RELATIONSHIP BETWEEN CHEMISTRY STUDENTS' PERCEIVED USE OF RESOURCES AND ACHIEVEMENT IN OXIDATION-REDUCTION REACTION

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CERTIFICATION

We, the undersigned, certify that this study was carried out by Elizabeth EDELEGBA, in the Department of Curriculum and Instructional Technology, Faculty of Education, University of Benin, Benin City.

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Project supervisor

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Dr. Festus Idehen **Date**

Head of Department

DEDICATION

I thank God for giving me the grace to complete this thesis, may His name be praised.

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ABSTRACT

This study examined the relationship between perceived use of resources and achievement in oxidation-reduction reaction, percentage perception of students' use of resources, and the contribution of sex, type of school, and level of perceived use of resources to students' achievement in oxidation-reduction reactions in Urban areas of Ovia-North East LGA, Edo state. Based on this, six research questions were raised and three were hypothesized and tested at 0.05 alpha level of significance.

A survey research design incorporating ex-post facto was adopted as research design for the study. The population for this study consists of four hundred and seventy-nine (479) senior secondary II chemistry students in public and private secondary schools in urban areas of Ovia North East LGA, Edo state. A sample of two hundred and seventy-seven (277) chemistry students were selected for the study through purposive random sampling techniques. An instrument titled Perceived use resource inventory and achievement test was used to collect data from the students in the study. The instrument was face and content validated by the researcher's supervisor, a lecturer in Chemistry Department and a chemistry teacher. The questionnaire had a reliability coefficient of 0.830 using Cronbach Alpha Statistics while the achievement test had a reliability coefficient of 0.731 using Kuder Richardson (KR-20), hence the instrument was deemed reliable. The instrument was administered by the researcher with the assistance of the chemistry teacher and retrieved from the students immediately they were completed. The data collected from the students were analyzed using, percentage, Pearson product moment correlation and multiple regression.

The results from the Study showed that majority of the students were well acquainted with the resources used in oxidation-reduction reactions. The result also showed that male students identified resources for teaching oxidation-reduction reaction correctly compared to female students. Furthermore, the results showed that male students identified resources for teaching oxidation-reduction reaction correctly more than the female students both in

public schools and private schools. The result also revealed that there was a significant relationship between perceived use of resources and the achievement of students inoxidation-reductions. It was also revealed from the result that there was no significant relationship between perceived use of resources and the achievement of male and female students in oxidation-reductions in public and private schools. The result further revealed that perceived use of resources significantly contributed to the achievement of the students in oxidation-reduction reaction, whereas, sex and school ownership did not significantly contribute to the achievement of the students. Based on the findings in the study, it was recommended that chemistry teachers should prioritized using resources in explaining concepts so as to increase the students' conceptualization and also deploy the most appropriate pedagogical contents that could help students conceptualize very well and know what is expected in oxidation-reduction reactions, chemistry teachers should ensure that both male and female science students are actively involved in science classes, government and private school owners should provide learning materials especially in the science areas like chemistry to meet the needs of students during their learning and study time.

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Background to the Study

Chemistry is the science that deals with the composition, structures, and properties of matter, the interactions between different types of matter, relationships between matter and energy (Sobel, 2020). Through the learning of chemistry, it is possible to acquire relevant conceptual and procedural knowledge as well as develop an understanding and appreciation of development in engineering, medicine, and other related scientific and technological fields. Furthermore, learning about the contributions, issues, and problems related to innovations in chemistry will help students develop a holistic view of the relationships among science, technology, and society. As numerous as the importance of chemistry is, students encounter difficulties learning the subject because of the abstract nature of the subject which has been confirmed by many authors (Patrick, Pamela, and Mark, 2008). The nature of chemistry teaching by extension chemistry subject particularly in public schools in Ovia-North East Local Government Area, Edo State has been described as abstract, fallen short of the standard expected, and uninspiring (Kennedy and Stanley, 2023). The teachers are described as dictating notes to the students and copying notes on the board without using any instructional resources to explain the context. Although most public and private schools in Ovia-North LGA are ill-equipped, teachers lack resources for effective teaching and this has led to the teachers not using the recommended teaching methods for science teaching. There is no best method of teaching but effective scientific teaching should be laboratory-centered and activity-oriented using teaching resources rather than a textbook or lecture-dominated methods which seem to characterize schools located in Urtban areas of Ovia-North East LGA (Kennedy and Stanley, 2023).

Resources materials refer to materials found in nature that have value and are used for practical purposes, providing concrete experiences that a learner needs to develop intellectually and are also capable of achieving the objectives of the concept to be taught by the teacher (Adebimpe, 2005). Examples are charts, animations, video clips, concrete objects, flip charts, pictures, various equipment, and reagents.

The purpose and role of using resource materials in the teaching and learning process makes the educational process more attractive, encourages active learning, breeds the development of different skills and adoption of desirable values and attitudes of students. It is also meant to make instructions more meaningful, clear, and much more interesting to students. The effect of these resource materials in teaching and learning chemistry can be accessed through the students' achievement results. It is therefore pertinent that chemistry teachers should adopt the teaching methods and strategies categorized with the use of resource materials and the most efficient among the two main types of teaching methods; teacher-centered methods and learner-centered methods is learner-centered methods (Nbina, 2012).

The new chemistry curricula 2014 by NERDC recommends a transition from a teacher-centered classroom to a student-centered learning environment since chemistry by nature is systematic, testable and its processes can be replicated. This justifies the fact that chemistry should be taught by doing, seeing, and practicing which is a pure discovery learning approach further called the guided-discovery teaching method, where the learner is left to discover by himself without any assistance or guidance. This teaching method is a student-centered and activity-oriented teaching strategy in which there is creativity and student participation in a well-equipped learning environment with resource materials while the role of the teacher is to guide the students through a problem-solving approach to discover answers to instructional topics at hand (Abdullahi, 2007). A sample of such instructional topic in chemistry is oxidation–reduction reaction among others, and this topic requires lots of explanation with resource materials showing the transformation of matter from one kind to another. Invariably, this will aid students' understanding and retention of the topic.

Oxidation-reduction reactions commonly referred to as redox reaction a chemical reaction that involves the transfer of electrons between chemical species (the atoms, ions, or molecules) involved in the reaction (Ababio, 2016). The word 'Redox' was coined by chemists as a result of the simultaneous occurrence of oxidation and reduction reactions. An oxidation-reduction reaction is one of the most important types of reactions among the several types of chemical reactions in the Senior secondary school two curricula. The other types of chemical reactions are combination reactions, decomposition reactions, displacement reactions, double decomposition reactions, catalytic reactions, reversible reactions, and thermal dissociation reactions. Oxidation-reduction reactions in Senior secondary school are streamlined into these contents namely; addition of oxygen, removal of hydrogen, the addition of electronegative elements, electron transfer, determination of oxidation number, and identification of oxidizing and reducing agents (Ababio, 2016). The addition of Oxygen describes the loss of oxygen for reduction and the gain of oxygen for oxidation. Removal of hydrogen describes the gain of hydrogen for reduction and the loss of hydrogen for oxidation. The addition of electronegative elements describes the addition of electronegative elements for oxidation and the removal of electronegative elements as well as the addition of electropositive elements for reduction. Electron transfer describes the gain of electrons for reduction and the loss of electrons for oxidation. Oxidation number in redox reactions describes the decrease in oxidation number for reduction and the increase in oxidation number for oxidation. Oxidizing and reducing agents are the two main reactants in redox reactions and this can be identified with the use of qualitative analysis through their various colour changes. The oxidizing agent (electron acceptor) will become reduced while the reducing agents (electron donor) will become oxidized. The general objectives in the secondary school chemistry syllabus for teaching and learning oxidation-reduction reactions are that students should be able to understand the nature of oxidation-reduction reactions apply its principles to electrochemical cells and show awareness of corrosion as an oxidation-reduction process and its economic cost. To achieve these objectives, the syllabus structured the evaluation contents of oxidation-reduction reactions into ‘define oxidation-reduction reactions in terms of electron transfer, calculate oxidation number, balance redox reactions, identify reducing and oxidizing agents, identify and balance redox equations’ (Ababio, 2016). The general objectives imply that students should conceptualization the meaning of oxidation-reduction reactions in other to appreciate their usage in everyday life such as its usage in pharmaceutical, industrial, biological, metallurgical, and agricultural areas. The importance of oxidation-reduction reactions in these areas is that burning different types of fuel for obtaining energy for domestic use, transport, and other commercial purposes, studying the behavior of drugs in the human body and their interactions with other substances, electrochemical processes for the extraction of highly reactive metals and non-metals, manufacturing of chemical compounds, operation of dry and wet batteries and corrosion of metals, all fall within the purview of redox processes.

