IMPACT OF LOW-COST EDUCATIONAL MATERIALS ON STUDENTS' KNOWLEDGE TOWARDS HEAT TRANSFER

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A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF HEALTH SAFETY AND ENVIRONMENTAL EDUCATION, FACULTY OF EDUCATION, UNIVERSITY OF BENIN, BENIN CITY.

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE B.SC (ED) DEGREE IN ENVIRONMENTAL EDUCATION

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CERTIFICATION

This is to certify that this study was carried out by OPUTA DEBORAH OGOCHUKWU with matriculation number EDU1904532 in the Department of Health Safety and Environmental Education, Faculty of Education, University of Benin and was approved adequate in scope and quality in partial fulfillment of the award of Bachelor of Science Degree in Environmental Education.

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DEDICATION

This project is dedicated to the God Almighty who has been my source of assistance, happiness, tranquility, and enlightenment, who, through His benevolence, has continually guided my journey and illuminated the path of this endeavor. Additionally, I express my heartfelt appreciation to the God for the wisdom acquired and the deepening of faith experienced throughout the course of this project.

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TABLE OF CONTENTS

CERTIFICATION iii

DEDICATION iv

ACKNOWLEDGEMENT v

TABLE OF CONTENTS vi

LIST OF TABLES ix

ABSTRACT x

CHAPTER ONE 1

INTRODUCTION 1

Background of the Study 1

Statement of the Research Problem 5

Research question 6

Hypothesis: 6

Purpose of the study 6

Significance of the Study 7

Scope/Delimitation of the Study 8

Limitation of the Study 8

Definition of Terms 9

CHAPTER TWO 11

REVIEW OF RELATED LITERATURE 11

The Concept of Heat Transfer 12

Heat Transfer in the Atmosphere, Hydrosphere and Lithosphere 15

Heat Transfer between the Environment and Flora and Fauna. 22

Mechanism of Heat Exchange in Homeotherms. 27

Importance of Heat Transfer 28

The Concept of Low Cost Instructional Materials 33

The Importance of Low Cost Instructional Materials 34

Summary of Reviewed Literature 35

CHAPTER THREE 38

METHODOLOGY 38

Population of the Study 40

Research Instrument 42

Validity of the Instrument 43

Reliability of the Instrument 43

Method of Data Collection 43

Method of Data Analysis 44

CHAPTER FOUR 45

PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS 45

Hypotheses Testing 49

Discussion of Findings 51

CHAPTER FIVE 54

SUMMARY, CONCLUSION AND RECOMMENDATIONS 54

Summary 54

Conclusion 56

Recommendations 57

Suggestions for Further Study 58

REFERENCES 59

APPENDIX 65

LIST OF TABLES

TABLE 3.0: Quasi Research Design 41

TABLE 3.1: Sampling Method 43

TABLE 4.0: Mean and standard deviation low-cost environmental education materials have an impact on the knowledge of concept of heat transfer among students in the University of Benin. 46

TABLE 4.1: Low cost environmental education materials have impact towards the concept of heat transfer attitude among students in the University of Benin. 48

TABLE 4.2: ANCOVA on low cost environmental education materials have no significant impact towards the knowledge heat transfer among students in the University of Benin. 50

TABLE 4.3: ANCOVA on low cost environmental education materials have no significant impact towards the heat transfer attitude among students in the University of Benin. 51

ABSTRACT

The research examines how affordable teaching materials affect students' understanding of heat transfer at the University of Benin. Two research questions and two hypotheses were developed and answered to guide the study.

A quasi-experimental survey design was utilized, with 50 participants selected purposefully from the Health, Safety, and Environmental Education (HSE) department, specifically 100 level students. A structured questionnaire created by the researcher was used to collect data, which was then analyzed using mean, standard deviation and frequency counts for descriptive purposes.

The findings indicate that inexpensive teaching materials have a significant impact on both teaching and learning processes, as well as on the long-term retention of environmental education knowledge when implemented in instruction.

CHAPTER ONE

INTRODUCTION

Background of the Study

The study aims to understand the effect of low-cost educational materials in the teaching of heat transfer in order to know the extent of understanding and comprehension of the students with the low-cost educational materials and without it. Particularly within Nigeria's educational system, where there may be inadequate facilities or funding of the educational sectors, which makes the teaching and learning process difficult for the teachers and students. This explores the use of cheap and available tools that can the learning process of heat transfer**.** Educational materials are highly essential in the teaching and learning process because they make learning more interesting, practical, realistic, and appealing. They could be visual and auditory media, curricula, textbooks, and other disposable or non-disposable items that enhance student understanding of the subject matter. They also enable both the teachers and students to participate actively and effectively in lesson sessions. In this regard, this research is to see how low-cost educational materials affect the knowledge and understanding of heat transfer to the students.

Low-cost teaching aid refers to aid prepared with simple materials costing very little by involving teacher and student. It involves minimal or nil input costs as they are made from

household waste and discarded items or from materials readily available in our immediate surroundings and natural environments (Devasis, 2022). It was also defined by Iqbal (2012) as teaching aids that require available resources and expedite the process of learning in the classroom. These materials are developed from waste and make the teaching interesting and concrete. Examples of these materials are plastic bottles, shoe boxes, buttons, bottle caps, small and big cartons, beads, ice cream sticks, pieces of cloth, old newspapers and magazines, etc.

Heat is related to thermal energy. The thermal energy of an object is the energy contained in the motion and vibration of its molecules. Thermal energy is measured through temperature (Randall, 2013). Transfer is the movement of something from one place to another but in this context, it is the movement of heat from one object to another.

Heat Transfer occurs between states of matter whenever a temperature difference exists and heat transfer occurs only in the direction of decreasing temperature, meaning from a hot object to a cold object (Woolridge & Luebbers, 2020). Heat transfer occurs between objects with different temperatures, with energy transferring from the hotter to the colder object until they reach the same temperature. The major effect of heat transfer is temperature change, with heating increasing and cooling decreasing. Heat transfer is a broad topic covering various scientific subjects, and this research focuses on its environmental aspects.

The National Oceanic and Atmospheric Administration (NOAA, 2024a) thoroughly gave a detailed explanation of how heat transfer occurs in our ecosystem through the use of the most powerful and natural source of light and energy, that is the sun which transfers space heat and energy that important to the existence of man, animals, plants and their various ecosystems. The energy from the sun warms the earth's surface and the warming of the atmosphere. As the hot air mass rises, it is replaced by the surrounding cooler, more dense air, which we feel as wind. These movements of air masses can be small in a certain region, such as local cumulus clouds, or large cycles in the troposphere, covering large sections of the Earth. The large cycles are called convection currents and are responsible for many weather patterns in the troposphere. Heat transfer can be said to be a flow of heat from a hotter region to a colder region. The transfer of heat can occur in three ways: conduction, convection, and radiation.

Radiation is the transfer of heat energy through space by electromagnetic radiation. An example of radiation is if you are in front of a fireplace, the side of your body nearest the fire warms while your other side remains unaffected by the heat. You have felt the heat transfer known as radiation. Although you are surrounded by air, the air has nothing to do with this transfer of heat. Most of the solar radiation is absorbed by the atmosphere, and much of what reaches the Earth's surface is radiated back into the atmosphere to become heat energy. Dark-colored objects, such as asphalt, absorb radiant energy faster than light-colored objects. However, they also radiate

their energy faster than lighter-colored objects. (The variations in how Earth's surface absorbs heat from the Sun are called differential heating).

Conduction refers to the transfer of heat energy either between substances or within a single substance. For instance, when water is boiled in a pot and left with a spoon inside it, one can observe that the handle of the spoon becomes hot after some time. This phenomenon occurs due to heat energy being transmitted from molecule to molecule or atom to atom. Conduction proves highly efficient for transferring heat in metals but air conducts heat poorly.

Convection is the method by which heat energy is transferred in a fluid. A prime example of this phenomenon can be observed when water is boiled, causing the hotter portion to rise while colder water sinks below. This results from the fact that colder water possesses greater weight than its warmer counterpart. It should be noted that air present within Earth's atmosphere functions as a type of fluid as well. When radiation from the Sun strikes Earth's surface, it triggers warming effects; consequentially, as conduction raises temperatures at said surface level, heat energy is expelled into surrounding atmospheric air pockets - creating an area of warmth relative to its surroundings - and resulting in rising bubbles of warm air ascending through the atmosphere only to eventually cool down and transfer their absorbed thermal energy into adjacent areas upon descent.

Statement of the Research Problem

The challenge in instructing heat transfer lies in the complexity of its terminology, which can prove to be a stumbling block for many students. Consequently, this deters their interest and engagement with the subject matter, leading to a lack of comprehension and boredom during lectures. The adverse effect of this predicament is felt most acutely by those pursuing scientific and environmental studies.

Addressing this issue would not only facilitate an understanding of heat transfer but also leave a lasting impression on the minds of students. It will foster greater utilization of educational resources while teaching environmental topics and encourage students to adopt more innovative approaches when approaching complex problems. It enables students to apply the instruction in practical scenarios, endowing them with problem-solving abilities rooted in the teachings. This enhances their learning outcomes and amplifies their drive to acquire knowledge about environmental topics.

