Lower	Upper
PostTest	Equal variances assumed	12.613	13.766
	Equal variances not assumed	12.572	13.807

Independent Samples Effect Sizes

		Standardizer[a]	Point Estimate	95% Confidence Interval	
				Lower	Upper
PostTest	Cohen's d	1.886	6.994	6.233	7.751
	Hedges' correction	1.893	6.967	6.209	7.721
	Glass's delta	2.098	6.288	5.114	7.457

a. The denominator used in estimating the effect sizes.

Cohen's d uses the pooled standard deviation.

Hedges' correction uses the pooled standard deviation, plus a correction factor.

Glass's delta uses the sample standard deviation of the control group.