The 'Perceived use of resources' in the teaching of oxidation-reduction reactions are materials the teacher uses in explaining concepts of oxidation-reduction reactions to aid students understanding and conceptualization. These resources are the oxygen model, hydrogen model, electronegativity model, electron transfer model, oxidation number model, glass-ware for testing oxidizing and reducing agents, animations, oxidizing and reducing reagents (Osterlund and Ekborng, 2009). The oxygen model is used to illustrate oxidation reaction as the addition of oxygen while reduction reaction as the removal of oxygen in a redox reaction. The hydrogen model is used to illustrate that in a redox reaction, oxidation is the removal of hydrogen while reduction is the addition of hydrogen. The electronegativity model illustrates that oxidation is the addition of an electronegative element to a substance or the removal of electropositive elements from a substance while reduction is the removal of an electronegative element from a substance or addition of electropositive to a substance. The electron transfer model is used to illustrate that the half-reaction in a redox reaction that involves the loss of electrons is called an oxidation reaction while the half-reaction that involves the gain of electrons is called a reduction reaction. The oxidation number model illustrates oxidation as the decrease in oxidation number while reduction is the increase in oxidation number. Animations are used to show video-clips of animate objects being used to explain redox reactions e.g. an elephant toothpaste reaction was used to illustrate that manganese in potassium permanganate undergoes reduction from +7 to +4. Common oxidizing and reducing laboratory reagents like aqueous potassium iodide and potassium manganate (vii) solution are used to illustrate reducing and oxidizing agents in a laboratory using glass wares such as beakers, and test tubes (Osterlund and Ekborng, 2009; Ababio, 2016; Ahmad, Muhamad, Naji and Avi, 2017).

Students are faced with the difficulty of the concept of oxidation-reduction reaction and are sometimes even confused about how to attempt redox reaction questions. Some of the achievement of students in chemistry examinations has shown that there is no proper conceptualization of oxidation-reduction reaction. In Edo State, the WAEC chief examiners' report on chemistry has continuously identified the concept of oxidation-reduction reactions as one of the difficult areas for most of the students (WAEC, 2013, 2015, 2019, 2021). It was stated that the majority of them were scared to solve questions on chemistry areas that involve chemical reactions, identify reducing and oxidation agents, and balancing redox equations and thus tend to perform poorly in such areas. Many reasons have been identified for this poor performance in chemistry among which include ineffective teaching methods, abstract nature of chemistry concepts, lack of teaching resources, and inability of teachers to use resources (Samba and Eriba,2012; WAEC, 2021).

Based on this premise, it is therefore necessary to find out if students can identify the resources used in teaching oxidation-reduction; the relationship between the perceived use of resources and the achievement of students; the contribution of sex, school ownership, and perceived use of resources to students' achievement. Hence, this study will investigate the relationship between the chemistry students' perceived use of resources and achievement in oxidation-reduction reactions

Statement of the problem

The observed students‘ poor achievement and weaknesses in chemistry in Edostate is a strong indication of students‘ poor conceptual knowledge and inadequate use of resources which might have been caused by the teaching methods often employed by the chemistry teachers (Kennedy and Stanley, 2023). However, the recommended approach of teaching chemistry is faced with some challenges in Edo state because of the present school structure in terms of ill-equipment, and lack of resource materials, thereby making students not actively involved in the teaching and learning process. Hence, students find some topics difficult to learn in chemistry. Analysis of students' performance in chemistry in WAEC 2013, 2015, 2019, and 2021, showed that candidate performance under questions on oxidation-reduction reactions was poor. For instance, in 2013, the chief examiner reported that candidates could not distinguish between oxidation and oxidizing agents as well as reduction and reducing agents and could not also define oxidizing and reducing agents in terms of electron transfer (WAEC, 2013). In 2015, the chief examiner reported that the candidate could not arrange elements in the other of reactivity for electrochemical series and that they also had no practical experience in the area of oxidation-reaction (WAEC, 2015). In 2019, the chief examiner reported that candidates could not write simple half-redox reactions, could not recognise redox reactions, and could not identify the strongest oxidizing and reducing agents in chemical equations (WAEC, 2019). In 2021, the weaknesses associated with the candidates‘ performance according to the chief examiners' report were the inability to balance chemical equations, poor knowledge of the concept of electrolysis, inability to properly define standard electrode potential, inability to draw and label correctly electrochemical Cell, failed to realise the role of the salt bridge in an electrochemical cell, could not solve for the oxidation states of chlorine and vanadium in Cl_2, ClO_3– and V_2O_5 and could not show that carbon is a reducing agent nor state the change in oxidation number of the species that reacted with carbon. WAEC chief examiners' reports have attributed the difficulties to the didactic methods of instruction without instructional materials, poor students‘ levels of conceptual understanding, problem-solving skills, among others. It was further reported that students had difficulty in responding to examination questions on oxidation-reduction reactions. Could the poor performance of students in oxidation-reduction reactions be related to the resources and materials used in teaching them? Could it be related to sex, school ownership, or perceived use of resources in oxidation-reduction reaction? This will be the problem to be resolved in this study. This study seeks to investigate the relationship between chemistry students' perceived use of resources and achievement in oxidation-reduction reactions.

Research Question

To guide this study, the following research questions were raised

1. What are the percentage of perception of students' use of resources in oxidation-reduction reactions?
2. What percentage of male and female students will identity resources for teaching oxidation-reduction reaction correctly?
3. What are the percentage of perceived use of resources identified by male and female students in oxidation-reduction reactions in the different types of schools?
4. What are the relationship between the perceived use of resources and the achievement of students in oxidation-reductions?
5. What are the relationship between the perceived use of resources and the achievement of male and female students in the different types of schools?
6. What are the contribution of sex, type of school, and level of perceived use of resources to students' achievement in oxidation-reduction reaction?

Hypotheses

Three hypotheses were formulated to guide this study:

1. There is no significant relationship between the perceived use of resources and the achievement of students in oxidation-reductions?

2. There is no significant relationship between the perceived use of resources and the achievement of male and female students in the different types of schools.

3. The contribution of sex, type of school, and level of perceived use of resources to students' achievement in oxidation-reduction reaction is not significantly different.

Purpose of the Study

The purpose of this study is to investigate the relationship between chemistry students' perceived use of resources and achievement in oxidation-reduction reactions in the Urban Area of Ovia-North East LGA, Benin City. Specifically, this study will seek to investigate:

1. The percentage of perception of students' use of resources in oxidation-reduction reactions?

2. The percentage of male and female students will identity resources for teaching oxidation-reduction correctly.

3. The percentage of perceived use of the resources identified by male and female students in the different types of schools?

4. The relationship between the perceived use of resources and the achievement of students in oxidation-reductions?

5. The relationship between the perceived use of resources and the achievement of male and female students in the different types of schools?

6. The contribution of sex, type of school, and level of perceived use of resources to students' achievement in oxidation-reduction reaction?

Significance of the Study

This study will be beneficial to students, teachers, school administrators, and policymakers. This study will provide relevant information on the relationship between chemistry students' perceived use of resources and their achievement in oxidation-reduction reactions. It will enable chemistry teachers in secondary schools to know the resources preferred by the students to facilitate the understanding of oxidation-reduction reactions, it will provide the teachers with insights into the recommended resources suitable for teaching oxidation-reduction reactions. This will lead to improved and effective teaching strategies which will in turn lead to improved achievement in oxidation-reduction reactions.

It will give the students a broad understanding of what is expected in oxidation-reduction reactions and how to balance and calculate redox reactions. Hence, the number of students going into science-related careers will increase. The empirical evidence from this research work is expected to guide both curriculum designers and authors of chemistry textbooks in their development and implementation process to include the resources to be used in teaching each topic.