The objective of this study is to comprehensively comprehend the influence of low-cost educational resources on heat transfer through quantitative means. A questionnaire will be administered to compare the effects on knowledge and attitude toward heat transfer with and without low-cost educational materials.

Research question

The following research questions will guide this study;

1. Will the use of low-cost environmental education materials have an impact on the knowledge heat transfer among students in the University of Benin?

2. Will the use of low cost environmental education materials have impact towards the heat transfer attitude among students in the University of Benin?

Hypothesis:

1. Low cost environmental education materials have no significant impact towards the knowledge heat transfer among students in the University of Benin.

2 Low cost environmental education materials have no significant impact towards the heat transfer attitude among students in the University of Benin.

Purpose of the study

The purpose of this study is to examine the impact of low-cost instructional materials on students' knowledge of heat transfer at the University of Benin.

Other objectives are:

I. To assess the efficacy of affordable teaching aids in enhancing students' comprehension and knowledge of heat transfer.

II. To evaluate the impact of budget-friendly instructional materials on students' understanding of heat transfer.

III. To investigate how low-cost teaching aids influence student motivation and engagement with regards to heat transfer.

IV. To ascertain the long-term retention effects of low-cost instructional materials on students' grasp of heat transfer concepts.

Significance of the Study

This research aims to enhance our comprehension of how low-cost educational materials can effectively improve student learning outcomes in heat transfer. The results may inform the development and implementation of tailored low-cost instructional materials that cater to specific contexts and learning needs, offering valuable insights for educators and policymakers seeking to address educational disparities and promote equitable access to quality science education for all students.

The study explores the significance of cost-effective teaching aids when conveying scientific concepts at tertiary institutions, particularly those lacking adequate equipment and funding. Educators are encouraged to leverage readily available resources within their immediate surroundings to create these aids, which bolster knowledge retention over extended periods. Given Nigeria's limited financial resources for education, it is challenging to equip laboratories with sophisticated scientific equipment. Hence this research strives to raise awareness regarding the utilization of local materials for producing low-cost teaching aids. The use of such apparatus is critical in facilitating effective instruction on scientific principles while also fostering student engagement during the learning process.

Scope/Delimitation of the Study

This research is confined to the examination of how low-cost educational resources affect University of Benin campus students' comprehension of the principles governing heat transfer.

Limitation of the Study

1. Temporal limitations that restrict the amount of time allocated for investigating research issues.

2. The researcher is currently honing their research abilities and may not possess the same caliber of expertise or mastery as seasoned professionals.

3. The research is limited in scope, as no study can encompass all aspects related to a topic. I acknowledge that my study has limitations and there is a necessity for future investigations to scrutinize additional relevant variables or concepts. This project has a distinct and confined objective.

Definition of Terms

1. **EDUCATIONAL MATERIAL**: encompasses a wide range of resources used by educators to facilitate student learning within an educational context. They play a crucial role in shaping the learning experience and influencing student understanding and engagement.

2. **LOW-COST EDUCATIONAL MATERIALS**: these are materials that require no cost or are available cheaply. It emphasizes resourcefulness, creativity, and effectiveness within budgetary constraints.

3. **HEAT TRANSFER**: Heat transfer refers to the movement of thermal energy from a region of higher temperature to a region of lower temperature.

4. **RADIATION**: The sun's energy reaches Earth primarily through radiation, warming the atmosphere and land surfaces. Earth also radiates heat back into space. This balance determines global temperatures.

5. **CONVECTION**: Convection currents in the atmosphere and oceans help redistribute heat globally. Warm air rises, cools, and descends, forming wind patterns and influencing weather systems. Ocean currents transport heat from equatorial regions to the poles, moderating climates.

6. **CONDUCTION**: Heat directly transfers from warmer to cooler objects in contact. For example, sunlight heats land, which conducts heat to air and plants.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

That chapter presents the review of related literature organized under the following sub-headings.

- The Concept of Heat Transfer.
- Heat Transfer in the Atmosphere, Hydrosphere, and Lithosphere.
- Heat Transfer between Environment and Flora and Fauna.
- Importance of Heat Transfer.
- The Concept of Low Cost Instructional Materials.
- The Importance of Low Cost Instructional Materials.
- Summary of Reviewed Literature.

The Concept of Heat Transfer

Heat is energy that takes the form of the movement or vibrations in particles of matter. The hotter a substance is, the faster the particles that make up the substance are moving or vibrating (Comunale, Zesiger & Cena, 2023). Heat transfer is the movement of thermal energy caused by temperature differences. The study of transport phenomena involves the exchange of momentum, energy, and mass through conduction, convection, and radiation *("What is heat transfer", 2023).*

1. **Radiation:**

Radiation is energy that moves in the form of waves or particles. We encounter radiation daily, from sources such as the sun, microwave ovens, and radios. While most radiation poses no threat to our health, some does. Generally, lower doses of radiation have lower risks but higher doses can be more dangerous. Depending on the type of radiation, different measures must be taken to protect ourselves and the environment while still benefiting from its many applications (IAEA, 2023).

Non-ionizing radiation refers to energy released from the lower-energy region of the electromagnetic spectrum, including sources such as light, radio waves, microwaves, infrared (heat), and ultraviolet light. On the other hand, ionizing radiation is powerful enough to remove

an electron from an atomic orbital, forming an ion. This category includes x-rays, gamma rays, alpha particles and beta particles (Helmenstine, 2019).

In terms of radiation to heat transfer, there is thermal radiation is also known as radiant heat, encompasses all forms of electromagnetic radiation that emanate from an object through the thermal emission process. This includes electromagnetic radiation of any frequency generated by the process of thermal emission, not just infrared frequencies. The thermal emission process involves random movements of atoms and molecules within an object in response to its temperature, which result in the release of electromagnetic radiation. All objects made up of atoms emit thermal radiation constantly; only an object at precisely zero absolute temperature would emit no such radiation. As an object's temperature increases, so does its output of thermal radiation and expansion in spectrum to include higher frequencies. Various combinations of radio wave thermal radiation, infrared thermal radiation, visible light thermal radiation, ultraviolet thermal radiation, x-ray thermal radiation and gamma ray thermal radiation can be emitted depending on the temperature level attained by said object (Baird, 2023).

2. **Conduction:**

Conduction is a way that heat moves through solids without the material itself moving. It happens when molecules vibrate and pass energy to their neighbors, which increases temperature

and spreads heat through the material. The speed of conduction depends on how well the material conducts heat, which is its thermal conductivity *("what is conduction", 2024)*.

Thermal conduction is a natural occurrence in our environment, whereby the sun's rays heat up the earth and transfer energy to the atmosphere through this process. However, during calm weather conditions, only a limited amount of air is warmed due to its relatively low thermal conductivity. This results in a significant temperature difference of up to 50 percent between surface level and five feet above ground level. Given this limitation, alternative methods must be employed for efficient energy transfer (Dastrup et al, 2020).

3. Convection:

Convection represents a significant mechanism for the transfer of heat. This phenomenon arises due to the tendency of hotter gases and liquids to ascend, while colder ones tend to descend (Harland, 2018). The mechanism of convection is facilitated by the phenomenon wherein a fluid, upon being heated, undergoes expansion and consequent reduction in density. This less dense and warmer fluid then ascends away from its heat source, thereby inducing a downward flow of cooler fluids to fill the void left behind. The newly arrived cool fluid is subsequently heated and continues this cycle by rising upwards while pulling down more cool fluid. This process manifests as a circular current that persists until homogenous distribution of heat throughout the

entire fluid volume is achieved (Kirchhoff, 2018). These movements are referred to as convection currents, and the convective flow of fluid persists so long as there exists a disparity in temperature among regions.

Heat Transfer in the Atmosphere, Hydrosphere and Lithosphere

The Earth is a complex system consisting of interconnected parts. These major systems, which are the atmosphere, hydrosphere, lithosphere and biosphere, interact with each other in various ways. For instance, the lithosphere forms the foundation for both the hydrosphere and atmosphere while the atmosphere helps regulate temperature in the biosphere. Additionally, processes like weathering and erosion by biospheric activities shape geospheric features. To understand Earth as a whole requires an understanding of these interactions between these four major systems. This discourse will expound on the transfer of thermal energy across diverse systems.

1. **Atmosphere:**

An atmosphere is made of the layers of gases surrounding a planet or other celestial body. Earth's atmosphere is composed of about 78% nitrogen, 21% oxygen, and one percent other gases (National Geographic, n.d.).

Heat moves through the atmosphere just like it does in solid ground. Radiation is when energy travels between objects via electromagnetic waves. The ground emits heat into the lower atmosphere (R. Adam, 2020). Clouds, aerosols, and gases in Earth's atmosphere affect radiation, including both sunlight or solar radiation and thermal or long-wave radiation. Various factors impact the amount of solar radiation reaching the Earth's surface and leaving its atmosphere, such as humidity, temperature, cloud droplets, atmospheric gases, aerosol particles, and land/ocean surfaces' characteristics (DOE, n.d.).

