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KNOWLEDGE OF THERMO-ELECTRIC PROPERTIES OF LOCAL OILS AND STUDENTS' INTEREST IN THE CONCEPT OF VISCOSITY

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Abstract

The research aimed at investigating students' interest in the concept of viscosity with respect to their knowledge of thermo-electric properties of local oils. To achieve the objectives of the study, three research questions and three null hypotheses were **stated**. The study was quasi-experimental with a co-relational design. A sample of 50 SS1 Physics students in one intact class in a co-educational secondary school in Itu Local Government Area of Akwa Ibom State was selected for the study using purposive sampling technique. Three researcher - made instruments containing 50 items each were used. The instruments were: Physics Interest Scale (PIS) and Performance Test on Thermoelectric Properties of Local Oils (PTTEP). Each of the two instruments was administered once. The result of Cronbach's Alpha showed that PIS has a reliability coefficient of .84. and the result of Kuder Richardson Formula-21 showed that PTTEP has a reliability coefficient of .98 and PTTEP. The students were guided by the researcher to conduct the experiments using three oil samples: coconut oil, groundnut oil and palm oil while teaching the concepts: Thermal conductivity, Specific heat capacity, Electrical conductivity and Viscosity. The data obtained from the test administered were analyzed using Pearson Product Moment Correlation (PPMC) and Simple Linear Regression. The results of data analyzed showed a relationship between students' knowledge of thermal properties of local oils and their interest in viscosity. A significant relationship between students' knowledge of electrical properties of local oils and their interest in the concept of viscosity was also observed. There is a significant relationship between students' knowledge of thermoelectric properties of local oils and their interest in viscosity. Based on the observations from this study, it was therefore concluded that students' knowledge of thermo-electrical properties of local oils relates highly to their interest in the concept of viscosity. Arising from the findings of this study, it is recommended that physics teachers should survey their environment extensively in order to bring some basic physics concepts that will increase students' interest towards learning a particular concept. Precisely, experiment with local oils should be carried out by physics

teachers in the teaching of the concept of viscosity

Keywords: Thermoelectric property, thermal conductivity, local oils, viscosity

Introduction

Nigeria is one of the countries of the World that is endowed with abundant natural resources. Prominent among these resources are different types of oils namely: crude oil, palm oil, coconut oil and groundnut oil. Crude oil is a thick smooth liquid with high viscosity that is found beneath the earth crust or underground as a natural resource in the form of petroleum with numerous chemical compositions. Other forms of this smooth thick liquid could be extracted from plants or animals. Oil is also used for cooking and other forms of applications such as in medicine, cosmetics, ornament and soap making (Etuk, 2010). This work focuses on the local oils which are the by-product of plants.

Over the years, man has transformed oil from its natural state to different forms for different applications through the use of heat. The forms to which this could be transformed are solid, semi-solid, liquid and highly volatile states such as gaseous form. This has been successfully achieved by the application or withdrawal of heat that is raising or reducing its temperature. These oils that are made locally from different plants react differently at the same temperature when exposed to the same quantity of heat. This brings to existence the different ways they could be put to use. The application of heat facilitates changes in thermal behavior of these oils. Sterilization, evaporation, cooking, chilling are examples of application of heat treatment during processing (Jana, 2012). Oils can exist in three phases: solid, liquid and gas. The liquid phase allows free flow of the molecules than its solid phase because the molecules that make up the liquid are loosely packed (Eno, 2004). The forces between the molecules which are randomly arranged are sufficiently weak to allow the liquid flow. However; they are strong enough to prevent molecules from moving away into space like gases. This makes the liquid to have a fixed volume and takes up the shape of any container in which it is placed. The molecules of oils are randomly arranged. When heat is transferred to the body (oil) it usually increase the internal energy of the body by increasing the kinetic energy of molecules causing the temperature of the body to increase (Eno, 2004). Temperature of the body depends on the amount of heat energy absorbed by the body, the mass, and nature of the body. It is observed that oils have played significant roles as media for thermal transfer. The mechanism of this process (heat transfer in local oils) can effectively be utilized through the process of science teaching and learning in general and physics in particular.

Effective physics education demands active participation and higher achievement by the students. In Nigeria the attainment of this goal, which ought to be the position of physics learning and high performance is marred by poor teaching conditions in the classrooms. A distinct approach is required in the teaching and learning of its concepts. Ogunneye (2001) maintains that learners would achieve significantly high scores if an integrative strategy is used than the conventional method. By integrative approach he means a teaching approach involving practical and theory at the same time and allow the students to participate in learning. Report on intellectual performance of learners by Hilgard (2002) showed that the availability and use of local materials provide an enriched environment for the child. While Farrant (2002) supports the use of local materials in teaching when he reported that these facilities help in appealing to all the five senses of the child. Millar (2008) suggested that practical work should be viewed as the mechanism by which materials and equipment are carefully and critically brought together to persuade the physics learner about the veracity and validity of the scientific world view. Critical thinking skills can be attained from practical work in physics. Practical work puts the students at the center of learning where they can participate in, rather than being told about physics. In this way the desire and eagerness to know more about what the subject can offer is developed (Millar, 2008). However, the reality on the ground is that most experiments are sterile, un-illuminating exercises whose purpose is often not achieved in the learner.

Science teaching requires benefit maximally from learning experiences (kwomo, 2009). Most scientific materials and equipment are improvised or locally produced. The use of local materials in teaching of science implies utilization of the scientist's environment (kwomo, 2009). These local materials include the one prepared by teachers, students and ones bought (Udokang, 2005). Improvisation is the concept that challenges a teacher to look in-ward and produce unavailable materials from resources within his environment. The concept emphasizes that the teacher should not be found wanting when he can produce the learning materials on his own (Adelakun and Echendu, 2006).

Some local resources can be used in the teaching of physical concepts. For instance, *piassava and tie-tie*, (when dry and dampened) have been used in teaching the concept of Young's modulus by Onwioduokit (2013). Johnson (2012) and Onwioduokit (2013) reported the use of Camphor in teaching the concept of Radioactivity. Essien, Essiett and Nyong (2004), reported the use of some soup thickeners in teaching the concept of Viscosity. They concluded that *Abelmoschus Esculentus* (Okro) and *Hibiscus Rosa Sinensis* (Garden Hibiscus) exhibited Newtonian fluid characteristics with low viscosity while Cocoa pods is Non-Newtonian with high viscosity. Local oils are one of such local resources that can be used in the teaching of physics.