The data generated from this study can be harnessed by educators and policymakers to understand the possible reasons why students lose interest in a science subject, particularly chemistry. The result of this study will be beneficial to researchers as a guide to conduct further research studies on chemistry topics that students find difficult to understand and how to provide remedies for them towards improved performance in chemistry.

This study will shed knowledge to school administrators and the government on the relevant resources needed for effective teaching and learning of oxidation-reduction reactions and to encourage chemistry teachers on the need to adopt and effectively use resources in teaching oxidation-reduction.

Scope and Delimitation of the study

This study will examine the relationship between chemistry students' perceived use of resources and their achievements in oxidation-reduction reactions in Senior Secondary Schools.

The study is restricted to only SS2 chemistry students in Public and Private secondary schools of Urban areas of Ovia North East Local Government Area.

Definition of Terms

The following terms will be operationally defined in this study as;

Percieved use of resources: sudents being able to identify the resources used in teaching them oxidation-reduction reaction

Achievements: Students' score in oxidation-reduction reaction test

Oxidation: It’s the gain of oxygen, loss of hydrogen and loss of electrons **Reduction**:

It’s the loss of oxygen, gain of hydrogen and gain of electron

CHAPTER TWO

Review of Related Literature

This chapter is concerned with the review of relevant literature. This is organized and subdivided into the following sections:

- Theoretical framework
- Concept of oxidation-reduction reaction
- Resource materials used in oxidation-reduction
- Role of resource materials in oxidation-reduction
- The interest of students in oxidation-reduction and chemistry
- Performance of students
- Summary of reviewed literature

Theoretical framework

This study is anchored on Gagne's theory of instructional design and Lev Vygotsky's sociocultural theory of learning. Instructional material theories assume that there is a direct link between the materials that the teachers use and the student's learning outcomes. These outcomes include higher abilities to learn, quality strategies to learn and perform classroom activities, and a positive attitude towards learning. Further, these theories assume that instructional materials can develop students the highest order of intellectual skills as they illustrate clearly, step by step how to follow the rules/principles and elaborate on the concepts, all of which have a positive impact on solving new problems by analyzing the situation and formulating a plan (Gagné et al., 2005). The use of resource material in oxidation-reduction reactions can impact students' performance. According to Gagne et al, instructional material can be used to develop higher learning abilities to the learners through self-teaching or guided learning. This implies that the instructional materials mainly comprise "eliciting performance" and "providing feedback on performance correctness," in addition to "providing learning guidance" for guided discovery learning. Hence, the process of learning oxidation-reduction processes with resource materials; elicits the students' achievement as well as provides learning guidance. Many of Gagné's 9 ideas have broad implications for secondary teachers and students in Ovia North local government area of Edo state. Many of these ideas have capacity-building undertones with themes of students' acquisition of the use of resource materials and problem-solving skills. Similar ideas by Lev Vygotsky, a Russian psychologist who held a view that tools and signs, animations, hydrogen model in redox reaction, oxygen model in redox reactions reagents and apparatus which are in the form of instructional materials, can develop students' higher level of thinking, which is important in problem-solving activities. However, since they are considered to be domain-specific, the relationship between science resource materials and achievement in oxidation-reduction reactions is yet to be studied with respect to Ovia-North East of Edo State. Thus, this study stretches these views.

The sociocultural theory of teaching, learning, and development is the second theory that framed this study. Largely inspired by the seminal works of Lev Vygotsky (1962), this theory assumes that human minds do not develop under some predetermined cognitive structures that unfold as one matures. Rather, this theory posits that human minds develop as a result of constant interactions with the social material world.

According to Vygotsky, the human mind develops through interaction with materials in the learning process where people learn from each other and use their experiences to successfully make sense of the materials they interact with. These experiences are crystallized in 'cultural tools', and the learners have to master such tools to develop specific knowledge and skills in solving specific problems and, in the process, become competent in a specific profession. Hence, achievement in oxidation-reduction reactions will be dependent on resource materials. In the classroom, these tools can be a picture, a model, or a pattern for solving a problem. Most often however, such tools are combinations of elements of different orders, and human language is the multi-level tool par excellence, combining culturally evolved arrangements of meanings, sounds, melody, rules of communication, and so forth.

Learning by using such tools is not something that simply helps the mind to develop. Rather, this kind of learning leads to new, more elaborated forms of mental functioning. For example, when chemistry students master such a complex cultural tool as human language, this results not only in their ability to talk but leads to completely new levels of thinking, self-regulation, and mentality in general. It is the specific organization of this tool (e.g., the semantic, pragmatic, and syntactic structures of language) that calls into being and in effect shapes and forms new facets of the student's mind. Importantly, cultural tools are not merely static 'things' but embodiments of certain ways of acting in human communities. In other words, they represent the functions and meanings of things, as discovered in cultural practices: they are "objects-that-can-be used- for-certain-purposes" in human societies. As such, they can be appropriated by the student only through acting upon and with them, that is, only in the course of actively reconstructing their meaning and function. Such reconstruction of instructional tools is initially possible only in the process of cooperating and interacting with other people who already possess the knowledge of a given instructional tool.

This short account is presented here to illustrate the fact that the sociocultural approach, unlike that of instructional materials by Gagne discussed above, not only allows for a synthesis of teaching, learning, and cognitive development; it actively calls for it. This theory implies that instructional materials lead to cognitive development because they mediate students' thinking through the tools, and such mediation constitutes the very cornerstone of mental development and improved achievement in oxidation-reduction reactions.

Concept of oxidation-reduction reactions

Oxidation-reduction reactions abbreviated as redox reactions involve the transfer of electrons between chemical species (the atoms, ions, or molecules) involved in the reaction. It can also be explained as the addition of oxygen, removal of hydrogen, addition of electronegative element, and removal of electrons (Ababio, 2016). An oxidation-reduction reaction is part of the groups of chemical reactions which are combination, decomposition, displacement, double decomposition, catalytic reactions, reversible reactions, thermal dissociation, and oxidation-reduction reactions (Ababio, 2016). Chemical reactions are changes in which some new chemical substances are formed. The substances substances which undergo the chemical change ars known as reactants, while the new substances formed are known as products.

The oxidation and reduction processes can be explained based on the addition of oxygen, removal of hydrogen, the addition of electronegative elements, electron transfer, determination of oxidation number, and identification of oxidizing and reducing agents (Ababio, 2016). The addition of Oxygen describes the loss of oxygen for reduction and the gain of oxygen for oxidation for example, in a reaction of 2 Mg (s) + O2 (g) → 2 MgO (s), magnesium is oxidized based on the addition of oxygen. Removal of hydrogen describes the gain of hydrogen for reduction and the loss of hydrogen for oxidation for example, in the reaction of H_2S(g) + O_2 (g) → 2 S (s) + 2 H_2O (l), Sulphur is oxidized based on the removal of hydrogen. The addition of electronegative elements describes the addition of electronegative elements for oxidation and the removal of electronegative elements as well as the addition of electropositive elements for reduction. Electron transfer describes the gain of electrons for reduction and the loss of electrons for oxidation, 2Na(s) + Cl_2 (g) → 2 Na^+ Cl^- (s) or 2 NaCl (s) showed involvement of electrons in redox reactions. Oxidation number in redox reactions describes the decrease in oxidation number for reduction and the increase in oxidation number for oxidation. Oxidizing and reducing agents are the two main reactants in redox reactions and this can be identified with the use of qualitative analysis through their various colour changes. The oxidizing agent (electron acceptor) will become reduced while the reducing agents (electron donor) will become oxidized. The general objectives in the secondary school chemistry syllabus for teaching and learning oxidation-reduction reactions are that students should be able to understand the nature of oxidation-reduction reactions apply its principles to electrochemical cells and show awareness of corrosion as an oxidation-reduction process and its economic cost. To achieve these objectives, the syllabus structured the evaluation contents of oxidation-reduction reactions into 'define oxidation-reduction reactions in terms of electron transfer, calculate oxidation number, balance redox reactions, identify reducing and oxidizing agents, identify and balance redox equations' (Ababio, 2016). The general objectives imply that students should conceptualization the meaning of oxidation-reduction reactions in other to appreciate their usage in everyday life such as its usage in pharmaceutical, industrial, biological, metallurgical, and agricultural areas. The importance of oxidation-reduction reactions in these areas is that burning different types of fuel for obtaining energy for domestic use, transport, and other commercial purposes, studying the behavior of drugs in the human body and their interactions with other substances, electrochemical processes for the extraction of highly reactive metals and non-metals, manufacturing of chemical compounds, operation of dry and wet batteries and corrosion of metals, all fall within the purview of redox processes.