Conduction is when heat transfers from a hotter area to a cooler one, through direct contact. In denser air at lower altitudes, conduction works better and can transfer heat upwards or laterally between warmer and cooler spots with less vigorous molecule movement (R. Adam 2020). Conduction is the process by which heat moves from a region of higher temperature to one of lower temperature through direct contact. Since air is a poor conductor, conduction primarily takes place near Earth's surface. Conduction has a direct impact on air temperature only within a few centimeters of the atmosphere. During daytime hours, sunlight warms up the ground and subsequently transfers heat directly to the surrounding air via conduction. Conversely, during night-time hours, as the ground cools down, heat flows from warmer air located above it toward cooler ground below via conduction (UCAR, 2018).

The process of transferring heat through the movement of heated materials is known as convection. Convection cells in the atmosphere are initiated by heat radiating from the ground. Convection is the process of transferring heat by moving heated materials (R. Adam, 2020). Heat radiating from the ground initiates convection cells in the atmosphere, which are areas within a fluid (liquid or gas) where lighter (less dense) warm material rises in the center and heavier (denser) cold material sinks (Nicholas & Nicholas, 2023). These cells can occur at small or large scales in the atmosphere. As air flows underneath and turns with the earth, it creates winds that, in turn, create surface waves on oceans.

2. **Hydrosphere:**

The hydrosphere comprises all of the water on Earth, including that found in oceans, underground, on the surface, and in the atmosphere. Water covers approximately 71% of Earth's surface area. However, only a small fraction - around three percent - is fresh water and the remaining ninety-seven percent is salt water (National Geographic, n.d.). Heat within the Hydrosphere occurs through convection and conduction, these hydrological effects result from heat acting upon the hydrosphere which includes the following processes;

The hydrological circle is when sunlight reaches the Earth, it heats the atmosphere, land, and ocean. This results in water evaporation. The movement of water from the ocean to the

atmosphere to the land and back again creates what we call the water cycle. The sun's energy is responsible for driving this process (NASA, 2024). The water cycle is a complex system that demonstrates the perpetual movement of water within the Earth and atmosphere. It encompasses various intricate processes, including liquid water's evaporation which is due to conduction of heat from the sun which changes liquid to gas, and in meteorology, water is the main substance of interest. Energy is necessary for evaporation and can come from various sources such as the sun or humans. Condensation occurs when water vapor turns into a liquid state forming clouds or dew depending on the difference between air temperature and dew point temperature. Precipitation results from tiny condensation particles that grow too large to be supported by rising air, falling back down as rain, hail, snow, or sleet. Runoff happens after excessive precipitation saturates the ground causing rivers and lakes to form; most returns to oceans while some evaporates back into the atmosphere if there's no outlet for it to flow out of a lake. The same also infiltrates and percolates into the ground while moving through it (groundwater). Groundwater moves into plants via their roots (plant uptake). Transpiration happens when plants release water through small openings called stomata on their leaves evaporating from them into the atmosphere. This process depends on atmospheric humidity and soil moisture content. In addition, solid ice and snow can directly transform into gas; this process is known as sublimation. Conversely, when water vapor becomes solid, it results in deposition (NOAA, 2023).

Another way that heat is transferred in the hydrosphere is through a process known as thermohaline circulation. This refers to the part of ocean circulation with the help of convection that is influenced by differences in density caused by variations in temperature and salinity. These differences are created by changes at the sea surface, such as heating or cooling, and from freshwater input like evaporation or ice formation which affect salinity levels. While there are some minor heat sources at the bottom of the ocean, they do not play a significant role (Rahmstorf, 2006).

The thermohaline process starts when ocean water in the polar regions becomes very cold and forms sea ice. This causes the surrounding seawater to become saltier as the salt is left behind. The increased salinity makes the seawater denser, causing it to sink. Surface water then replaces the sinking water, which eventually becomes cold and salty enough to sink as well. This sets off deep-ocean currents that drive the global conveyor belt - a constantly moving system of deep-ocean circulation driven by temperature and salinity. This motion is caused by both thermohaline currents in the deep ocean and wind-driven currents on the surface. Cold, salty water sinks to the bottom of the ocean because it's dense while warm water remains on top due to its lower density, this is due today the convectional process they occurs in the ocean. The Norwegian Sea is where this conveyor belt begins: warm Gulf Stream water heats up northern latitudes but loses heat to the atmosphere making it cooler and denser so that it sinks to form part of bottom waters flowing

southward down towards Antarctica before returning back up through mixing and wind-driven upwelling continuing around globe (NOAA, 2024).

3. Lithosphere:

The lithosphere refers to the solid outer layer of Earth, which comprises the brittle upper mantle and crust (National Geographic, n.d.). There are two ways the lithosphere get heated and that is through the sun and the core. The heat that powers it comes from the core and deep mantle through two main types of transfer: conductive and convective. It involves this process by which Earth makes heat is called radioactive decay.

Geological Disgression (n.d.) noted that heat transfer occurs in the earth crust and interior, its states that the disintegration of natural radioactive elements, like uranium, radium, thorium, polonium, potassium inside the Earth produces heat. This process is called radioactive decay and it happens to many rocks in the Earth's crust and interior. The decay releases subatomic particles that collide with surrounding material and create heat energy. Without this process, there would be fewer earthquakes, volcanoes, and mountain ranges on Earth. However, the amount of heat produced by this process is much less than what we receive from the sun which drives weather patterns and erosion. It's interesting to note that while Earth's internal heat creates mountains, the sun slowly breaks them down over time.

Heat transfer through conduction occurs at the molecular scale, primarily from molecular vibrations. Although slow in rocks over geological time scales, it remains important in the lower crust and mantle lithosphere. In contrast, heat transfer in the upper crust relies on convective and advective flow of fluids due to higher porosity and permeability. Convective heat flow involves mass movement or transfer as the primary mechanism for heat transfer in the mantle but not in lithosphere where conduction is relatively more significant. Mantle convection is believed to involve viscous creep.

Fluids can also cause convective motion via a porous and permeable crust with only fluid flowing while rock mass remains stationary; this kind of mass transport is known as advective flow. Advective flow plays a crucial role in nearly all diagenetic reactions by transporting heat through intergranular porosity, fractures, and faults. According to Encyclopedia advection is a lateral or horizontal transfer of mass, heat, or other property. Accordingly, winds that blow across Earth's surface represent advectional movements of air. Groundwater flow represents one example of advective transport that delivers dissolved solids (including contaminants) along hydraulic gradients while transferring heat.

Additionally, radiation from the sun contributes indirectly to heat transfer on the lithosphere (ground), the Lithosphere is connected to the Hydrosphere and the atmosphere. The atmosphere

absorbs most of the solar radiation, and what reaches Earth's surface (which includes hydrosphere and lithosphere) is sent back into the atmosphere as heat energy. Dark objects on the earth's surface like asphalt absorb radiant energy quicker than lighter objects but also radiate their energy faster. This difference in how Earth's surface absorbs heat from the Sun is known as differential heating (NOAA, 2024b).

Heat Transfer between the Environment and Flora and Fauna.

This encompasses the impact of heat transfer on both plants and animals in their natural habitats, including their responses to temperature changes. Plants, as eukaryotes (any cell or organism that possesses a clearly defined nucleus) belonging to the kingdom Plantae, are primarily photosynthetic organisms utilizing chloroplasts derived from endosymbiosis with cyanobacteria. Through this process, they convert carbon dioxide and water into sugars using chlorophyll - a green pigment that harnesses energy from sunlight (Wikipedia, 2024).

Multicellular, eukaryotic organisms belonging to the biological kingdom Animalia are commonly referred to as animals. Primitively, they consume organic matter and require oxygen to sustain life while possessing myocytes (muscle cell) that enable their movement. Additionally, most animals reproduce sexually and undergo embryonic development from a hollow sphere of cells known as blastula. (Source: Wikipedia, 2024)

1. **Flora (Plants):**

For plants, leaf temperature is more important than the surrounding air temperature. The process of synthesizing vital compounds for growth and yield requires light absorption by leaves. Plants use only a small amount of available light energy, causing excess energy to increase leaf temperature. When water evaporates from the leaves, it results in significant cooling effects due to energy expenditure. Warm leaf surfaces emit energy back into cooler surrounding air through conduction while convection involves cooler air displacing warmer air near the surface of the leaf (Wiebold 2012 as cited in Geist, 2022). According to Wiebold (2012), plants release heat through water evaporation, convection, and conduction. These methods are interrelated and crucial for preventing excessive leaf temperatures that would harm plants. On sunny days with low wind, leaf temperatures can exceed air temperatures without adequate moisture supply causing insufficient evaporation leading to high leaf temperature. Crop plants have developed mechanisms like grass leaves rolling into cylinders or tilting upwards while broad-leafed soybeans align their leaves parallel to incoming sunlight or flip them over so lighter-colored bottom sides face up during water stress reducing sunlight absorption and thus lowering leaf temperature necessary for conserving moisture.