The current approach recommended by the National Policy on Education (FRN, 2013) for teaching of science in Nigeria emphasizes the use of local materials available in the environment. It is generally held that this approach will enhance a better understanding of science given the familiarity of the materials to the child. There is also the economic benefit if funds earlier earmarked for the purchase of Science equipment are applied to meeting some other school needs (Gbamanja, 2000). The negative attitude of Nigerian teachers and educators towards looking inward to their environment for local resources in science teaching is certainly not to the best interest of science education. Teaching students should afford them opportunities for having scientific experience with his environment. Such children can be made to create questions and establish problem-solving approaches to life situations. This enables students to acquire knowledge about their environment while simultaneously learning scientific concepts, ideas, and skills through seeing and handling (Uche and Umoren, 2006).

Physics is a branch of science that deals with the fundamental constituents of the universe, the forces they exert on one another, and the effects of these forces (Omiwale, 2011). Abdullahi (2002) viewed physics to be a study of the relationship between matter and energy. Chandrajeet (2008) defined physics as natural science which explores concepts like mass, energy, matter and its motion while Omosewo (2009) considered physics to be science of measurement. Physics as one of the science subjects involves both theoretical and practical experiences. Among the sciences, physics is considered a fundamental subject (Wenham, 2004). It imbues learners with systematic thinking and supplies the theories necessary for understanding the mechanics of how the things mankind relies on work. It provides students with analytical, problem solving and quantitative skills which are important for many sciences. Physics prepares students to synthesize and analyze data and to present their findings in understandable formats.

Effective teaching and learning of physics in Nigeria and indeed all over the World as a stepping stone for development is a noble one that will be continuous. Within the given context of science education, physics has been identified as a very important subject and its importance in scientific and technological development of any nation has been widely reported (Zhaoyao, 2002). It was as a result of the recognition given to physics in the development of the individual and the nation that it was made a important subject among the natural sciences and other related courses in Nigerian education system. It has been a pre-requisite subject for offering most science oriented courses in the tertiary institutions and calls for the need to teach it effectively. Physics teaching is supposed to be result- oriented and students- centered. This can only be achieved when students are willing and teachers are favorably disposed to using appropriate methods and resources in teaching students. Students by nature are curious, they need to be

actively involved in the learning process in which they are continuously equipping, testing, speculating and building their own personal construct and knowledge (Miller, 2008). It is only by personalizing such knowledge that it becomes valid, meaningful and useful to them. In the learning of physics, students need to actively construct their own personal awareness and meaning. This is to show that the brain is not a passive consumer of information and to learn with understanding. A learner must actively construct meaning of what is to be learned.

However, students' interest plays an important role in the knowledge of a particular concept in physics. When a learning task is set before the students, the aptness in responding to the set learning task is centrally controlled by interest. Organization and presentation of the learning task are geared towards awakening the students' interest to the learning of the concept. Interest promotes intrinsic motivation which has been shown to drive and sustain students' engagement in a particular task. The extent to which a student is interested in a particular course of study is indicated by active participation in the study of the subject with good performance. According to Person-Object Theory of Interest (POI) "that the self is not simply a social construction or a reflection of social appraisals" (Deci, 2008). Rather, it assumes that individuals have a great influence on their own development, through an inborn tendency to interact with the social and physical environment in a constructive and self-determined way. Human beings are active by nature, and this "intrinsic proactivity" can be found from birth onwards. They are curious, explore their surroundings, manipulate things, try to affect the objects in their social and physical environment, and through these activities elaborate their own sense of self. One can assume that, at the earliest stages of development, the aims and intentions that are visible in these activities belong to the child's actual state of self, although they would not exist as cognitive representations. As the child gets older the role of cognition becomes more important. During the course of life the self-system changes continually, such that already the existing components become more differentiated and integrated. POI refers to these developmental changes using general concepts such as differentiation, integration, and "disintegration" (Fink, 2001).

Every teacher strives to obtain order to transfer learning to the students with good feedback (Okoro, 2011). This is done through the application of knowledge acquired and possibly transfers to the students. Students who have interest in study perform better than those with little or no interest. There is therefore the need to assess the extent to which the use of local oils in teaching will affect students' interest in physics.

Constructivism is a philosophy of learning founded on the premise that, by reflecting on our experiences, we construct our own understanding of the world we live (Effiong and Udo,

2010). Each of us generates our “rules” and “mental models” which we use to make sense of our experiences. Learning therefore, is simply the process of adjusting our mental models to accommodate new experiences. Constructivism has been considered as a dominant paradigm or research programme in the field of science education. According to Nwosu (2003), Constructivism is a dynamic and interactive conception of human learning which essentially holds the view that scientific knowledge is personally constructed and reconstructed by learners, based on the experiences. This is because learners bring to the class ideas which affect any new information they receive and what they learn, therefore, results from interaction between their previous knowledge and what is experienced during learning.

Gagne's Hierarachy of learning states that learning of new concepts or skills depends upon mastery of pre-requisite concepts or skills (Okoro, 2011). This law places emphasis on task analysis starting from pre-requisite to the main study that will enhance achievement on knowledge acquired. It is a step by step process from simple to higher learning.

Thermal conductivity (λ) is the ability of heat to flow across a material in the presence of a differential temperature (Fotsing and Takam, 2004). When heat is applied the particles vibrate faster because of the increase in heat content, kinetic energy of the particles then increase resulting to collisions with neighbouring particles, thereby transferring energy from one place to another. No transportation of the particles takes place. Conduction of heat is also enhanced by numerous free electrons that easily move through the metal as in the case with electrical conduction. It has been observed that good conductors of electricity are also good conductors of heat (Eno, 2004).

$$\frac{dQ}{dt} = -\lambda A \frac{d\theta}{dt} \quad \text{---- (1)}$$

where $\frac{d\theta}{dt}$ the temperature gradient and equation (1) could also be written as

$$\frac{Q}{t} = \lambda A \frac{(\theta_2 - \theta_1)}{x} \quad \text{---- (2)}$$

Electrical conductivity (σ) is a measure of the extent to which a material will allow current to flow easily through it when a potential difference is applied at a specified temperature (Anyakoha, 2011). The commonly used units for measuring electrical conductivity are $\mu\text{S/cm}$ (microSiemens/cm), dS/m (deciSiemen s/m), mmhoms/cm (millimeters ohms/cm).