Examples of redox reactions that occur around us are the burning of fuels, the corrosion of metals, and even the processes of photosynthesis and cellular respiration. Some examples of redox reactions in chemistry that are taught in secondary school chemistry are:

$C_{(s)} + 2ZnO_{(s)} \rightarrow CO2_{(g)} + 2Zn_{(s)}$

R.A O.A

$H_2S_{(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)} + S_{(s)}$

R.A O.A

The donor of the oxygen was the oxidizing agent (O.A) while the acceptor was the reducing agent (R.A). this means that the oxidizing agent zinc oxide donates oxygen to the carbon and oxidizes it to carbon(IV) oxide, or the reducing agent carbon removes oxygen from zinc oxide and reduces it to metallic zinc.

The concept of oxidation-reduction reactions is considered to be challenging for secondary school chemistry students. Adu-Gyamfi, Ampiah, and Agyei (2020) investigated the 'Participatory Teaching and Learning Approach: A Framework for Teaching Redox Reactions at High School Level'. A mixed-method research design was employed and a stratified sampling procedure was used to select fifteen students from a second-year senior high school class in Ghana. Percentages, sample t-tests, and themes were used to analyze the data. It was reported from the results that chemistry teacher was able to identify students' alternative conceptions of redox reactions and they were able to confront students through cognitive engagements leading to a conceptual understanding of redox reactions. The result further showed that there was an improvement in students' conceptual understanding of redox reactions. This study will assess chemistry students' perceived use of resources used by the teacher in teaching oxidation-reduction reactions.

The study by Ojelade, Aregbesola, and Akinola (2017) on the effects of the webbing teaching method on secondary school students' performance in a redox reaction, with a quasi-experimental design and a sample size of 82 male and female students from two different secondary schools in Gwagwalada Area Council; Abuja, reported their findings that webbing instructional strategy enhances students learning in the redox reaction. The study further concluded that the webbing instructional method is a very effective teaching method that enhances students' performance in chemistry and thus should be implemented by chemistry teachers in teaching chemistry. Hence, this study will assess students on different instructional resources used in oxidation-reduction reactions in different types of schools.

Ahmad, Muhamad, Naji, and Avi (2017) explored whether the use of teachers' demonstrations significantly improves students' understanding of redox reactions compared with control group counterparts who were not exposed to the demonstrations. The sample consisted of 131 Israeli 8th graders in middle schools (junior high school). Students' attitudes and achievements as well as their understanding of redox and electrolysis were assessed by administering a questionnaire that investigated their attitudes (perceptions) towards a demonstration in chemistry. The findings showed that the experimental group's achievements and understanding of the subject were statistically significantly better than those of their control group counterparts. This study will compare the relationship between perceived use of resources and performance of students in oxidation-reduction.

In the study by Hunt et al. (2010) on Juan's Dilemma: A New Twist on the Old Lemon Battery; they used one sample real-life situation to develop the concept of redox reactions to students. The salt bridge in a regular galvanic cell battery facilitated the redox reactions between the anode and cathode plates. The two plates are made of two dissimilar metals, acting as a solution for the ions involved. The anode oxidizes to release electrons to the cathode, which undergoes reduction by accepting the electrons from the anode thereby providing the flow of current. Hunt and his colleagues propounded that, the use of hands-on experiments enables students to conceptualize the electron transfer model of redox reactions. This study, however, will use a survey research design incorporating expos facto where the students will be given multiple choice tests to assess the students on their knowledge and application of redox reactions.

Resource materials used in oxidation-reduction

Resource materials are instructional materials that have been defined and explained by various researchers. Eniayeju (2005) defined instructional materials as materials that provide concrete experiences that a learner needs to develop intellectually. Adebimpe (2005) defined instructional materials as materials capable of achieving the objectives of the concept to be taught by the teacher. Instructional materials are alternative channels of communication, which can help a teacher to compress his information and present it to students in a clearer manner.

The relevance of instructional materials in the teaching and learning process has gained the attention of researchers in the field of education to find out how true that, a learner; especially in senior secondary school requires some form of motivation and interest for learning to take place and for performance to be enhanced. Some authors believe that the instructional materials required for various activities of the school program after the teacher are the school building, alongside with chalkboard, apparatus such as wall charts, maps, textbooks, writing materials, and equipment for laboratory and library, etc. Omoifo (2012) argued that the effectiveness of science education depends highly on the use of instructional materials to increase students' interest in the subject, motivate students' learning, and deepen students' understanding of the topics. She further emphasized that science teachers need to recognize the importance of scientific materials in teaching chemistry.

The use of instructional materials used in the teaching and learning of chemistry is also called science materials and it is essential, as chemistry is a science subject that deals principally with the properties of substances, the changes they undergo, and the natural laws that describe the changes. In addition, chemistry is addressing the social objective of substance development as education is now the primary means for empowerment, participation, cultural preservation, social mobility, and equity (Emmanuel, 2013). Chemistry is so important to the other fields of science and many other areas of study like physics, biology, mathematics, and agriculture (Nwafor, 2014). Its importance in the scientific and technological development of any nation has been widely reported. The recognition given to chemistry in the development of the individual and the nation has led researchers to look into its principles of teaching and learning to enhance students' performance. Chemistry in the senior secondary school is divided into chemistry theory and practical and for effective teaching and learning of chemistry to take place in a school, there must be good instructional material to aid its understanding and retention. Therefore, instructional materials are those things, personnel, objects, etc. that can be seen, touched, or felt, that the teacher employs in his teaching to enable the learners to learn at ease. They can be used to transmit, retrieve, recover, and preserve the information they are also specially designed to fulfill the stated objectives in teaching and learning situations. There are various types of instructional materials (resource materials) used in teaching and learning oxidation-reduction reactions they include the oxygen model, hydrogen model, electronegativity model, electron transfer model, oxidation number model, glass-ware for testing oxidizing and reducing agents, animations, oxidizing and reducing reagents (Osterlund and Ekborng, 2009).

Oxygen Model: These are the various readable materials presented in a printed form and its used to illustrate oxidation reaction as the addition of oxygen while reduction reaction as the removal of oxygen in a redox reaction (Osterlund and Ekborng, 2009). Oxygen models are represented in various patterns in chemistry textbooks, chemistry magazines, pamphlets, chemistry catalogues, posters like the periodic table, chemistry brochures, etc. They offer vast qualities of information about redox reactions. They are used in illustrating the addition and removal of oxygen in a meaningful way for the students to easily understand the concept and also, provide a starting point for learning. The oxygen model offers guidance on how to study, and read redox equations, and also allows students to work without digital distractions and errors on redox equations and reactions. They also provide students with a great variety of information about chemical material, reagents, apparatus, and equipment, which are very interesting and motivating. Chemistry textbooks, an example of printed material where the oxygen model can be illustrated, have been explained by Ughamadu (1998) that they are superbly compact, economical, and practical devices for storing (in print form) and, retrieving information of knowledge vital for teaching chemistry. Oladejo et al (2011) affirmed that whatever the method one chooses to employ in teaching, the use of relevant resource materials may improve the quality of teaching and learning.

Animations: These are instructional materials that can be seen with the eyes and are used in teaching the classification and explanation of chemical concepts or ideas. Animations are used to show video-clips of animate objects being used to explain redox reactions e.g. an elephant toothpaste reaction was used to illustrate that manganese in potassium permanganate undergoes reduction from +7 to +4. It makes use of visuals for learning and manipulating still images to represent moving images (Ahmad, Muhamad, Naji, and Avi, 2017. The use of animation in teaching redox reactions in senior secondary schools cannot be underestimated. Daniel I.Y (2001) identified the following as animations that can be used in learning oxidation-reduction and provide a clear and immediate insight into the topic which may be difficult and time-consuming to explain verbally to students. These materials include animated videos to teach chemistry charts, sketches to teach electron transfer, still pictures to show oxidizing and reducing agents, diagrams, videos, slides, and real objects to illustrate redox reactions. They can be used in explaining oxidation-reduction reactions and also used to explain certain topics in chemistry like periodic chemistry, metals, and non-metals, volumetric and qualitative analysis, acids, bases, salt, etc. They often make the lesson real and interesting. Fakomogbon and Adegbija (2006) were of the view that visual aids allow the learner to benefit from various experiences with events, and objects and soon they add varieties to lessons to bridge the monopoly of lecture method. They also arouse the learner's interest and make them participate actively in the lesson. They also believe that visual aids expedite learning through the sense of vision.