Plants have a similar temperature to the surrounding air, which means they need different ways to handle cold compared to warm-blooded animals (Fisher, 2024). According to Michael P. (2020), trees possess remarkable internal adaptations for coping with cold temperatures. As winter approaches, the plant hormones signal certain changes to occur. To prevent their cell fluids from freezing, some trees can relocate these fluids within their cells towards “extra-cellular” spaces outside of the cells where they freeze safely. This strategy is widely employed by evergreens and other plants that drop their leaves to reduce surface area exposure to cold air while also conserving water in the plant itself. Nutrients from these leaves are broken down and returned back into the soil, which signals a reduction or near cessation of growth thanks to hormonal signaling that induces dormancy in plants during colder seasons. Many such dormant plants lose their green parts on the surface and retreat underground beneath bulbs and perennials where temperature is warmer even amidst snowfall. Once spring arrives with its warmth, these plants leave dormancy behind and resume growing again. VanDerZanden (2008a) explained that plants are categorized as hardy or nonhardy based on their capacity to endure low temperatures. Hardy plants are those that have evolved to thrive in cold climates. Woody plants in temperate regions have intricate mechanisms for detecting the transition from autumn to winter. The reduction in daylight hours and temperature prompts hormonal shifts that lead to leaves ceasing photosynthesis and transferring nutrients to branches, buds, stems, and roots.

2. Fauna (Animals):

The animal kingdom is classified into two distinct subdivisions, namely endotherms and ectotherms, which are characterized by their respective abilities to regulate body temperature in response to external heat. Additionally, animals can be further categorized as poikilothermic or homeothermic based on their ability to maintain a consistent internal body temperature.

A. Endotherms and Ectotherms:

Animals can be classified into two groups based on their body temperature regulation. Ectotherms do not control their body temperature and rely on external energy, while endotherms rely on internal sources for heat production. Ectotherms are sometimes referred to as "cold-blooded, “but this term is not always accurate as some animals in warm environments may have high body temperatures. Endotherms are able to maintain a constant level of activity even at lower temperatures due to their ability to regulate their own body heat, which ectotherms cannot do because of differences in enzyme activity levels (Rye et al 2016, 2e).

B. Poikilotherms and Homeotherms:

i. **Poikilotherms** are animals whose internal temperatures constantly vary, as they cannot regulate it themselves. This means their body temperature depends on the external temperature, making them exothermic and commonly known as "cold-blooded “animals. They rely on external sources of heat and cold to regulate their body temperature, such as reptiles sunbathing on rocks for warmth. Unlike homeothermic animals that maintain a constant body temperature, poikilotherms can survive longer without food because they do not depend on metabolizing what they eat to maintain their body temperature. Although poikilotherms cannot tolerate extreme temperatures in their habitat, they generally handle internal temperature changes better than homeotherms. Most poikilothermic animals are found in reptiles and amphibians with very few rare cases in mammals (Romero, 2022).

ii. **Homeotherms**- Internal physiological processes allow organisms to maintain a steady body temperature, even when the external environment changes drastically. Homeothermic animals are traditionally known as "warm-blooded,"but this is not entirely accurate since there are many different types of thermoregulation in animals. Many homeotherms can drop their body temperatures considerably at certain times, such as during hibernation. The Arctic ground squirrel is an example of a homeothermic animal that can lower its body temperature

thanks to a reduction in metabolic activity during winter months when food and resources are scarce. Birds and mammals are currently considered homeothermic animals, with the exception of the Argentine black and white tegu lizard which has some endothermic behavior but also relies on environmental temperature for survival (Romero, 2022).

Mechanism of Heat Exchange in Homeotherms.

According to Whitmer and K.M (2021) noted that the body of some animals has four ways to regulate heat when the environment is not at a comfortable temperature. These are conduction, convection, radiation, and evaporation. Each way depends on how hot or cold it is outside. This is particularly evident in homeothermic or endothermic animals and diurnal terrestrial reptiles.

Conduction happens when two things touch each other and heat moves between them. For example, if you hold something cold in your hand, your hand will warm it up. Only 3% of the body's heat escapes through conduction.

Convection is when air or water close to the skin gets warmer and rises away from the body while cooler air or water takes its place. This can cause hypothermia if too much heat leaves the body this way. About 15% of the body's heat goes away through convection.

Radiation occurs between objects with different temperatures using infrared waves. Radiators use this type of transfer to warm rooms while sunlight warms our skin outdoors. The human body loses about 60% of its heat through radiation.

Evaporation works by sweat evaporating off our skin which takes a lot of energy from our bodies because it takes so much energy for liquid water to become gas (water vapor). How much we sweat depends on humidity - less humid environments make us sweat more which cools us down during exercise but only accounts for about 20% of overall cooling at rest.

Importance of Heat Transfer

1. **Weathering:** As rocks heat up and cool down, they expand and contract. This causes physical weathering that breaks the rock into fragments. The process is called thermal fatigue and creates stress on the rock surface. Moisture or oxygen in the atmosphere can also alter the chemical composition of rock minerals through a process called chemical weathering, which is accelerated by heat. Layers of rock peel away from the surface like an onion skin due to this combination of physical and chemical weathering, known as exfoliation when observed on a large scale. This phenomenon occurs not only on surfaces but also between mineral crystals within rocks due to differences in their thermal

properties. As a result, stresses grow between mineral grains until they crack apart in a process called granular disaggregation (Kielmas, 2017).

2. **Water cycling:** The sun's energy is indispensable to the water cycle. Its heat causes liquid and frozen water to transform into water vapor gas, which rises high in the sky to form clouds (water science school, 2016). The transformation of gaseous water into its liquid state is known as condensation. This process plays a crucial role in cloud formation, which can lead to precipitation and ultimately return water back to Earth's surface. As molecules of water transition between their various states - gaseous (vapor), liquid and solid - their arrangement undergoes alteration. In vapor form, these molecules assume a more random configuration than those present in a liquid state. However, as condensation occurs and transforms vapor into liquid form, these molecules become more organized while releasing heat into the atmosphere (water science school, 2019).

3. **Global weather and climate:** Thermal energy is distributed across the Earth through heat transfer processes occurring in both the hydrosphere and the atmosphere. This redistribution of solar energy minimizes temperature disparities on our planet, resulting in the cooling of tropical climates and the warming of polar regions to levels that would not be achievable without this heat distribution. The hydrosphere and atmosphere serve as

heat sinks, with the hydrosphere being particularly effective due to its ability to absorb a significantly larger amount of thermal energy compared to air. When the air temperature surpasses that of the ocean surface, the ocean absorbs heat from the air, whereas when the air temperature drops below that of the ocean surface, the ocean releases heat back into the air. This mechanism explains why large bodies of water have a significant impact on the climate of the surrounding regions (Virgilio's climate change project, n.d.a).

4. **Formation of wind and ice:** Atmospheric heat transfer is responsible for the generation of air currents. Air tends to move from areas of high pressure to low pressure, resulting in the formation of air currents, commonly known as winds. The existence of permanent high and low-pressure zones leads to prevailing winds that flow consistently. The rotation of the Earth causes these prevailing winds to deflect around the globe instead of following a straight north-south or south-north trajectory. These air currents can influence ocean currents, such as the Gulf Stream. Similarly, heat transfer within the hydrosphere drives the movement of water currents, impacting various Earth systems like the formation of sea ice in the cryosphere and the shaping of land formations in the lithosphere (Virgilio's climate change project, n.d.b).

5. **Plant processes:** Temperature plays a crucial role in various plant functions such as photosynthesis, transpiration, respiration, germination, and flowering. An increase in temperature generally leads to an increase in photosynthesis, transpiration, and respiration, up to a certain point. Additionally, temperature, along with day length, influences the transition from vegetative to reproductive growth in plants. The impact of temperature on this transition can either accelerate or decelerate depending on the plant species and environmental conditions. Excessive temperatures can elevate respiration rates, surpassing those of photosynthesis, resulting in faster depletion of photosynthates than their production. For optimal growth, photosynthesis must exceed respiration. Insufficient daytime temperatures can hinder photosynthesis, leading to poor growth and reduced yield, such as in fruit or grain production. Some plants that thrive in cold climates require a specific period of low temperatures to enter dormancy (VanDerZanden, 2008b).

6. **Physiological and behavioural change in animals:** Heat transfer plays a crucial role in the physiology of living organisms, impacting the density and state of water. It holds significant sway over living beings since only a few can endure extreme temperature variations. Organisms must either regulate their internal temperature or inhabit surroundings that maintain a temperature conducive to metabolism. Certain animals have

evolved mechanisms to withstand substantial temperature changes, as evidenced by hibernation or reptilian torpor. When faced with temperature fluctuations, animals may adapt through strategies like migration to ensure survival. Migration, the act of moving from one location to another, is a common practice among animals, especially those residing in regions with seasonal cold spells. Some animals opt for hibernation or estivation to endure harsh temperatures. Hibernation allows animals to endure cold conditions, whereas estivation helps them survive the challenges of hot, arid climates. Animals that hibernate or estivate enter a state called torpor, during which their metabolic rate significantly decreases. Certain amphibians, like the wood frog (Rana sylvatica), possess an antifreeze-like substance in their cells, preserving cell integrity and preventing them from rupturing (LibreTexts biology, 2023).