Electrical conductivity is a very useful property since values are affected by such things as substance chemical composition and stress state of crystalline structures. Electrical

conductivity information can be used for measuring the purity of oil, sorting out material, checking for proper heat treatment of oils and inspecting for heat damage in some materials. . Electricity conduction requires electrons that move from atom to atom and at low voltages, this usually does not happen very quickly except in conductors like metals or conductive plastics and glasses

Electrical resistivity is the opposition of a body or substance to flow of electrical current through it, resulting in a change of electrical energy into heat, light, or other forms of energy.

$$(\sigma) = \frac{1}{\rho} \quad \text{--- 3}$$

where (σ) is the Electrical conductivity and ρ is the resistivity. The amount of resistance depends on the type of material, length of the material (l) and cross sectional area (A) of the material, hence equation 6 can be written as

$$\sigma = \frac{l}{RA} \quad \text{--- 4}$$

Materials with low resistivity are good conductors of electricity and materials with high resistivity are good insulators.

Knowledge of electrical properties of oil is essential to assess the potential of their applicability in determining the quality of oil. Fritsch (2001) has observed that the change in the dielectric constant of oils provided the simplest method for assessing their deterioration Augustin (2007) reported the existence of highly significant correlation between the dielectric constant of oil and the polar components present in it. Electrical properties provide opportunities for non-destructive sensing of quality characteristics in local oils where those quality characteristics can be well correlated with electrical properties. If good correlation exists, these properties can be sensed with appropriately designed instrument which can be calibrated to provide the desired information about the quality of the product

Among solids, metals and graphite are good conductors of electricity which have high electrical conductivity. Some liquids are also good conductors. Pure water or distilled water is a poor conductor of electricity. But the presence of even small amount of impurities makes water a good conductor. Water from taps, wells, ponds, rivers, seas, lakes conduct electricity as they contain impurities. Solutions of acids, bases and salt dissolved in water are good conductors of electricity. Electrical conductivity of a liquid can be tested by simple activity of taking a liquid like lemon juice, in container, inserting electrodes in it, connecting the two electrodes to the

terminals of a battery with a led bulb, indicating that lemon juice is a conductor of electricity. A liquid that conducts electricity due to the presence of ions is called electrolyte. Again, liquids like distilled water, oil, alcohol do not conduct electricity. But conductivity can be increased at high temperature and at a very high voltage for a sizeable current conducted to be detected. However, if oil contains some water, salts or other impurities it may make it much more conductive.

Specific heat capacity is the quantity of heat needed to raise the temperature of a unit mass (1kg) of the substance by 1 Kelvin (Eno, 2004). It can be written mathematically as:

$$Q = mc\theta \quad \text{---} \quad 5$$

where, Q is the quantity of heat, m, is the mass of the body, θ is the change in its temperature and c is a constant known as the specific heat capacity of the body, c is dependent on the nature of the body. Equation (8) can be written as:

$$c = \frac{\theta m Q}{m} \quad \text{---} \quad 6$$

The specific heat capacity (c) of a substance is the quantity of heat required to raise the temperature of a unit mass of the substance by 1^oC (1K).

Where Q is in Joules, m is in kg and θ is in ^oC or K, the unit of specific heat capacity is Joules per kilogram per Kelvin (j/kg. k). Water has a specific heat capacity of 4200J/Kg. K (42 J/g. k). Hence, to raise the temperature of 1Kg of water by 1K, 4200J of heat is required.

The amount of heat needed to change the temperature of a body depends on:

- (1) the material of the body
- (2) the mass (m) of the body
- (3) the change in temperature.

Thermoelectric effect is the direct conversion of temperature difference to electric voltage and vice versa. A thermoelectric device creates voltage when there is a difference in temperature on each side and when the voltage is applied to it, it also creates a temperature difference. At atomic scale level, an applied temperature gradient causes charge carriers in the materials to diffuse from hot region to cold region. This phenomenon can be used to generate direct electricity, measure temperature or change the temperature of objects. Thermoelectric devices can also be used as temperature controllers because the direction of heating and cooling is determined by the polarity of the applied voltage. Thermoelectric effects are thermodynamically reversible. It encompasses three separate effects which are Seebeck, Peltier, and Thomson named after them respectively are reversible. However, the heating that is generated when current is passed through a resistive material-joule heat is also related but not generally termed thermoelectric effect and is not thermodynamically reversible.

Heat capacity is among the thermo-physical and thermodynamic properties of food materials (Ngadi, Eze and Alakali, 2013). The property is directly linked with temperature

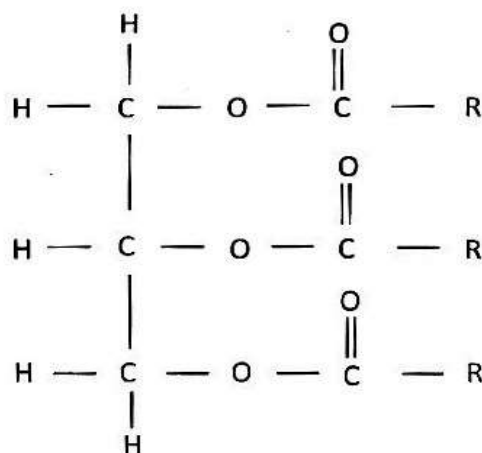
derivations of basic thermodynamic functions and therefore indispensable for the calculation of differences in these functions between different temperature (Za'bransky, Ruzicka and Eugene, 2002). It is used for establishing energy balances, entropy and for calculating changes in reaction enthalpies with temperature.

Heating cause changes in the physical and chemical properties of the local oils which influence the overall properties of the final product like taste, appearance, texture, stability, and chemical reactions such as hydrolysis, oxidation or reduction, may be promoted or physical changes such as evaporation, melting, crystallization, aggregation may also occur. The changes which comprise direct cleavage or scission of component fatty acids due to thermal energy leave the component fatty acid quite unstable with the generation of free radicals. It has been well established that the specific heat capacity of oil increase with increase in temperature (Jana, 2012). In a study carried out by Fasina and Colley (2007) on specific heat capacity of Australian Honey, they observed that specific heat capacity of the oil increase linearly with increase in temperature. They postulated that the increase in specific heat capacity of the oil with increase in temperature is because of expansion of the oil during heating. Their conclusion was that temperature affects specific heat capacity of Australian Honey.

Palm oil is red in colour, which depicts the presence of beta – carotene, an established precursor of vitamin A, a potent anti-oxidant. It also boasts of large concentrations of tocopherols and toco-trienols which are also potent antioxidants (Etuk, 2010). These give palm oil an anti-cancer effect.