Hydrogen Model: Hydrogen model graphics are used to illustrate that in redox reactions, oxidation is the removal of hydrogen while reduction is the addition of hydrogen (Osterlund and Ekborng, 2009). These graphical materials are used for instruction characterized by their vivid nature, they can be clearly described and can effectively present messages in which it is designed. Graphics materials according to Achuonye, (2004) are arts by which we express ideas in lines, pictures, sketches, and diagrams. They are materials that inculcate facts and ideas clearly through a combination of drawing words and pictures. The purpose of using graphic materials in teaching redox reactions is to translate ideas and relationships into a concrete form. Some oxidation-reduction reaction concepts like balancing of redox reaction, ideas on redox experiment, identification of glass wares for redox experiment, and titration set-up, can be illustrated using graphics. According to Soetan et al. (2010), graphics including charts, posters, sketches, cartoons, graphs, and drawings. Graphics communicate facts and ideas clearly through a combination of drawings, words, and pictures. The use of graphics in teaching creates definitiveness to the materials being studied. They help to visualize the whole concept. Examples of graphics are charts, maps, drawings, chemical icons, diagrams, sketches, and so on. These produce good illustrations which arouse the interest of learners and develop their understanding.

Oxidizing and reducing reagents: Oxidizing and reducing laboratory reagents like aqueous potassium iodide and potassium manganate (vii) solution are used to test for reducing and oxidizing agents in a laboratory using glass wares such as beakers, test tubes (Osterlund and Ekborng, 2009). They can be in liquid, solid, or aqueous form and are stored in reagent bottles usually in the laboratory. They are physically seen to be real and they make students participate actively in the classroom. According to Bellingham (2007), Students make contact with real things when they go for excursions, and field trips, carryout practical work in the laboratory, come in contact with resource persons and thereby witness events that have first-hand information about the events. In chemistry, real things are chemistry apparatus like glass wares, classrooms, laboratories, and reagents used in chemistry practicals. The chemistry laboratory is a physical facility designed and equipped for carrying out chemistry experiments for students' practice, teaching, or research. It serves as a knowledge resource center where students can test and identify oxidizing and reducing agents and conceptualize the theoretical teaching of redox reactions. So the laboratory needs to be well equipped with materials that can be used to support teaching and learning which will avail the students the opportunity to know the right apparatus, reagents, and skills to carry out various chemistry practicals.

Electropositive and Electronegativity model: The electronegativity model illustrates that oxidation is the addition of an electronegative element to a substance or the removal of electropositive elements from a substance while reduction is the removal of an electronegative element from a substance or addition of electropositive to a substance (Osterlund and Ekborng, 2009). These are in the form of photographs and other forms of pictures that teachers can use in the classroom to show certain electropositive and electronegative elements. Dike, (1999) states that pictures illustrating ideas are used to show certain events or recast events that took place in the past and this could reinforce the knowledge of the students, arouse their interest, attention, and clarity of the topic illustrated (Dike, 1999). By extension, pictures, stock photos, and images are samples of electronegativity models used to show and explain electropositive and electronegative elements in oxidation-reduction reactions.

Electron Transfer Model: The Electron transfer model is used to illustrate that the half-reaction in a redox reaction that involves the loss of electrons is called an oxidation reaction while the half-reaction that involves the gain of electrons is called a reduction reaction (Osterlund and Ekborng, 2009). These models can be animate or inanimate representations of our surroundings which can used to stimulate or motivate students to learn how electrons are transferred in redox reactions. The electron transfer model can be described through audio aids like the recorder, periodic table charts, and videos. Fakomogbon and Adegbija (2006) stated that a recorder can assist the teacher in the classroom in the sense that they can be played back several times thereby enabling learners to detect their mistakes or errors and thereby make the necessary corrections. The electron transfer model presented in audio aids, video aids, and periodic table charts can be used to explain the transfer of electrons in an oxidation-reduction reaction. According to Akanbi (2003) stated that resource materials are used to describe a variety of products of educational technology and also, fulfill objectives in the teaching/learning process. These resource materials bring life to learning by stimulating the students to learn.

Role of resource materials in Oxidation-reduction

The role of resource (instructional) materials in the teaching and learning process in our school cannot be over-emphasized. Knowledge is acquired through the five senses namely those of hearing, touching, seeing, tasting, and smelling. It is of great importance for the teacher or instructor in the school to make use of instructional materials known to help him or her utilize the teaching and learning process to make the process easier for both the teacher and the students. The great educator, John Dewey once remarked that learning is a transition. He believed that active perception, interpretation, or understanding comes as a result of a transition between the interpreter and the interpreter or between the observer and the observed.

Resource materials used in oxidation-reduction help to improve the teaching and learning process, it is used to get the attention of the students and eliminate boredom, they can be used to support and supplement the content of a lesson, help students learn new concepts, and provide practice opportunities. The role of resource materials in the teaching and learning activities of chemistry through charts, visual aids, sketches, graphics, and pictures, provides clear and immediate insight into the subject matters which may be difficult and time-consuming to explain verbally to students. Therefore, teachers in senior secondary schools must familiarize themselves with many reading resources to enable them to select those that would be suitable for chemistry lessons. Resource materials in chemistry subjects used by the students in senior secondary school should be that which the students can check the meaning of various concepts from textbooks, dictionaries, journals, etc. Fakomogbon and Adegbija (2006) pointed out that "visual aids" should be used at all stages of study to intensify and clarify the mental and pictorial image related to the problems to be solved. He further opined that good instructional materials will include activities, illustrations, and other elements that capture students' attention and help them to better understand and retain the information presented. Good resource materials should be well-organized and easy to use, which means that less time will be spent trying to figure out what to do next or troubleshooting issues. This is especially beneficial in classrooms where teacher-student ratios are high or there is little time for direct instruction due to other factors such as testing requirements. In addition, using various types of resource materials can keep students from getting bored with the material or feeling like they're "just going through the motions" in class. Another role of resource materials is that it helps to impact concepts taught vividly in the mind and memories of the students thereby making students transfer knowledge from one situation to another. Resource materials also generate new ideas and bring the learner's passive knowledge into action. It increases the rate of perception of the students and helps to arrest and sustain the interest and attention of the students in the classroom in the teaching and learning process. With resource materials, learning becomes more concrete, real, immediate, and permanent. Similarly, the review of related literature has shown that resource (instructional) materials are very important in the teaching and learning process for all the subjects that are being offered in senior secondary school. That is to say, it has a great influence on students' cognitive abilities.

The interest of students in oxidation-reduction and chemistry

Interest according to (Essien *et al*.,2015) is defined as a pre-determinant of one's perceptions that is, what aspect of the world one is most likely to see always. It could also be explained as the focusing of the sense organs on or giving attention to some person, activity, situation, or object. It is an outcome of experience rather than a gift and can either result in or cause motivation. It can also be viewed as a condition in which an individual associates the essence of certain things or situations with his needs or wants.

In chemistry, interest is viewed as the quality of personal significance to the chemistry subject. This invariably means that, to the students, the topics in chemistry that were taught without instructional materials and relevance to everyday life, lead to a lack of interest and poor performance in that topic. The topics that were explained with instructional materials become significant to the chemistry students thereby increasing performance. To this effect, (Krapp and Prenzel, 2011) reported that experiments in chemistry are a significant tool for the development of more stable interests, which later influence the choices of courses, higher studies, and careers.

Students bring curiosity with them when they are in chemistry classes and to resolve this quest, instructional materials should be used to further explain the concepts to their understanding. Akram et al. (2017) opined that the delay or absence of fulfillment of curiosity may lead to a decline in interest. He further states that interest is the feeling that prompts one to spontaneous activity, it's a powerful dictator and motivator in the learning process.