7. **Geological processes** play a crucial role in understanding the temperature gradient differences between the mantle and lithosphere. The lower temperature gradient in the mantle compared to the lithosphere is evidence of convection occurring in the mantle. Convection in the mantle involves the physical movement of hot rocks, transferring heat throughout the mantle. This process is driven by heat transfer from the core to the base of the lower mantle. Mantle convection is essential for plate tectonics as it allows for a higher rate of heat transfer, keeping the asthenosphere weak. The mantle will cease to

convect once the core cools enough that the heat transfer is not strong enough to overcome the strength of the rock. Convection is a more efficient way of carrying heat to the surface of the mantle compared to conduction (Panchuk, 2021).

The Concept of Low Cost Instructional Materials

Educational resources, commonly referred to as instructional materials or teaching/learning materials (TLM), encompass a wide array of items, both living and non-living, human and non-human, that educators utilize to enhance the learning process and accomplish specific educational goals. These materials serve to enhance a student's understanding of the subject matter, making the learning process more engaging, captivating, and interactive. They are instruments employed in educational endeavors, which encompass hands-on learning and evaluation. This term encompasses all the tools and physical resources an educator may utilize to deliver instruction and support students in achieving educational objectives (Wikipedia, 2018).

Low cost instructional materials can be described as instructional aids that are either inexpensive or readily accessible, created using locally available resources, and facilitate the learning process in the classroom. These materials are repurposed from waste and assist educators in delivering concrete and engaging lessons (Javed, 2010b).

Importance of Instructional Materials / Teaching Learning Materials

According to Ecole Globale (2021a), instructional materials can enhance students' acquisition of knowledge that can be applied in real-life situations. In the past, students were often required to memorize vast amounts of information in school without truly understanding it, leading to forgetfulness over time. However, students now engage with materials in a more practical manner, using logical reasoning and creative thinking to comprehend even the most complex subjects easily. By changing teaching methods, students not only understand the material but also implement their knowledge in practical ways. This shift in teaching also serves to boost student motivation, as engagement is crucial for effective learning. Teachers now involve students in the learning process by assigning tasks that are relevant and engaging, thereby fostering motivation and preventing monotony in the classroom.

The Importance of Low Cost Instructional Materials

According to Etienne & Mujawimana (2020a) which stated the importance in the use of low cost educational materials in developing counties to help in the shortage of standard instructional materials and stated how effective it is in motivating and engaging of students in the teaching and learning process especially in science education.

Investments in equipment for all students at a given level pose a significant financial burden for schools. Essential follow-up procedures, such as teacher training in the pedagogical and technical use of the equipment, maintenance, and replenishment, are often neglected due to financial constraints. Additionally, establishing language laboratories and demonstration rooms is challenging due to limited funds. Many language topics can be effectively taught using cost-effective teaching aids, which not only ensure maximum pupil participation but also promote students' active engagement in the learning process. Furthermore, improvisation leads to long-term retention of information, providing students with firsthand experiences in various ways. The development of low-cost teaching aids fosters interaction between teachers and students, as well as among students themselves (Devasis, 2022b). According to Sivakumar (2014a) low cost educational materials has several importances which includes the enhancement of knowledge and understanding of the students, it's also promotes interaction among students and also teachers, and also promotes engagement and participation of the students in the teaching and learning process.

On the other hand, the benefits of affordable and locally produced equipment comprise cost savings, easier upkeep and repair, better availability of spare parts, closer alignment with the curriculum, greater integration of local aspects, fostering self-reliance, and flexibility in introducing new topics into the curriculum (Engida, 2012).

Summary of Reviewed Literature

Heat transfer encompasses the movement of thermal energy through mechanisms such as radiation, conduction, and convection. These mechanisms play pivotal roles in various systems, including the atmosphere, hydrosphere, and lithosphere. In the atmosphere, for instance, heat transfer occurs through radiation from the sun, driving processes like the water cycle. Similarly, the hydrosphere experiences heat transfer through convection and circulation processes, impacting global weather patterns. Understanding these concepts is crucial for comprehending phenomena such as weather patterns, water cycling, and geological processes.

Moreover, heat transfer significantly influences flora and fauna. Plants regulate their temperature through processes like evaporation, convection, and conduction, while animals respond to temperature changes through physiological and behavioral adaptations. These adaptations involve mechanisms such as conduction, convection, radiation, and evaporation. Understanding heat transfer is therefore essential for grasping geological processes, plant functions, and animal survival strategies.

In educational settings, the use of low cost instructional materials can enhance student engagement and understanding, particularly in resource-constrained environments. These materials promote active learning and practical application of knowledge, fostering student

motivation and better comprehension. Additionally, they contribute to long-term retention of information, ensuring that students retain a solid grasp of heat transfer concepts over time. By evaluating the impact of budget-friendly instructional materials on students' comprehension, motivation, engagement, and retention, educators can refine teaching strategies and optimize learning outcomes in the field of heat transfer.Educators can employ creative and resourceful approaches, utilizing Low-Cost Instructional Materials (LCIMs), to enhance student learning about heat transfer. Through the utilization of Low Cost Instructional Materials (LCIMs), educators aim to make the subject engaging and accessible for all students. The efficacy of these affordable teaching aids in improving students' comprehension and knowledge of heat transfer is a key focus. This involves assessing how LCIMs influence students' understanding, motivation, engagement, and long-term retention of heat transfer concepts.

CHAPTER THREE

METHODOLOGY

This chapter describes the method and procedure used by the researcher in conducting the study. It is presented under the following subheadings:

- Design of the Study
- Population of the Study
- Sample/Sampling Technique
- Research Instrument
- Validity of the Instrument
- Reliability of the Instrument
- Method of Data Collection
- Method of Data Analysis

Research Design

The Quasi experimental research design was adopted for this study. The design is appropriate to investigate the impact of low-cost educational materials on students' knowledge towards heat transfer. The quasi-experimental design is used to show the cause and effect relationship that exist among variables, that the independent (manipulated) and the dependent (resultant) variable. It gives insights and direction into the effectiveness of the interventions or policies, as well as help researchers understand the impact of certain variables on outcome. In this research, the quasi-experimental design is appropriate as it helps to measure the impact of low-cost educational materials on students' knowledge towards heat transfer.

Table 3.0 Quasi Research Design.

R1 - O1 X O2
R2 - O1 O2
Where:
R1= Experimental group
R2= Control group
O1 = Pretest
X = Treatment (Environmental Education Workshop)
O2 = posttest

Population of the Study

The population of this study consisted of all 100 level students in the department of health, safety and environmental education (H.S.E), with a total population of 153 students across two course areas, health education and environmental education (Department of Health, Safety and Environmental education 2022/2023 session). With a total number of 50 (fifty) students collected at random to make up the experimental and control group.

Sample and Sampling Technique

Respondents were selected for this study using a purposive sample technique. Purposive sampling is a non-probability sampling technique in which researchers purposely select individuals that possesses the specific characteristics or qualities of interest to the study. This method is used to gather in-depth information and explore specific dimensions of a phenomenon. The respondents were categorized into two, the experimental group and the control group. Those who responded in the experimental group category received a treatment (environmental education workshop) while those under the control group did not receive any treatment. A total of fifty (50) respondents were chosen at random from the total population, which were further divided into two, 25 (twenty five) in the experimental group and 25 (twenty five) in the control group. Those available for the Environmental Education Workshop were categorized as the Experimental group, while those that weren't available and didn't receive any treatment made up the control group.

The sampling method is best explained in the table below;

Table 3.1 Sampling Method

S/N	Selected groups	Number of Respondents
1.	(Experimental Group)	25
2.	(Control Group)	25
TOTAL		50

Research Instrument

The Instrument for this study is the questionnaire of 20 items used to elicit information from respondents. The questionnaire will be divided into three sections. Section A covers demographic data of the respondents while section B tests the respondents knowledge about the dangers of self-medication. And section C provides information that asks the respondents to indicate their level of agreement with a series of questions using A four point scoring scale drawn along the modified Likert summated rating scale for measurement (SA = Strongly agree, A = Agree, D, D=Disagree, and SD= Strongly disagree) to show their attitude towards the dangers of self-medication.

Validity of the Instrument

The content validity of the instrument will be established by the Supervisor and two experts from the Department of Health, Safety and Environmental Education, university of Benin. Their inputs and correcting in terms of clarity and appropriateness of language will be used to develop the final draft.

Reliability of the Instrument

Internal consistency reliability was adopted in this study to pilot test the questionnaire. Twenty (20) questionnaires were administered to food sellers who are not part of the study population. Then their response was subjected to data analysis, Cronbach's alpha (α) was calculated with SPSS for attenuation. Cronbach alpha value of .764 was observed. Thus the instrument is reliable.