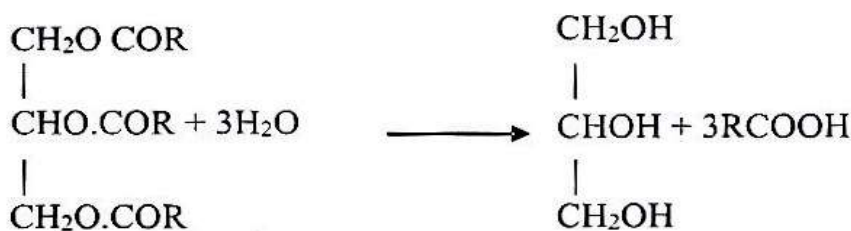
Palm oil is liquid at ordinary temperature with it near equivalent composition, of about fifty percent, saturated and fifty percent unsaturated fatty acids (Etuk, 2010).Fats are solid at ordinary temperature and contains mostly saturated carboxylic acids. Fats and oil have the general formula, $(RCOO)_3CH_2$.

The structural formula (Etuk, 2010) is:



Where R stands for fatty acid chains (Ibemesi, 2007).

When palm oil is superheated with steam, it is hydrolyzed to glycerol and free fatty acids are obtained as follows:



Palm oil can be changed into fats by converting the unsaturated acids into saturated acids. This is done by the introduction of hydrogen and the process is known as hydrogenation or hardening of oils. Hydrogen is passed into palm oil heated to 150- 200°C under pressure in the presence of a finely divided nickel catalyst. The nickel is recovered by filtration.

In addition, if palm oils are hydrolyzed with an alkali, soap is obtained. This process of hydrolyzing the palm oil with alkali to obtain soap is called saponification. In this process, fat is heated with aqueous sodium hydroxide (NaOH_(aq)) in large iron kettles until fat is completely hydrolyzed. The soap that is formed can be precipitated by the addition of saturated solution of common salt. The precipitated soap is removed by filtration, washed and mixed with dyes, perfumes or some other ingredients.

The lower aqueous layer contains glycerol and excess sodium hydroxide (NaOH) solution. This excess NaOH solution is neutralized with tetraoxosulphate (VI) acid (H₂SO₄) and then evaporated into vacuum until the liquid contains about 50% glycerol. Sodium chloride (NaCl)

used for salting out the soap is precipitated by evaporation in Vacuo to obtain about 85% glycerol. To obtain 99% glycerol, steam distillation in Vacuo is used.

Red palm oil is the richest dietary source of provitamin A carotenes (beta carotene and alpha-carotene). It has 15 times more provitamin A carotenes than carrot and 300 times more than tomatoes (Etuk, 2010). This has made it so value resource in the treatment of Vitamin A deficiency, just one teaspoon a day of red palm oil supplies children with the daily recommended Vitamin A. The adding of red oil in diet can double or triple the amount of vitamin A in mother's milk.

The microscopic effect of heat on matter could be explained using the kinetic theory of matter (STAN, 2008). This theory shows that all substances are made up of minute particles, atoms, ions or molecules which are in constant motion. Oil being in a liquid state obeys this theory, its difference in properties compared to those of solid and gaseous form of matter notwithstanding. The particles in oil are quite close together so the density of oil is fairly high. When heat is applied at the bottom of the containing vessel, its temperature rises steadily until the oil starts to boil and consequently evaporates. It could be observed that the boiling of the oil breaks the intermolecular forces of attraction keeping the molecules together and also breaks the adhesive forces between the oil molecules and the walls of the containing vessel. The breaking of the intermolecular and adhesive forces consequently increases the temperature of the oil as a result of increase in the kinetic energy of vibration of the oil molecules.

According to Ionic theory, in an electrolyte there are positively and negatively charged particles called ions. The molecules that constitute electrolyte are split in solution into these ions through the process of electrolytic dissociation. The dissociation of an electrolyte occurs irrespective of whether or not an electric field is applied to the electrolyte. The ions in an electrolyte execute random movement until a battery is connected to the electrodes of a voltmeter. When a potential difference is set across the electrodes, the positive ions are attracted to the cathode, which is the negative potential while the negative ions are attracted to the anode which is the positive potential. The positive and negative ions thus move in opposite directions on the electrolyte. The directional movement of ions is the electric current flowing through the electrolyte. Local oils are able to conduct electricity because the electrolyte in solution can dissociate into ions. The charge carriers are both positive and negative ions.

Viscosity is the measure of the resistance to flow in a liquid and fluids, generally (Eno, 2004).

Fluids resist the relative motion of immersed objects through them as well as the motion of layers with differing velocities within them. Applications of Viscosity are:

- (1) Oils, grease and air are used as lubricants because of their viscosity.
- (2) Engine oils are used in lubricating engines and other machines so as to keep metal surfaces from rubbing against each other.
- (3) It is because of viscosity of air that the bob of a swinging pendulum comes to rest more quickly with a cord attached to the string than without a cord. The wider the surface area of the cord, the greater the viscous force opposing the pendulum's motion and hence the quicker the pendulum comes to rest.
- (4) The knowledge of viscosity is necessary for the designing and operating the processing equipment.
- (5) The knowledge of viscous drag is applied in the design of ships and air crafts.
- (6) The knowledge of viscosity is important and necessary because of its application in food designs. A food product's resistance to flow is critical to processing applications such as pumping, filling and moulding.

Terminal velocity is the velocity with which an object moves downward through a liquid or fluid when the resultant force on the object is zero. When a stone falls through a viscous liquid, it is subjected to three forces: its weight (W) acting downwards, the upthrust (U) of the liquid on the stone acting upwards and the viscous force (V) opposing its motion. The viscous force acts opposite the motion of the stone that is upwards.