The implication of interest in the learning of chemistry in senior secondary school is that students are likely to pay attention to learning, remember what was taught, imagine the theories postulated, and read more readily when their interests and emotions are positively provoked. Interest as a human sentiment goes along with values, attitudes, and other forms of human preferences. This means that interest motivates, and compels attention (Tutoo, 1998) and is operating in the realm of the affective domain.

Factors that affect interest include personal and socioeconomic/environmental factors. Personal factors, according to Aggarwal (2010) include students' physical health and physical development, mental health and development, age, sex, emotions, and teaching aids. The socio-economic status includes rearing practices in the family, cultural status, and education, among other aspects. Interest, therefore, makes the students feel alert, awake, and excited at the delivery of learning instructions in the chemistry class. The interest aroused to learn a particular subject should be sustained for more enduring learning.

Students' interest can also be triggered by certain environmental factors such as teacher behaviours, government and school heads attitudes towards development. Some of the behaviours of teachers towards teaching chemistry can be attributed to some of these challenges. Teachers in public secondary schools most especially face some challenges in accessing instructional materials. One of the big challenges that these teachers face in accessing instructional materials is meagre funds provided by the government for purchasing instructional materials most public schools especially, depend to a large extent on the government for funding, and very little support is received from local government and communities around the schools most especially in rural areas due to poverty.

According to Onche (2014), the government's Policy towards the efficient provision of these aspects of educational resources has not been encouraging and has always not been well planned, monitored, supervised, and evaluated with rural schools as the back bench of implication of these policies. Teachers also face the challenge of lack of clear policy and monitoring mechanisms to ensure that enough funds are provided to public secondary schools for purchasing instructional materials and also these funds are used for the intended purpose. Teachers also face the challenge of lack of exposure and limited accessibility to modern instructional facilities like access to information communication technology (ICT) which could alleviate the shortage of instructional materials. All these challenges can influence the negative attitude of teachers toward teaching chemistry.

Chang et al. (2009) studied ninth graders' learning interests, life experiences, and attitudes toward chemistry. A total of 942 urban ninth graders in Taiwan were involved in the study. Pearson correlation was used for data analysis. The results indicated that boys showed higher learning interests in sustainability issues and scientific topics than girls. However, girls recalled more life experiences about chemistry than boys. The results also showed that there was a high correlation between learning interests and life experiences related to chemistry.

Achievement of students

Several authors agree that academic achievement is the result of learning, prompted by the teaching activity by the teacher or instructor and produced by the students. From a humanistic view, Martinez (2007) defined academic achievement as the answers given by the students, and it is often interpreted in school grades. Caballero *et al.* (2007) say academic achievement involves meeting goals, and objectives set in the program or course, or work that a student attends or performs. These are expressed through grades which are the result of an assessment. Torres and Rodriguez (2006 cited in Willcox, 2011), say academic achievement is the level of knowledge displayed in an area or subject and it is measured in grade point. Academic achievement involves factors such as personality, intellectual level, motivation, self-esteem, skills, teacher-students relationship, or interest (Hector, 2015). Poor academic achievement is one below the expected achievement which can sometimes be related to teaching methods, lack of facilities, and lack of adherence to instruction.

The purpose of academic achievement is to attain an educational goal and learning. Achievement varies according to circumstances, environmental conditions, the transformation of a given school, and even beliefs. The measurement of academic achievement is holistically based on the student's age, sex, school, the student's previous experience, and the student's capacity related to social skills, and education skills in which the use of instructional material is a factor of its achievement.

Adeogun (2001) revealed a strong positive link between instructional materials and academic performance in Osun state. According to Adeogun, schools that possess more instructional resources performed better than schools that have fewer instructional resources. This finding supported the study by Babayomi (1999) that private schools performed better than public schools because of the availability and adequacy of teaching and learning resources. Adeogun (2001) noted that there was a low level of instructional resources available in public schools and hence commented that public schools had acute shortages of both teaching and learning resources. He further commented that effective teaching and learning cannot occur in the classroom environment if essential instructional resources are not available. This study will examine the relationship between resources and achievement in redox reactions of male and female chemistry students in public and private schools.

Onasanya and Omosewo (2011) researched the effect of improvisation and standard materials on students' achievement. The research employed a quasi-experimental design of the pretest-posttest non-randomized control design. There was a significant difference between the students taught with standard instructional materials and those taught with improvised instructional material in their mean scores ($t=4.09$, $df=14$, $p=0.005$). Students acquire more information through many instructional materials to bring a deeper understanding of the topic under consideration. This study will examine chemistry students perceived use of resources with descriptive survey incorporating expos facto.

Adu-Gyamfi, Ampiah, and Agyei (2020) investigated the 'Participatory Teaching and Learning Approach: A Framework for Teaching Redox Reactions at High School Level'. A mixed-method research design was employed and a stratified sampling procedure was used to select fifteen students from a second-year senior high school class in Ghana. Percentages, sample t-test, and themes were used to analyze the data. It was reported from the results that chemistry teacher was able to identify students' alternative conceptions of redox reactions and they were able to confront students through cognitive engagements leading to a conceptual understanding of redox reactions. The result further showed that there was an improvement in students' conceptual understanding of redox reactions. This study will assess chemistry students' perceived use of resources used by the teacher in teaching oxidation-reduction reactions.

The study by Ojelade, Aregbesola, and Akinola (2017) on the effects of the webbing teaching method on secondary school students' performance in a redox reaction, with a quasi-experimental design and a sample size of 82 male and female students from two different secondary schools in Gwagwalada Area Council; Abuja, reported their findings that webbing instructional strategy enhances students learning in a redox reaction. The study further concluded that the webbing instructional method is a very effective teaching method that enhances students' performance in chemistry and thus should be implemented by chemistry teachers in teaching chemistry. Hence, this study will assess students on different instructional resources used in oxidation-reduction reactions in different types of schools.

Ahmad, Muhamad, Naji and Avi (2017) explored whether the use of teachers' demonstrations significantly improves students' understanding of redox reactions compared with control group counterparts who were not exposed to the demonstrations. The sample consisted of 131 Israeli 8th graders in middle schools (junior high school). Students' attitudes and achievements as well as their understanding of redox and electrolysis were assessed by administering a questionnaire that investigated their attitudes (perceptions) towards a demonstration in chemistry. The findings showed that the experimental group's achievements and understanding of the subject were statistically significantly better than those of their control group counterparts, male students showed more understanding of the subject better than the female students. This study will compare the relationship between perceived use of resources and achievement of students in oxidation-reduction.

The study by Hunt et al. (2010) on Juan's Dilemma: A new twist on the old lemon battery; they used one sample real-life situation to develop the concept of redox reactions to students. The salt bridge in a regular galvanic cell battery facilitated the redox reactions between the anode and cathode plates. The two plates are made of two dissimilar metals, acting as a solution for the ions involved. The anode oxidizes to release electrons to the cathode, which undergoes reduction by accepting the electrons from the anode thereby providing the flow of current. Hunt and his colleagues propounded that, the use of hands-on experiments enables students to conceptualize the electron transfer model of redox reactions. This study, however, will use a survey research design incorporating expos facto where the students will be given multiple choice tests to assess the students on their knowledge and application of redox reactions.

Adebola and Ademola (2011) researched school quality factors and secondary school students' achievement in Mathematics in South Western and North Central Nigeria. A descriptive survey research design of the ex-post facto type involving a sample of 1,014 Mathematics teachers and principals selected through a multi-stage sampling procedure. The analysis of data gave a $t=2.370$; $p<0.05$. Achievement in mathematics was significantly related to instructional materials. This study relates the chemistry students' perceived use of resources in oxidation-reduction reactions to their performance in oxidation-reduction reactions.

Ikedolapo and Adetunji (2009) studied the comparative effect of the guided discovery (D) and concept mapping teaching strategies on senior Secondary School Students' (SSS) chemistry achievement in Nigeria. A total of 360 SSS chemistry students from Bauchi state were used for the study. Students taught with the guided discovery method had a lower mean (X =19.55) than those taught with concept mapping (21.22). There was a significant difference at a 5% level of confidence in the level of retention of both groups of students.