Method of Data Collection

The Research questionnaire was administered both personally and electronically (Online Google forms) to the 2022/2023 admitted 100 level students in the department of health, safety and environmental education (HSE). The same questionnaire was readmitted to them after conducting an environmental education workshop in which the students under the experimental group received various environmental knowledge on the heat transfer. The responses from both the experimental and control groups were later compared and analyzed.

Method of Data Analysis

Data collected through the administration of questionnaires was analyzed using descriptive statistics for easy interpretation. Descriptive statistics are brief informational coefficients that summarize a given data set, which can be either a representation of the entire population or a sample of the population. It involves summarizing, organizing, and presenting data meaningfully and concisely. This enabled the researcher to meaningfully describe independent factors in the study, as well as helping to indicate the number and percentage of respondent rank, and rank variables under this study.

CHAPTER FOUR

PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

This chapter deals with the analysis of the research question which were carried out using the Quasi experiment research design in finding answers to the research questions. The presented results is based on the data that were retrieved from a total of fifty (50) questionnaire were administered and fifty (50) questionnaires were retrieved which represents a 100% return rate. The data are presented in a tabular format and analysis were drawn from them.

Research question one: Will the use of low-cost environmental education materials have an impact on the knowledge of concept of heat transfer among students in the University of Benin?

Table 4.0 Mean and standard deviation low-cost environmental education materials have an impact on the knowledge of concept of heat transfer among students in the University of Benin.

Group		Pre Knowledge	Post Knowledge
Experiment	Mean	6.6000	8.2400
	N	25	25
	Std. Deviation	2.27303	1.58850
Control	Mean	6.0800	6.6000
	N	25	25
	Std. Deviation	1.52534	1.77951
Total	Mean	6.3400	7.4200
	N	50	50
	Std. Deviation	1.93370	1.86362

From table 4.0, it shows that the experimental group, which took part in the environmental education workshop, demonstrated a higher mean knowledge score both before and after the intervention with a mean of 6.6000 for the Pre Knowledge and 8.2400 for the Post knowledge and the standard deviation of 2.27303 for the Pre Knowledge and 1.58850 for the Post knowledge.

The table further shows the knowledge level of the control group. The data from the table shows a mean of 6.0800 and 6.6000 for pre knowledge and post knowledge respectively and a standard deviation of 1.52534 and 1.77951 for pre knowledge and post knowledge from the respondents on the control group, on the impact of low cost educational materials towards the knowledge of students in University of Benin. This shows that the post-knowledge mean 6.6000 is only slightly higher than their pre-knowledge mean 6.0800, indicating a minimal increase in knowledge without the environmental education workshop.

The findings in table one shows that the environmental education workshop had a positive impact on students' knowledge of heat transfer at the University of Benin. The experimental group, which received the environmental education workshop, showed a significant increase in knowledge compared to the control group. These results support the effectiveness of utilizing

low-cost educational materials to enhance environmental education and awareness among students.

Research question two: Will the use of low cost environmental education materials have impact towards the heat transfer attitude among students in the University of Benin.

Table 4.1 Low cost environmental education materials have impact towards the concept of heat transfer attitude among students in the University of Benin.

Group		Pre Attitude	Post Attitude
Experiment	Mean	25.0000	30.4800
	N	25	25
	Std. Deviation	3.10913	3.38034
Control	Mean	26.2000	29.2400
	N	25	25
	Std. Deviation	4.07226	3.34515
Total	Mean	25.6000	29.8600
	N	50	50
	Std. Deviation	3.63655	3.38671

From table 4.1, it shows that the experimental group showed a notable increase in post-attitude scores compared to the control group having a mean of 25.0000 and 30.4800 for pre attitude and post attitude respectively and a standard deviation of 3.10913 and 3.38034 for pre attitude and post attitude respectively.

The table further shows the level of students' attitude of the control group towards heat transfer with a mean of 26.2000 and 29.2400 of pre attitude and post attitude respectively and a standard deviation of 4.07226 and 3.34515 of pre attitude and post attitude respectively. The mean post-attitude score of the experimental group 30.4800 surpassed both the control group's mean post-attitude score 29.2400 and the total mean post-attitude score 29.8600.

The table further shows that the experimental group, which presumably had access to these materials, exhibited a more significant improvement in attitude scores compared to the control group. The standard deviation values indicate relatively consistent responses within each group, suggesting the reliability of the results.

The findings in table two shows that the environmental education workshop had a positive impact on students' attitudes towards heat transfer at the University of Benin, as evidenced by the significant increase in post-attitude scores among the experimental group compared to the control group.

Hypotheses Testing

Hypothesis one: Low cost environmental education materials have no significant impact towards the knowledge heat transfer among students in the University of Benin.

Table 4.2 ANCOVA on low cost environmental education materials have no significant impact towards the knowledge heat transfer among students in the University of Benin.

Tests of Between-Subjects Effects
Dependent Variable: Post knowledge

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	49.358[a]	2	24.679	9.600	.000
Intercept	126.245	1	126.245	49.109	.000
Pre Knowledge	15.738	1	15.738	6.122	.017
group	27.100	1	27.100	10.542	.002
Error	120.822	47	2.571		
Total	2923.000	50			
Corrected Total	170.180	49			

a. R Squared = .290 (Adjusted R Squared = .260)

Table 4.2 showed the ANCOVA on impact of low cost educational materials on the knowledge of concept of heat among students in the University of Benin. It can be seen that the F-value is 10.54 and the level of significance is 0.00 which is less than the set alpha level of 0.05. Hence the null hypothesis which stated that low cost educational materials have no significant impact

towards the knowledge of heat wave among students in the University of Benin is rejected. This showed that low cost educational materials have significant impact towards the knowledge of heat wave among students in the University of Benin.

Hypothesis two: Low cost environmental education materials have no significant impact towards the heat transfer attitude among students in the University of Benin.

Table 4.3 ANCOVA on low cost environmental education materials have no significant impact towards the heat transfer attitude among students in the University of Benin.

Tests of Between-Subjects Effects
Dependent Variable: Post Attitude

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	60.262[a]	2	30.131	2.822	.070
Intercept	513.177	1	513.177	48.070	.000
Pre Attitude	41.042	1	41.042	3.844	.056
group	29.057	1	29.057	2.722	.106
Error	501.758	47	10.676		
Total	45143.000	50			
Corrected Total	562.020	49			

a. R Squared = .107 (Adjusted R Squared = .069)

Table 4.3 showed the ANCOVA on impact of low cost educational materials on the attitudes towards the concept of heat wave among students in the University of Benin. It can be seen that

the F-value is 2.72 and the level of significance is 0.10 which is greater than the set alpha level of 0.05. Hence the null hypothesis which stated that low cost educational materials have no significant impact towards the attitude of heat wave among students in the University of Benin is accepted. This showed that low cost educational materials have no significant impact towards the attitude towards the concept of heat wave among students in the University of Benin.

Discussion of Findings

The purpose of the research is to evaluate the impact of low cost instructional materials on students' knowledge towards heat transfer in the University of Benin. This study's aim was centered on the impact environmental education workshop has in equipping students with knowledge of heat transfer. The analysis revealed a significant positive impact of low-cost instructional materials on students' knowledge of heat transfer. The experimental group, which received the education, demonstrated greater knowledge improvement with the mean of 8.2400 compared to the control group with the mean of 6.6000. This findings shows that providing access to such materials can enhance students' understanding of the transfer of heat. Thank s findings is in line with the study conducted by Ecole Globale (2021b) which showed the importance of instructional materials can increase students' acquisition of knowledge that can be applied in real-life situations. However the study carried by Sivakumar (2014b) to show the impact of low cost teaching aids in teaching science, which verify the study through their

findings which clearly states in the advantages of low cost instructional materials is that it aids in enhancing knowledge and understanding of the science education including environmental studies.

The analysis also revealed a significant positive impact of low cost instructional materials on students' attitude of heat transfer. The experimental group, which received the education had a positive attitude of the low cost educational materials with the mean of 30.4800 compared to the control group with the mean of 29.2400. This findings shows that providing access to such materials can enhance students' behaviour and attitude towards environmental studies. However this study carried out by Etienne & Mujawimana (2020b) to show the effectiveness of locally made instructional materials on students' academic performance and retention in science education in eastern province of Rawada. Their finding support this research as its shows that the students were more motivated and interested in the learning of science subjects including environmental education.

The analysis did not find a significant effect of initial knowledge levels on knowledge acquisition regarding heat waves. This indicates that the impact of low-cost educational materials on knowledge improvement was consistent across students with varying levels of prior knowledge. Thus, the intervention appears effective regardless of students' prior understanding.

Similarly, the analysis did not find a significant effect of initial attitude levels on attitude change towards heat attitude. This implies that the influence of low-cost educational materials on attitude improvement was not influenced by students' initial attitudes. The intervention seems capable of fostering positive attitudes irrespective of previous attitudes.