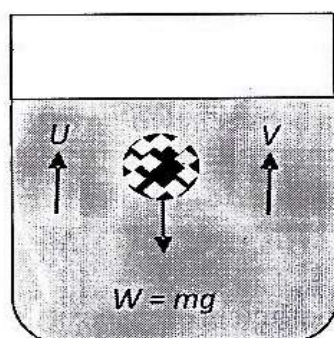


Fig. II: Motion of sphere in a viscous liquid

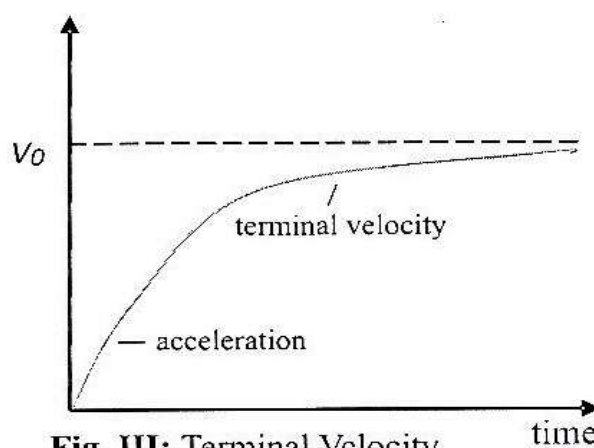


Fig. III: Terminal Velocity

Viscosity of Newtonian Liquids

Newtonian liquids are those with streamline flow. They have minimum drag forces and minimum amount of turbulent flow. When velocity gradient exist there is a viscous shearing force between the two surfaces of liquid. The faster of the two exerts the force F on the slower one in the direction of v , since it is trying to drag it along. The slower layer also exerts the force F on the faster layer in the opposite direction to v , since it is trying to slow it down. The tendency of the force F is to eliminate the difference in velocity between the two layers. According to Newton's law of viscous flow, the frictional force F is directly proportional to the velocity gradient in the region of the liquid under consideration. Thus if A is the area of the liquid surface considered the frictional force F on the surface is given by

$$F \propto A \times \text{Velocity Gradient}$$

Or with constant of proportionality η ,

$$F = \eta A \frac{dv}{dx} \quad \dots \quad 7$$

The constant of proportionality η is called coefficient of viscosity of the liquid. Coefficient of viscosity is the frictional force per unit area between two surfaces in a liquid when it is in a region of unit velocity gradient. Therefore,

$$\frac{dv}{dx} AF = \eta \quad \dots \quad 8$$

Measurement of Viscosity

The two basic methods of measuring the coefficient of viscosity of liquids are:

- (a) By observing the motion of a solid falling through the liquid according to Stoke's law
- (b) By measuring the rate of flow through the capillary tube using Poiseuille's method

Factors Affecting Viscosity of liquids

- (i) **Materials:** The structure of material affects the viscosity of the material. Ordinary liquids have viscosities of the order of 1 to 1000mPas whereas the viscosity of water at 20°C is 1.0020 mPa seconds. Fats like butter or margarine are so viscous that they seem more like soft solids than flowing liquids.
- (ii) **Temperature:** From everyday experience, it is a common knowledge that viscosity varies with temperature (www.physics.hypertextbook.com). The viscosity of all oils decrease with an increase in temperature. The dependency of viscosity of fluid on temperature is a manifestation of its cohesive and thermal energies behavior. With a rise in temperature, the attraction between the polar molecules decrease while their thermal energies increase, thereby viscosity of oil decreases. Honey and syrup can be made to flow more readily when heated. Engine oil is found to be dielectric in nature with a relationship between the relative permittivity and their viscosities (Etuk, 2010). Engine oil and hydraulic fluids thicken appreciably on cold days and significantly affect performance of cars and other machinery during winter months. In general, the viscosity of a simple liquid decreases with increasing temperature (and vice versa). As temperature increases the average speed of the molecules in a liquid increases and the amount of time they spend 'in contact' with the nearest neighbors decreases. The exact manner in which the two quantities vary is nonlinear and changes abruptly when the liquid changes phase.
- (iii) **Pressure:** Viscosity is independent of pressure. Liquids are normally incompressible therefore; an increase in pressure does not really bring the molecules significantly closer together.

Statement of the Problem

Physics education has been undergoing a crisis (Musasia, Abacha and Biyoyo, 2012). Many students consider physics as difficult, abstract and theoretical (House of Lords, 2006). Akpan (2011) indicated that among the physics concepts considered by both teachers and students as being difficult are Viscosity, Electrolysis, Radioactivity, Waves, Current Electricity and Gravitational field. Students seem to have negative attitude towards these physics concepts (Omiwale, 2011). The students find these concepts boring and unenjoyable (Hirschfeld, 2012). The concepts are considered devoid of applications in the day to day life, perhaps, due to the wrong notion of physics being abstract and difficult. Interest in physics is decreasing, learning motivation is declining, and the examination results are getting worse (Garwin and Ramsier, 2003; Manogue and Krane, 2003). Teaching in most cases, is geared around memorization of basic concepts and their reproduction in the examinations (Sadiq, 2003).

The purpose of the study was to investigate the extent to which the knowledge of thermo-electric properties of local oils relates with students' interest in the concept of viscosity. The specific objectives of the study are to:

- (1) Determine the relationship between students' knowledge of thermal properties of local oils and their interest in the concept of viscosity.
- (2) Examine the relationship between students' knowledge of electrical properties of local oils and their interest in the concept of viscosity.
- (3) Examine the relationship between students' knowledge of thermo-electric properties of local oils and their interest in the concept of viscosity.

Research Questions

The following research questions were formulated to facilitate the investigation.

- (1) What is the relationship between students' knowledge of thermal properties of local oils and their interest in the concept of viscosity?
- (2) To what extent does students' knowledge of electrical properties of local oils relate with their interest in the concept of viscosity?
- (3) What relationship exists between students' knowledge of thermo- electric properties of local oils and their interest in the concept of viscosity?

Research Hypotheses

- (1) There is no significant relationship between students' knowledge of thermal properties

of local oils and their interest in the concept of viscosity.

- (2) There is no significant relationship between students' knowledge of electrical properties of local oils and their interest in the concept of viscosity
- (3) There is no relationship between students' knowledge of thermoelectric properties of local oils and their interest in the concept of viscosity

RESEARCH METHOD

Research Design

The study made use of quasi-experimental posttest only, no control group design. Precisely, the relationship between students' knowledge of thermal, electrical and thermoelectric properties, and their interest in each case were assessed. The area of the study was Itu Local Government Area of Akwa Ibom State. The population comprised of all the Senior Secondary one physics students, consisting of three thousand two hundred (3,200) students in all the eight public co-educational Secondary Schools during the 2015/2016 academic session in Itu Local Government Area (State Secondary Education Board, Itu Zone, 2015). The sample size of 50 Senior Secondary one (SS1) physics students was drawn from one intact class in one public co-educational secondary school in the study area. Purposive sampling technique was used in selecting the one school with the following criteria:

- (i) the school that has Professional physics graduate teachers with at least three years of teaching experience,
- (ii) the school that has well equipped physics laboratory,
- (iii) School that has presented candidates in the past five years for Senior Secondary School Certificate Examination (SSCE). Three schools met the criteria and a simple random sampling technique was used to select one school from the population.