This difference is in favour of the concept mapping strategy (t-cal. =2.82, t – critical = 1.96). Similarly, in the study by Adebola and Sakiru (2012), they explored the problem-solving model as a strategy for improving secondary school student's achievement and retention in Further Mathematics in Ijebuode Ogun State. The study adopted the pre-test post-test control group design. Data collected were analysed using ANCOVA. Students taught with problem-solving models had a higher retention mean of 22.45 compared with the conventional method mean of 2.78. The (F1,75) F = 196.345 *p<.05. The result was significant. The guided inquiry produced higher retention scores.

In another related study, Effiong (2011) carried out a study on the effects of problem-solving guide discovery and expository teaching strategies on students' performance in redox reactions. A sample of 112 SS2 students was used from four coeducational public secondary schools in Uyo of Akwa Ibom State. After investigations, the result showed that those taught using problem-solving and guided discovery methods performed significantly better than those taught with the expository teaching method. This study will examine the teaching and learning resources used by the teacher in teaching oxidation-reduction reactions.

Nja and Cecilia (2021) examined the use of home materials in the teaching of thermochemistry to SS1 Chemistry students in public and private schools. A total of 100 senior secondary chemistry students (60 males and 40 females) in Ikom Local Government Areas in Cross River State, were involved in the study. Kuder Richardson Formula 21 was used to establish the reliability of the Chemistry Achievement Test (Cat). Analysis of covariance and descriptive statistics was used for data analysis and findings showed no significant relationship between home materials in teaching of thermodynamics and achievement of the students, Furthermore, there was a non-significant difference in the type of school environment and sex. This study will consider SS2 chemistry students in the urban area of Ovia-North East within the Benin Metropolis of Edo state.

Dahar and Faize (2011) conducted a study on the effect of Availability and the use of instructional material on the academic performance of students in Punjab (Pakistan). 20 students and 10 teachers from each school were randomly selected as samples for the study. The study used the value-added approach. A questionnaire for teachers and a result sheet were the instruments of the study. Pearson Product Moment Correlation was used to find out the relationship (association) and stepwise regression analysis with the linear function was used to find out the differential impact (causal relationship). The study found that the availability and the use of teaching guide are significantly related with academic achievement of the students. Furthermore the study revealed that the relationship between availability and the use of teaching guide and the achievement of the students, are positive for both types of schools (public and private schools), it also revealed that science guide had a positive correlation with academic performance of students and that there is great efficiency in the availability of materials. This study will look into the percentage perception of perceived use of resources used in teaching oxidation-reduction reaction topic.

Research work by Stephen and Isaac (2013) on the influence of instructional materials (teaching aids) on students' academic performance in senior secondary school Chemistry in Cross River State, revealed that students taught with instructional materials performed significantly better than those taught without instructional materials and also that the use of instructional materials generally improved students' understanding of concepts and led to high academic achievements. It will be revealed in this study whether students' achievement is based on the type of resources used in teaching them.

A positive attitude toward science can be promoted by instructional congruence specifically in chemistry practical work (Sakariyau *et al*., 2016; Zain *et al*., 2010). Several studies indicated that secondary school students show positive attitudes toward chemistry (Sarjou *et al*., 2012) revealed that secondary school students have neutral views about chemistry. On the other hand, the study suggested that secondary school students see chemistry as uncreative, and difficult. They do not recognize its study as important for developing transferrable skills such as technical competence, numeracy, analysis, and problem-solving. This study will show whether students' achievement in oxidation-reduction reactions is based on sex, school type, or type of resources.

Yunus and Ali (2013) study on attitude towards learning chemistry among secondary school students in Malaysia stated that doing chemical experiments in the laboratory made students show a positive interest in chemistry. He suggested that students' poor interest is caused by the many and varied chemistry learning materials to be studied in a short time.

This shows that instructional materials will help simplify too many chemistry materials, increase students' interest rate, it also showed the relationship between chemistry materials and students' achievement, it revealed that majority of the students had positive attitude towards learning chemistry when they conduct experiment in the laboratory, it also revealed that majority of the students also show positive attitude towards teachers' teaching style hence this study. This study will assets various types of resources used in oxidation-reduction reactions and as well the percentage perception of students' acquaintance to resources used in oxidation-reduction reactions.

Cheung (2009) surveyed 576 high school students in Greece and identified the factors that could positively influence students' attitudes toward learning chemistry; using an attitude scale with four subscales: the difficulty of chemistry courses; the interest in chemistry courses; the usefulness of chemistry courses for students' future careers; and the importance of chemistry for students' life. He identified and organised the factors that could positively influence students’ attitudes to learning chemistry into three main categories: teaching approaches, educational tools, non-formal educational material, and activities. The study found that students had a positive perception in attitudes regarding the usefulness, and importance of chemistry as a result of the teachers’ attitude and motivation in the teaching and learning process of education. This study will prove if the achievement of students in oxidation-reduction reactions is based on a teaching approach or available resources.

Bartram (2006) mentioned students' lack of interest in learning activities such as copying from the board/book, working with partners, groups, and textbooks, answering questions, listening to explanations, and doing language exercises. They also mentioned that students prefer popular learning activities such as pair group work with tools which is instructional materials, explanation of concepts with more graphics and real object to unpopular learning activities such as reading aloud, copying of notes, a test of vocabulary, and
copying from board/book. This shows that students will learn and understand more in chemistry with the use of resource materials which is the basis for this study to find out the relationship between resource materials used in chemistry and students’ achievement.

Aworor and Helen (2023) opinions from their study titled postgraduate Students perception and utilization of serial Materials stated that postgraduate students have a positive perception on the use of serial materials, that is materials that carry current information on a variety of subject areas; materials that are essential for researchers and students; materials that contains the facts and figures needed for research; materials that present reports of current research findings more quickly than any other publication; and materials that represents various author's ideals on a variety of subjects. The result also showed lack of resources, poor power supply, poor searching abilities, outdated information, lack of manpower were some of the challenges encountered. The findings of the study recommended that there should be increased funding for the acquisition of materials for the libraries.

The results by Emmanuel et.al, 2012 on the study of gender dimensions in predictors of students' performance in MOCK-SSCE practical and theory Chemistry examinations in some senior secondary schools in Nigeria, with a population of all senior secondary school two science students from government grant-aided schools and privately owned schools in Benue state, showed that male and female students' performance in a test of theoretical knowledge in Chemistry does not significantly predict their performance in MOCK-SSCE Chemistry theory examination. It was also reported that male and female "Students' Alternative to Test of Practical Knowledge of Chemistry (SATPKC)" scores could not significantly predict their MOCK-SSCE mean practical scores. They recommended that schools should ensure that both male and female science students are actively involved in practical work weekly and efforts aimed at increasing the practical performance of students in secondary school chemistry should not be gender discriminatory.

Tsobaza and Njoku (2021) studied the effect of practical Chemistry teaching strategies on students' acquisition of practical skills in secondary schools in Kogi State. The results of the study show that female students acquired a mean score of 166.41 in Chemistry practical skills which is a little lower than that of male students (mean = 166.15). The study also revealed that gender did not significantly influence students' acquisition of Chemistry practical skills.

Bonah (2015), whose work was on the effects of laboratory exercises on science secondary school students' performance in chemistry, in Kaduna state, Nigeria, reveals that there exists a statistical difference in the performance of male students exposed to chemistry laboratory exercises with a mean of 17.70 (SD= 1.74) performing better than their female counterparts that are also exposed to chemistry laboratory exercises with a mean of 16.68 (SD= 1.96).

Musibau (2010) carried out a study on the influence of sex, location, and type on students' academic performance. The sample size consists of four thirty-six public secondary schools and private schools. An instrument of school type, sex, location, and students' academic performance inventory was used to collect data for the study. Data collected were analyzed using percentage scores and t-test statistics. Three null hypotheses were generated and tested at a 0.05 level of significance. Findings from the study showed that the level of students' academic performance was low. It was also revealed that school type, sex, and location had no significant influence on students' academic performance.

The research by Cecilia et.al (2019), investigated the influence of learning styles on academic performance among Science Education undergraduates of the University of Calabar, Nigeria. Expo facto design was used for the study with a total of two hundred science education undergraduate students from a public university chosen at random from the population. Findings showed that students have different learning styles and preferences. Data analysed revealed that there was a significant difference in students' choice of learning styles. There was a positive correlation between learning styles and the academic performance of students.

Since there are no clear trends of gender and types of schools, it becomes necessary to investigate the relationship between perceived use of resources of male and female students in public and private schools and as well whether gender and type of schools contributes to the achievement of students in oxidation-reduction reaction.