The findings of this research shows that low-cost educational materials can play a crucial role in enhancing both knowledge and attitudes towards environmental issues such as ozone depletion among students at the University of Benin. These materials not only contribute to increased understanding but also promote positive attitudes and perceptions, potentially leading to greater engagement in environmental conservation efforts. However, further research may be necessary to explore additional factors influencing the effectiveness of such interventions and to validate the long-term sustainability of the observed effects.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter deals with the conclusions drawn from the data analysis, the summary of the study and the various recommendations based on the findings made;

Summary

The purpose of this research is to study the impact of low cost instructional materials on students' knowledge towards heat transfer. The following research questions and hypotheses were raised to guide the research:

1. Will the use of low-cost environmental education materials have an impact on the knowledge heat transfer among students in the University of Benin?
2. Will the use of low cost environmental education materials have impact towards the heat transfer attitude among students in the University of Benin?
3. Low cost environmental education materials have no significant impact towards the knowledge heat transfer among students in the University of Benin.
4. Low cost environmental education materials have no significant impact towards the heat transfer attitude among students in the University of Benin.

The purpose and significance of the research were clearly stated as well as definitions of major terminologies as they are used in the research. Furthermore, important literature related to heat transfer were reviewed, specifically on the concept of heat transfer, definitions, , It's effects on the atmosphere, hydrosphere, and lithosphere, how it affects the environment and flora and fauna, and the importance of heat transfer. Literature on the impact of low cost instructional materials on knowledge of students towards heat transfer were also reviewed as well as the impact of educational level on the knowledge of heat transfer towards the use of low cost instructional materials practices.

The Research methodology discussed the Research design, population of the study, sample and sampling technique, research Instrumentation, validation of the instrument, reliability of the instrument, administration of the instrument, method of data collection, and method of data analysis. Necessary data were tabulated.

From the analysis of the data collected, the researcher was able to find out the impact of low cost instructional materials towards heat transfer. Based on the data analyzed, it was found out that low cost environmental education materials can significantly impact the knowledge and attitudes of students towards heat transfer and the null hypothesis that “there is no significant impact on student’s knowledge and attitudes towards heat transfer” was therefore proven wrong and rejected.

Conclusion

The research work shows the impact of low education materials on student's knowledge towards heat transfer at the University of Benin. It was discovered that the use of low cost instructional materials in schools can effectively impact the knowledge towards various concepts such as heat transfer.

Students in the department of health safety and environmental education were used for both the experimental and control group through the purposive sampling technique because the department has specialized course provision for health and environmental education and award of degree in health and environmental education. Both groups contained 25 (twenty five) students each making it a 50:50 ratio between the experimental and control group.

Data was collected using a multiple choice and Likert scale items questionnaire from both groups and analyzed, based on the analysis of the data, it was discovered that low cost environmental educational materials had significant impact on the knowledge of heat transfer as students in the experimental groups who were exposed to the workshop demonstrated better knowledge towards heat transfer compared to those in the control group who weren't exposed to the environmental education workshop. It was also shown that Environmental educational workshop with low cost materials has significantly improved the attitudes of students towards heat transfer.

Recommendations

With proper analysis of the research findings the researcher therefore makes the following recommendations:

i. It is recommended that low cost instructional materials should be adopted as an effective means and teaching method of disseminating environmental information in educational institutions.

ii. It is recommended that low cost environmental educational materials should be utilized to reduce barriers to learning and ensure that all students have the opportunity to engage with environmental science concepts like heat transfer, regardless of their school's budget.

iii. It is recommended that low cost environmental educational materials should be utilized to promote teacher empowerment and flexibility in the teaching and learning process. Low-cost materials also gives teachers more freedom and flexibility in designing engaging lesson plans. They are not restricted to pre-packaged kits or specific equipment, and can tailor their approach to fit the needs of their students and available resources.

iv. It is recommended that low cost educational materials adopted in creating environmental awareness through the reusing and repurposing materials aligns with environmental

education principles. Students become aware of the value of reducing waste and using resources responsibly, which is a crucial lesson for sustainability.

v. It is recommended that environmental education available materials should be adopted in promoting stronger learning through hands-on activities. Students learn by doing, and these activities solidify their understanding of heat transfer and also environmental concepts through practical experience.

Suggestions for Further Study

i. Research how low-cost materials can be complemented by free or low-cost digital resources (online simulations, educational apps) to enhance learning experiences of heat transfer.

ii. Analyze the environmental impact of low-cost materials compared to traditional resources towards heat transfer.

iii. Research the effectiveness of engaging students in the creation of low-cost instructional materials for heat transfer information for their peers.

REFERENCES

Baird C.S. (2023, December 13). Is there different between thermal radiation and infrared radiation. Wtamu edu.https://www.wtamu.edu/~cbaird/sq/mobile/2023/12/13/is-there-a-difference-between-thermal-radiation-and-infrared-radiation/

Comunale J., Zesiger T. & Cena C.(2023, November 21). Heat/definition, thermodynamics & examples. Study.com.https://study.com/academy/lesson/what-is-heat-definition-lesson quiz.html#:~:text=Heat%20is%20the%20form%20of,energy%2C%20usually%20calories%20or%20joules.

Dastrup.R. A., MA & GISP (2020, June 1) Physical Geography and Natural Disasters. Slcc.pressbooks.pub.https://slcc.pressbooks.pub/physicalgeography/chapter/8-2/

Department of Energy (n.d.) explains... Atmospheric radiation (n.d). Office of science. https://www.energy.gov/science/doe-explainsatmosphere-radiation

Devasis C. (2022a, February 7). Low-cost teaching aids: meaning of low-cost teaching aids, advantage of low cost teaching aids and development of low cost teaching aids. wordpress.com.https://onlinenotebank.wordpress.com/2022/02/07/low-cost-teaching-aids-meaning-of-low-cost-teaching-aids-advantages-of-low-cost-teaching-aids-and-development-of-low-cost-teaching-aids/#:~:text=Low%20cost%20teaching%20aids%20helps,the%20active%20method%20of%20learning.

Ecole globale (2021, Feb 5a). Important of teaching learning materials. Ecole globale. https://www.ecoleglobale.com/blog/teaching-learning-materials/

Encyclopedia (2018, May 14). Weather and climate:terms and concepts: advection (earth science). Encyclopedia.com.https://www.encyclopedia.com/earth-and-environment/atmosphere-and-weather/weather-and-climate-terms-and concepts/advection-earth sciences#:~:text=Earth's%20atmosphere%20is%20a,represent%20advectional%20movements%20of%20air.

Engida T. (2012, January). Development of low-cost educational materials for chemistry. AJOL.https://www.ajol.info/index.php/ajce/article/view/82439/72594

Etienne, T. & Mujawimana, E. (2020, May a). Effectiveness of locally made instructional materials on students' academic performance and retention in science education in eastern province of Research gate. https://www.researchgate.net/publication/341670675_effectiveness_of_locally_made_instructional_materials_on_students'_academic_performance_and_retention_in_science_education_in_eastern_province_of_rwanda/link/5ece2cf2299bf1c67d204691/download

Fisher T. (2024, January 18). Plants and cold. Atlantahistorycenter. https://www.atlantahistorycenter.com/blog/plants-and-the-cold/

Geist L. (2022, July 27). Plants respond to heat differently than humans. University of Missouri Extension. https://extension.missouri.edu/news/plants-respond-to-heat-differently-than-humans

Geological Disgression(n.d.). Thermal structure of the lithosphere. Geological disgression.com https://www.geological-digressions.com/the-thermal-structure-of-the-lithosphere/

Harland B. (2018, April 19). How do ocean and wind affect weather and climate. Sciencing. https://sciencing.com/convection-currents-8172073.html

Helmenstine.A.M.(2019, December 8). Definition of radiation and examples. Thoughtco. https://www.thoughtco.com/definition-of-radiation-and-examples-605579#:~:text=Radiation%20includes%20emanation%20of%20any,light%2C%20heat%2C%20and%20particles.

International Atomic Energy Agency (2023, January 25). What is radiation. IAEA. https://www.iaea.org/newscenter/news/what-is-radiation

Javed I. (2012a, April 8). Low cost and no cost materials. Slideshare. https://www.slideshare.net/Javed Iqbal 15/low-cost-and-no-cost materials

Kielmas M.(2017, April 25). Heat weathering. Sciencing.com.https://sciencing.com/heat-weathering-19386.html

Kirchhoff H.(2018, April,23). What is convection current. Sciencing. https://sciencing.com/convection-currents-8172073.html

LibreTexts biology (2023, August 15). Temperature, water, and other factors. Bio libretexts.org https://bio.libretexts.org/Courses/Evergreen_Valley_College/Introduction_to_Ecology_(Kappus)/05%3A_Adaptations_to_the_Environment/5.02%3A_Temperature_Water_and_other_Factors#:~:text=Temperature%20affects%20the%20physiology%20of,C%20(113%20%C2%B0F).

Michael P. (2020, November 4). How plants survive the winter: adaptation and damage. GBBG. https://www.gbbg.org/how-plants-survive-winter/#:~:text=By%20dropping%20their%20leaves%2C%20plants,returned%20back%20into%20the%20soil.