Research Instruments

The following researcher- made instruments were used to collect data for the study:

- (i) Physics Interest Scale (PIS)
- (ii) Performance Test on Thermoelectric Properties of Local oils (PTTEP)

Reliability of the Instruments

The Instruments were trial tested to establish its reliability with fifty SS1 physics students in a school within the population that was not part of the main study. The instruments were administered once. The data were analyzed using Kuder Richardson

Formula-21. The reliability coefficient of PTV was 0.78 while PTTEP has a reliability index of 0.98. The result of Cronbach's Alpha showed that PIS has a reliability index of 0.84.

Research Procedure

The researcher obtained permission from the authority of the sampled school to use the school for the study, and also solicited the co-operation of the subject teachers in the school as research assistants. The researcher discussed the nature of the research with the assistants. The study incorporated six lessons as shown in the learning packages. The packages included the teaching of the following concepts: Thermal conductivity, Specific Heat Capacity, Electrical conductivity, Viscosity, Viscosity of Newtonian Liquids and Factors affecting Viscosity. The teaching of each concept and the experimentation were done using the three oils (coconut, groundnut and palm) and lasted within 80minutes each. The teaching lasted for the period of one month. The teaching of the concepts and experimentation was done using Guided discovery method. Students got involve in the determination of the concept of thermo-electric properties of the oils as guided by the researcher. After which, PTV, PTTEP and PIS were administered to the subjects by the research assistants.

Table 3.3 Experimental Investigations Using Local Oils

Oil	Boiling Points in Degree Celsius (°C)	Electrical Conductivity in Mmhos/cm	Specific Heat Capacity in KJ/kg k	Coefficient of Viscosity in Nsm⁻²
Coconut	220.0	0.002	380.95	0.46
Groundnut	222.0	0.001	375.59	0.36
Palm	235.0	0.003	355.56	0.76

Method of Data Analysis

Data obtained from PIS and PTTEP were analyzed using Pearson Product Moment Correlation (PPMC) and Simple Linear Regression Analysis. The results were used in answering the research questions and in testing the research hypotheses at .05 alpha level of significance.

Data Analysis and Results

In this subsection the summary of results used in answering the six research questions and testing the six null hypotheses formulated to guide the study, are presented and interpreted one after the other.

Research Questions

Pearson Product Moment Correlation (PPMC) was used to answer the research questions since the study was to ascertain the relationship between the variables.

Research Question 1: What is the relationship between students' knowledge of thermal properties of Local oils and their interest in the concept of viscosity?

Table 2: Result of Correlation Coefficient Analysis between Students' Knowledge of Thermal Properties of Local Oils and Their Interest in the concept of Viscosity.

Variables	N	$\sum X^2$	$\sum Y^2$	$\sum XY$	r-cal
Thermal Properties Knowledge	50	1968	83432	137900	.70
Students' Interest	50	3358	236836		

The data presented in Table 2 indicates that, the correlation coefficient (r-value) is .70. This indicates that a relationship exists between students' knowledge of thermal properties of local oils and their interest in viscosity. The relationship from the r-value indicates that, it is positive and high relationship. This implies that as students' knowledge of thermal properties of local oils improves their interest in viscosity will highly improve.

Research Question 2

What is the relationship between students' knowledge of electrical properties of local oils and their interest in the concept of viscosity?

Table 3: Result of Correlation Coefficient Analysis between Students' Knowledge of Electrical Properties of Local Oils and Their Interest in the Concept of Viscosity.

Variables	N	ΣX	ΣX^2	ΣXY	r-cal
		ΣY	ΣY^2		
Electrical Properties Knowledge	50	1302	36428	90372	.55
Students' Interest	50	3358	236836		

The result in Table 3 shows that the regression coefficient (r-value) is .55. This indicates that a relationship exists between students' knowledge of electrical properties of local oils and their interest in the concept of viscosity. The relationship from the r-value shows that, it is positive and moderate relationship. This implies that as students' knowledge of electrical properties of local improves, students' interest will moderately improve.

Research Question 3

What is the relationship between students' knowledge of thermo-electrical properties of local oils and their interest in the concept of viscosity?

Table 4: Result of the Regression Coefficient showing the Relationship between students' Knowledge of Thermo-Electrical Properties of Local Oils and Their Interest in the Concept of Viscosity.

Variables	N	R	R- squared
Knowledge of Thermo-Electrical Properties	50	.72	.52
Students' Performance	50		

Table 5 shows that the regression coefficient (R-value) is .72. This indicates that a relationship exists between students' knowledge of thermo-electrical properties of local oils and their interest in the concept of viscosity. The r-value indicates a positive and moderate joint relationship. This implies that as knowledge of thermo-electrical properties of oil improves,

students' interest moderately improves. The table also shows an R-squared value of .52 which indicates that 52.0% of the variance in the dependent variable (students' interest) is due to the independent variables (knowledge of thermo-electrical properties).

Testing of hypotheses

The hypotheses were analyzed using correlation and F-statistics of the simple linear regression.

Hypothesis One

There is no significant relationship between students' knowledge of thermal properties of local oils and their interest in the concept of viscosity.

Table 5: Correlation Analysis showing the Relationship between Students' Knowledge of Thermal Properties of Local Oils and Their Interest in the Concept of Viscosity

Variables	N	ΣX	ΣX^2	ΣXY	r-	r-crit
		ΣY	ΣY^2		cal	
Thermal Properties Knowledge	50	1968	83432	137900	.70*	.288
Students' Performance	50	3399	241629			

* = Significant at .05 level of significance.

Data presented in Table 5 shows that the calculated correlation coefficient value (r-value) .70 is greater than the critical correlation coefficient value at .05 alpha level which is .288. Therefore, the null hypothesis is rejected. This implies that there exist significant relationship between students' knowledge of thermal properties of local oils and their interest in the concept of viscosity.

Hypothesis Two

There is no significant relationship between students' knowledge of electrical properties of local oils and their interest in the concept of viscosity.

Table 6: Correlation Analysis showing the Relationship between Students' Knowledge of Electrical Properties of Local Oils and Their Interest in the Concept of Viscosity

Variables	N	ΣX	ΣX^2	ΣXY	r-cal	r-critical
Thermal Properties Knowledge	50	1302	36428	90372	.55	.288
Students' Performance	50	3358	236836			

* = Significant at .05 level of significance.

Data presented in Table 6 shows that the calculated correlation coefficient value (r-value) .55 is greater than the critical correlation coefficient value at .05 alpha level which is .288. Therefore, the null is rejected. This implies that there exist significant relationship between students' knowledge of electrical properties of local oils and their interest in the concept of viscosity.