National Aeronautics and Space Administration (2024, February 25). Water & Energy Cycle. Terra.com. https://terra.nasa.gov/science/water-energy-cycle

National Geographic(n.d.). Hydrosphere. https://education.nationalgeoegraphic.org/resources/resource-library-hydrosphere

National Geographic (n.d.). Lithosphere. https://education.nationalgeographic.org/resource/lithosphere/

National Oceanic and Atmospheric Administration (2023, March 24). Hydrologic Cycle. https://www.noaa.gov/jetstream/atmosphere/hydro

National Oceanic and Atmospheric Administration (2024a, January 2). The transfer of heat energy. NOAA. https://www.noaa.gov/jetstream/atmosphere/transfer-of-heat-energy

National Oceanic and Atmospheric Administration (2024, January 18). What is the global ocean conveyor belt? https://oceanservice.noaa.gov/facts/conveyor.html

Nicholas A. & Nicholas P.(2023 November 11). Convention cells definition,currents and causes. Study.com.Mhttps://study.com/academy/lesson/atmospheric-convection-definition-currents-cells.html

Panchuk K. (2021). Earth's Interior Heat. Opentextbc.ca. https://opentextbc.ca/physicalgeologyh5p/chapter/earths-interior-heat/#:~:text=A%20convecting%20mantle%20is%20an,the%20strength%20of%20the%20rock.

R.Adam(2020, June 1). Heat transfer in the atmosphere. Physical geography. https://courses.lumenlearning.com/suny-geophysical/chapter/heat-transfer-in-the-atmosphere/

Rahmstorf S.(2006). Thermohaline ocean circulation. Stefan Rahmstorf, a brief sheet. https://www.pik-potsdam.de/~stefan/thc fact sheet.html#:~:text=As%20opposed%20 to%20 wind%2Ddriven,hence %20the%20name%20thermo%2Dhaline

Romero N.A.(2022, December 26). AnimalWised. Poikilothermic animals.animalwised. https://www.animalwised.com/homeothermic-and-poikilothermic-animals-4510.html

Rye C., Wise R., Jurukovski V., DeSaix J., Choi J. & Avissar Y. (2016, October 21).Biology. OpenStax.org. Book URL: https://openstax.org/books/biology/pages/1-introduction

Biology 2e. Provided by: OpenStax. Located at: http://cnx.org/contents/185cbf87-c72e-48f5-b51e-f14f21b5eabd@10.8. License: CC BY: Attribution. License Terms: Access for free at https://openstax.org/books/biology-2e/pages/1-introduction

Sivakumar, R. (2014, December 3a). Impact of low cost teaching aids in teaching science. Research gate. https://www.researchgate.net/publication/273165475_IMPACT_OF_LOW_COST_TEACHING_AIDS_IN_TEACHING_SCIENCE

University Corporation for Atmospheric Research (2018). Coduction. Center for science education. UCAR. https://scied.ucar.edu/learning-zone/earth-system/conduction

VanDerZanden. A.M. (2008a, January). Environmental factors affecting plant growth. OSU Extension Service. https://extension.oregonstate.edu/gardening/techniques/environmental-factors-affecting-plant-growth#:~:text=buds%20will%20form.-,Temperature,photosynthesis%2C%20transpiration%20and%20respiration%20increase

Virgilio's climate change project (n.d.b) Heat transfer.weebly.com.https://virgiliosclimatechangeproject.weebly.com/d32---heat-transfer.html#:~:text=Heat%20transfer%20occurs%20in%20both,there%20was%20no%20heat%20distribution.

Water Science School (2019, June 8). Condensation and water cycle from USGS.https://www.usgs.gov/special-topics/water-science-school/science/condensation-and-water-cycle#overview

Water school science (2016, November 28). The sun and the water cycle. USGS. https://water.usgs.gov/edu/gallery/watercyclekids/sun-earth.html

What is conduction?(2024). Huksefluxusa. https://huksefluxusa.com/learn/what-is-conduction/

What is heat transfer? (2023, November 20). simscale.com. https://www.simscale.com/docs/simwiki/heat-transfer-thermal-analysis/what-is-heat-transfer/

Whitmer H., K.M. (2021). A Mixed Course-Based Research Approach to Human Physiology. Ames, IA: Iowa State University Digital Press. https://iastate.pressbooks.pub/curehumanphysiology/

Wiebold W.J.(2012, July 2). None like it hot. University of Missouri Extension.https://ipm.missouri.edu/croppest/2012/7/None-Like-It-Hot/#:~:text=Convection%20means%20that%20cooler%20air,where%20plants%20could%20not%20survive.

Wikipedia (2024, April 19). Animal. Wikipedia. https://en.m.wikipedia.org/wiki/Animal

Wikipedia (2018, June). Instructional Materials. https://en.m.wikipedia.org/wiki/Instructional_materials#:~:text=Instructional%20material%2C%20also%20known%20as,help%20achieve%20desired%20learning%20objectives.

Wikipedia (2024, April 7). Plant. Wikipedia. https://en.m.wikipedia.org/wiki/Plant

Wooldridge M.& Luebbers R. H.(2020, March). Heat transfer. McGraw hills access science. http://www.accessscience.com/content/article/a311100#:~:text=key%20concepts, object %20 to%20a%20cold%20 object

APPENDIX

DEPARTMENT OF HEALTH, SAFETY AND ENVIRONMENTAL EDUCATION

FACULTY OF EDUCATION, UNIVERSITY OF BENIN,

BENIN CITY, EDO STATE.

STUDENT'S QUESTIONNAIRE

Dear Respondents,

The Researcher is a student of the above named institution, conducting a research on “the impact of low-cost educational materials on students’ knowledge towards heat transfer”.

You are kindly requested to fill the questionnaire. All information gathered shall be used purely for research purposes and shall be treated with utmost confidentiality.

SECTION A (Demographic Data)

Gender: Male [ ] female [ ]

Age: 16-19 [ ] 20-23 [ ] 24 years and above [ ]

Level: 100 [ ] 200 [ ] 300 [ ] 400 [ ]

Course Area: Health Education [ ] Environmental education [ ]

SECTION B: Impact of low-cost educational materials on students' knowledge towards heat transfer?

Please tick as appropriate

1. Heat transfer from the sun to the Earth's surface primarily occurs through:

(a) Convection (b) Conduction (c) Radiation (d) Precipitation

2. When sunlight strikes a dark-colored surface, compared to a light-colored surface, the dark surface will likely:

(a) Reflect more heat (b) Absorb more heat (c) Conduct heat faster (d) Emit more heat

3. The transfer of heat through the direct contact of two objects is called:

(a) Convection (b) Conduction (c) Radiation (d) Insolation

4. How do animals primarily respond to temperature changes?

(a) Migration (b) Photosynthesis (c) Hibernation (d) Physiological and behavioral adaptations

5. Heat transfer mechanisms play a significant role in shaping global weather patterns.

(a) True (b) False

6. What is the primary role of low-cost instructional materials in educational settings?

(a) To make learning inaccessible to students (b) To enhance student engagement and understanding (c) To increase the cost of education (d) To limit student access to educational

7. The use of low-cost instructional materials is not effective in resource-constrained educational environments.

(a) True (b) False

8. Which mechanism of heat transfer involves the transfer of energy through electromagnetic waves?

(a) Radiation (b) Conduction (c) Convection (d) Absorption

9. In which Earth system does heat transfer primarily occur through the movement of molten rock beneath the surface?

(a) Atmosphere (b) Hydrosphere (c) Biosphere (d) Lithosphere

10. How do plants primarily regulate their temperature in cold environments?

(a) By increasing metabolic activity (b) By absorbing heat through radiation (c) By evaporating water through transpiration (d) By seeking shade or shelter

SECTION C: Impact of Environmental Education Workshop on Impact of Low-cost Instructional Materials towards Heat Transfer

SA= Strongly Agree

A= Agree

D= Disagree

SD= Strongly Disagree

S/N	ITEMS	SA	A	D	SD
11	I think heat transfer does not impacts various Earth systems.				
12.	I feel that it is important to understand the three main mechanisms of heat transfer (radiation, conduction, and convection).				
13.	I believe that the knowledge gained through the use of low-cost instructional materials will have a lasting impact on your understanding of heat transfer concepts.				
14.	I do not believe the use of low-cost environmental education materials will have a significant impact on my knowledge of heat transfer.				
15.	I believe that low-cost environmental education materials will positively influence my attitude towards heat transfer.				

16.	I do not feel that low-cost instructional materials are in promoting active learning and practical application of heat transfer concepts.				
17.	I feel that low cost instructional materials have the potential to increase student motivation and engagement in learning about heat transfer.				
18.	I don't feel that low cost instructional materials could lead to better retention of heat transfer knowledge among students on heat transfer.				
19.	I believe that the use of low-cost instructional materials for teaching heat transfer concepts should not be recommended to other educators.				
20.	I feel that using low-cost instructional materials allowed you to learn about heat transfer concepts more efficiently compared to traditional methods.				

Reliability

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	20	100.0
	Excluded[a]	0	.0
	Total	20	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.764	20