Hypothesis Five:

There is no significant relationship between students' knowledge of thermo-electric properties of local oils and their interest in the concept of viscosity.

Table 7: F-Statistics of the Regression Coefficient showing the Relationship between Students' Knowledge of Thermo-Electric Properties of Local Oils and Their Interest in the Concept of Viscosity.

Source of Variation	Sum of Squares	Df	Mean Square	F-cal	F-critical
Regression	5878.53	1	5878.53	51.93	4.08
Residual	5434.19	48	113.21		
Total	11312.72	49			

* = Significant at .05 level of significance

Data presented in Table 7 shows that the calculated F-value (51.93) is greater than the critical F-value (4.08). Hence, the null hypothesis is rejected. This implies that there exist significance relationship between students' knowledge of thermo-electric properties of local oils and their

interest in the concept of viscosity.

Discussion of Findings

The discussion was done based on the objectives of the study.

Relationship between Students' Knowledge of Thermal Properties of Local Oils and Their Interest in the Concept of Viscosity

The findings from the results on the relationship between students' knowledge of thermal properties of local oils and their interest in the concept of viscosity indicated the nature of the relationship as positive and significant. The significant relationship could be attributed to the excitement and commitment of students as of the use of the local oil they are familiar with. The study is in agreement with the findings of Floyd-Smith, Kwon, Burmester, Dale, Vahdat and Jones (2006), they demonstrated and assessed a Simple viscosity experiment for high school science classes and found that students gained by at least 36% in the knowledge of and interest in fluid viscosity. According to Mussia et. al (2011), by enabling students to carry out practical investigations, theoretical investigations are clarified. Moreover, from the standpoint of interest theory, a learner is intrinsically motivated when his or her main incentive for learning is related to the qualities of the respective knowledge domain (Schiefele, 2006). In so far as a person's relationship towards this knowledge domain fit the activity specific criteria of an interest, the individual will experience a related learning task or learning episode as intrinsically motivated (Boekaerts, 2006).

Relationship between Students' Knowledge of Electrical Properties of Local Oils and Their Interest in the Concept of Viscosity.

The findings from the results on relationship between students' knowledge of electrical properties of local oils and their interest in the concept of viscosity indicated a positive and significant relationship. The observed result may have been as a result of the students being thrilled of the electrical properties of the local oil. The study's findings is in agreement with agrees with Fink, (2001) who found that interest plays an important role in the knowledge of a particular concept in physics. When a learning task is set before the students, the aptness in responding to the set learning task is centrally controlled by interest. The extent to which the student is interested in a particular course of study is indicated by active participation in the study with good performance. This is done through the application of knowledge acquired and possibly transfers to the learning concept.

Relationship between Students' Knowledge of Thermoelectric Properties of Local Oils and Their Interest in the Concept of Viscosity

The findings from the results on the relationship between students' knowledge of thermoelectric properties of local oils and their interest in the concept of viscosity indicated a positive, moderate and significant relationship between the variables. The findings also showed that 50.5% of the variance in the dependent variable (students' interest) can be predicted from the independent variables (knowledge of thermal and electrical properties). The finding of this study is in agreement with the finding of Eni and Aliyah (2015) who found that students' were interested and think positively about this interactive Virtual experiment of fast motion like water flow with difference percentage to real experiment of 0.15%. This may have been so because a student having interest in studying physics may not only enjoy studying it but could derive satisfaction from the knowledge of physics ideas gained. According to Renniger (2000), a person's valuing of an activity or content is closely related to his or her self-esteem and idea can readily applied to the value component of the interest concept. When a learner is interested in an activity, whether it is work or play, he put in more effort to learn it. The student would not do so when he has less interest or bored.

Summary of study

- (1) The results of data analyzed showed a relationship between students' properties of local oils and their interest in viscosity.
- (2) A significant relationship between students' knowledge of electrical properties of local oils and their interest in the concept of viscosity was also observed
- (3) There is a significant relationship between students' knowledge of thermoelectric properties of local oils and their interest in the concept of viscosity.

Educational Implications of the Study

The findings of this study have a possible effect for the improvement of teaching physics and science in general. The sustenance of students' interest and performance in the concept of viscosity can be enhanced by the utilization of local oils in teaching.

A relationship between students' knowledge of thermo electric properties of local oils and their interest in the concept of viscosity as observed from this study shows that students' interest and learning motivation have increased.

Conclusion

Students' knowledge of thermo-electric properties of local oils relates highly to their interest in the concept of viscosity. The use of local materials in the environment for teaching physics concepts is encouraged.

References

- Abdullahi, A. (2002). *Science Teaching in Nigeria*. Illorin: Atoto Press Ltd. Kwara State, Nigeria. pp. 12-14
- Adelakun, K. and Echendu, P. (2006). Improvisation of Material Resource As a Variable Alternative Teaching of Physical Education Abstraction. *47th Annual STAN Conference Proceedings*, 275-279
- Akpan, A. A. (2011). Effects of the Process-Product Approach (PPA) and Expository Strategy (ES) on the performance of Students in Solving Verbal in Mathematics. *Journal of social Studies Review* 4(1).
- Alakali, J. S., Eze, S. O., and Ngadi, M. O. (2010). Specific Heat Capacity of Crude Palm oil. *International Reviews of Chemical Engineering*. 2 (5): 598-605. Available at Retrieved 8th January, 2014.
- Anyakoha, M. W. (2011). *New School Physics for Senior Secondary Schools*. 1 Africana, First Drive, P.M.B. 1139, Onitsha. Africana First Publishers Plc. pp. 212-230.
- Augustine, M.A. (2007). Relationship between Measurement of Fat Deterioration during Heating and Frying in RBD olein. *Journal of American Oil Chemical Society*. 64 (12): 1670-1675. doi: 10.1007/BF02542501: Retrieved 15th February, 2016.
- Boekaerts, M. (1996). Personality and the Psychology of Learning. *European Journal of Personality*, 10, 377-404.
- Chandrajeet, A. B. (2008). *Mathematics in Physics and Chemistry*. Available at: www.articlebase.com. Retrieved 6th June, 2013.
- Deci, E. L. (2008): The Relation of Interest to Motivation and Human Needs: The Self – Determination Theory Viewpoint, Interest and Learning. *Proceedings of the Seon - Conference on Interest and Gender* (pp 146-162).
- Effiong, E. and Udo, E. J. (2010). *Theories of Administration*. Unpublished Post-Graduate Seminar Paper, University of Uyo, Uyo.
- Eni, and Aliyah (2015). *Partner Gender Influence on Students' Interest and Mark on*

Determination of Viscosity Coefficient of Fluid Viscosity Using JavaScript Interactive Experiment. 69, (247), 217-227. Available at: www.researchgate.net, Retrieved 27th September, 2015.

Eno, E. E. (2004). *First University Physics*. 43 Willington Bassey Way, Uyo Akwa Ibom State, YAKNDARA Publishers.pp.77-89.

Essien, I. E., Essiett, A. A. and Nyong, A. (2004). Comparative Study of Viscosity Some Soup thickening Materials. The Researcher, *Journal of Nigeria Education Research Reporters' Association Vol.7 (1)*.pp.62 -66.

Etuk, E. U., (2010). *Perspectives on the Nutritional Toxicology of Tropical Foods*. 28th Inaugural Lecture Series. University of Uyo. Abaam Publishing Co.G72, Ewet Housing Estate, Uyo – Nigeria. Pp.26 – 42.

Farrant, J. S. (2002). *Principles and Practice of Education*. London: Longman Group Limited.p.89.

Fasina, O. O. and Colley, Z. (2008). Viscosity and Specific Heat Capacity of Vegetable oil as a Function of Temperature. *International Journal of Food Properties*, 11 (4): 738-746. Available at: <http://www.ijcea.org/papers/204-B20003.pdf>. Retrieved 14th January, 2014.

Federal Government of Nigeria (2006). A Report of Population Census, Akwa Ibom State.

Fink, B. (2001). Interest Development as Structural Change in Person-Object Relationships in L. Oppenheimer and J. Valsiner (Eds.), *The Origins of Action: Interdisciplinary and International Perspectives* (pp. 175-204). New York: Springer.

Floyd-Smith, T.M., Kwon, K.C., Burmester, J.A., Dale, F.F., Vahdat, N. and Jones, P (2006). Demonstration and Assessment of A Simple Viscosity Experiment for High School Science Classes. *Journal of Chemical Engineering Education*. 1(18), 226-236

Fotsing, J. A.M. and Takam, M. (2004). A prediction of the Thermal Conductivity of Sapelli.

Garwin, M. R. and Ramsier, R. D., (2003). Experiential Learning at the University Level: US Case Study, *Education and Training*, 45(5), 280-285.

Manogue, B. and Krane, K. (2003). Students' Factors Influencing Students' Academic Achievement in Secondary Schools in Nyandara County, Kenya. *International Journal of Education and Research*, 3 (2-6)

Musasia, A. M., Abacha, O. A. and Biyoyo, M. E. (2012). Effect of Practical Work in Physics on Girls' Performance, Attitude Change and Skills Acquisition in the Form Two-Form Three Secondary Schools' Transition in Kenya. *International Journal of Humanities and Social Science*. 2 (23). Available at:

<http://all-abt-agric.blogspot.com/2013/01/factors-that-affect-learning-subject.html>.

Retrieved 15th January, 2014.

- Ngadi, M. O. Alakali, J. S., Eze, S. O., and (2013). Specific Heat Capacity of Crude Palm oil. *International Reviews of Chemical Engineering*. 2 (5): 598-605. Available at :www.ice//.org/content/.../EPF892.pdf. Retrieved 8th January, 2014.
- Nwosu, A. A. (2003). Constructivism as an Innovation Model for Science Teaching: Importance and Extent of use in Secondary Schools. *Journal of Science Teachers' Association of Nigeria*, 38, 1and2, 7-87.
- Ogunmeye, W. (2001). Students' Understanding of the Concept of Gradient in Physics: A Case Study of Physics Students from Tai Solarin College of Education, Ijebu-ode: *Journal of Science Teachers' Association of Nigeria*, 38 (1 and 2) 100-106.
- Okoro, C. C. (2011). *Basic Concepts in Educational Psychology*. Blesseth Publishers, Uyo, Nigeria.pp.39 – 52.
- Omiwale, J. B. (2011). Relationship between Problem-solving Ability and Achievement in Physics among Senior Secondary School Students in Osun State, Nigeria. *The African Symposium: An Online Journal of the African Education Research*.vol.(11),158-165 Available at:www.ncsu.edu/aern/TASII.I/TASII.I_Omiwlae.pdf. Retrieved February 15, 2014
- Omos ewo, E. O. (2009). Views of Physics Teachers on the Need to Train and Retrain Physics Teachers in Nigeria. *African Research Review* 3 (1).
- Onwioduokit, F. A. (2013). *The Ordeal of Science Teaching in the Contemporary Society: A Need for Paradigm shift for the New Generation*. 36th Inaugural Lectures Series. University of Uyo. University of Uyo Press.p.31.
- Renniger, K.A.(2000). *Idividual interest and Development: implications for Theory and Practice, Intrinsic and Extrinsic Motivation, the search for Optimal Motivation and Performance*. New York: Academic Press, p.404
- Sadiq, A., (2003). *Evaluation of Scientific Enterprise in Paskistin*. Towards Understanding the State of Science in Pakistan. Karachi, Muizz Publishers. 22(3), 191-198.
- Schiefele, U. (2006). Interest, Learning and Motivation. *Educational Psychologist*, 26 (2 &3) 299-323.
- STAN (2008).Chemistry for Senior Secondary Schools. Ibadan: Oyelade Industrial Prints.,p.225.
- State Secondary Education Board (2015).Students Enrolment Figure for 2015.Itu Zone: Akwa Ibom State.

- Udokang, S. J. (2005). Resource-Based Learning and Qualitative Education in Nigeria. *Journal of Eduaction. Vol.(1),50 -56.*
- Wenham, E. J., (2004). *Physics: Concepts and Models*, Addison-Wesley, pp .92, DOI:10.1080/00107518518508210742.
- Za'bransky, M; Ruzicka, V. J. and Eugene, S. D. (2002). Heat Capacity of Liquids: Critical Review and Recommended Values. *Journal of physics and chemistry Ref. Data 30 (5): 1199-1205.*
- Zhaoyao, M. (2002). *Physics Education for 21st Century: Avoiding a Crisis*. *Physics Education*, 37 (1) 18-24. Available at: <http://all-abt-agric.blogspot.com/2013/01/factors-that-affect-learning-subject.html> Retrieved 13th January, 2014.
- [https:// www.physics.hypertextbook.com](https://www.physics.hypertextbook.com) Retrieved 12th February, 2016.