Summary of related literature

Several kinds of literature reviewed on the type of resources and chemistry students' achievement focused on students' general achievement in chemistry, the use of technology tools, devices, and software to supplement traditional teaching, and their effect on students’ academic achievement. Most of the studies on the type of resources and achievement in oxidation- reduction reactions that were available to the researcher were done in western countries like the Arab sector of Isreal and Ghana except one done in the Northern part of Nigeria. These study were by Ahmed, Muhammed, Naji and Avi (2017) whose exploration was on the effectiveness of teachers' use of demonstrations for enhancing students' understanding and attitudes to learning the oxidation-reduction concept; Adu- Gyamfi, Ampiah, and Agyei (2020) whose study was on the participatory teaching and learning approach: A Framework for teaching redox reactions at high school level; and Ojelade, Aregbesola, and Akinola (2017) whose work was on effects of webbing teaching method on secondary school students’ performance in a redox reaction, respectively. None has been conducted in Ovia north and Edo state to the researcher’s knowledge. Two of the studies reviewed mixed research design methods, most of the Studies were on experimental design while only one was done using the survey design method. None of the studies compare the relationship between the perceived use of resources and the achievement of students in oxidation-reductions. They did not compare the relationship between the perceived use of resources and the achievement of male and female students in the different types of schools. They did not also investigate the contribution of sex, type of school, and level of perceived use of resources to students’ achievement in oxidation-reduction reaction. There has not been a research study on the relationship between chemistry students' perceived use of resources and achievement in oxidation-reduction reactions in urban areas of Ovia-north East Local Government Area of Edo State. North East Local Government Area within

Benin Metropolis to the researcher’s best of knowledge. This study therefore will fill in these gaps.

CHAPTER THREE

METHODOLOGY

This chapter presents the methodology of the study under the following sub-headings

- Design of the Study
- Research Instrument
- Validity of Instrument
- Reliability of Instrument
- Method of Data Collection

Research Design

This study will be a survey research incorporating ex-post facto. This design will be used because the researcher will be looking at students in many schools, getting information from them about resources used in teaching them oxidation-reduction reactions, and will assess them on the knowledge already known on oxidation-reduction reactions. The independent variable in this study is the perceived use of resources while the dependent variable is achievement in oxidation-reduction reactions. The intervening variables are sex, and school ownership.

Research Instrument

Perceived use resource inventory and achievement test will be used to collect data for the study. The instrument was developed by the researcher with the assistance of the supervisor. The key points addressed in the instruments are as follows: Section A covers the bio-data of the students which includes sex and type of school. Section B consists of twenty (20) items on 4-point Likert scale items with the numerical values as; strongly agree (SA), Agree (A), disagree (D), and strongly disagree (SD). It covers the resources used in oxidation-reduction reactions which are to be identified by the students, the resources perceived to be used by the teacher in oxidation-reduction reactions, and the resources the students will prefer that should be used in teaching oxidation-reduction reactions. Section C of the instruments covers test questions on oxidation-reduction reactions. It consists of fifteen (15) questions selected from 2016-2021 WAEC past question papers and will be used to assess the students' achievement on oxidation-reduction reactions. It is a multiple-choice test with four alternatives, one correct answer, and three distracters.

Validity of Instrument

The instrument was face and content validated. The instrument was validated by the researcher's supervisor, a lecturer from the Department of Chemistry, University of Benin, and a chemistry teacher from a secondary school. This ensured the relevance and clarity of the questions in the instrument, which was used to determine the validity of the instrument. To ensure content validity, a table of specifications for the achievement test was developed by the researcher and validated to ensure the effectiveness in selecting questions considering the percentage allocation of the various levels of content units that were covered according to Bloom's taxonomy.

Reliability of Instrument

To determine the reliability, the instruments were initially tested on 20 students purposely selected from a public and a private school that will not be used for the study. The reliability of the instruments was tested using Chronbach alpha and Kuder-Richardson. The instrument for assessing students' perceived use of resources in oxidation-reaction had a Cronbach alpha value of 0.830 while the achievement test instrument has a reliability coefficient of 0.731 using Kuder-Richardson (KR-20)

Method of Data Collection

Students will be required to select the option that is correct in the achievement test and also respond to the perceived use of resource items. The instrument will be immediately retrieved from the students after they are completed and collated for data analysis.The researcher will personally visit the schools selected for the study and with the help of the chemistry teacher, will administer the instruments to the respondents in the selected schools. With the assistance of the chemistry teachers, the questionnaires and the chemistry achievement test will be administered to the respondents in the selected schools. The researcher will work closely with the chemistry teacher in soliciting the cooperation of the school and students chosen for the study.

CHAPTER FOUR

RESULTS

The results of this study are presented in tables below, which addressed the researcher's questions and hypothesis.

Research Question 1:
What are percentage of perception of students' use of resources in oxidation-reduction reactions?

Table 3: Percentage of perception of students' use of resources in oxidation-reduction reactions

S/N	STATEMENTS	Response (%)				Remarks
		SA	A	SD	D	
1	The oxidation as the removal of redox reaction	52	19.5	0	28.5	Agree
2	I have seen redox reaction	9	0	54.2	38.6	Disagree
3	The model was used to explain oxidation as the addition of a redox reaction	62.8	26	11.2	0	Agree
4	I have not watched the redox reaction	48	0	45.8	6.1	Disagree
5	The is used to show electronegative elements in redox reactions	31.8	44.4	0	23.8	Agree
6	The model shows how to calculate the oxidation number in a redox reaction	22.7	50.2	0	27.1	Agree
7	A bottle were used as an apparatus to test for oxidizing and reducing agents	6.3	29	47.6	17.1	Disagree
8	iodide is a reducing agent in the laboratory	8.3	41.5	26	9.4	Agree
9	I have watched in video clips	6.3	29	47.6	17.1	Disagree
10	Calcium is an oxidizing agent in the laboratory	41.9	22.7	26	9.4	Agree
11	My teacher illustrated how the oxidation number is calculated only on the board	70.4	17.3	12.3	0	Agree
12	I understood the balancing of redox reactions through the animation display	28.2	6.1	36.8	28.9	Disagree
13	My teacher has shown us elements on the periodic table chart	20.2	32.1	39.4	8.3	Agree
14	I hate reaction because it's too difficult to understand	27.8	33.2	18.4	20.6	Agree
15	I cannot write oxidizing agents because I have never seen it	43.3	30.3	12.3	14.1	Agree

Benchmark: Average of SA & A > 50%: Agree; Average of SD & D < 50%: Disagree

The result in Table 3 above indicated that out of the 20 questions on the perception of students' use of resources in oxidation-reduction, the students disagreed on 8 (40%) questions on resources in oxidation-reduction, while 12 (60%) agreed on the questions on the perception of students' use of resources in oxidation-reduction. This implies that the students are well acquainted with the resources needed in oxidation-reduction reactions.

Research Question 2:

What percentage of male and female students identified resources for teaching oxidation-reduction reaction correctly?

Table 4: Percentage of male and female students who identified resources for teaching oxidation-reduction reaction correctly

S/N	STATEMENTS	Sex	Response (%)			Remarks
		SA	A	SD	D	
	The oxidation as the removal of hydrogen in a redox reaction	52	19.5	0	28.5	Agree
	I have seen redox reaction	9	0	54.2	38.6	Disagree
	The model was used to explain oxidation as the addition of a redox reaction	62.8	26	11.2	0	Agree
	I have not watched the redox reaction	48	0	45.8	6.1	Disagree
	The is used to show electronegative elements in redox reactions	31.8	44.4	0	23.8	Agree
	The model shows how to calculate the oxidation number in a redox reaction	22.7	50.2	0	27.1	Agree
	A bottle were used as an apparatus to test for oxidizing and reducing agents	6.3	29	47.6	17.1	Disagree
	iodide is a reducing agent in the laboratory	8.3	41.5	26	9.4	Agree
	I have watched in video clips	6.3	29	47.6	17.1	Disagree
	Calcium is an oxidizing agent in the laboratory	41.9	22.7	26	9.4	Agree
	My teacher illustrated how the oxidation number is calculated only on the board	70.4	17.3	12.3	0	Agree
	I understood the balancing of redox reactions through the animation display	28.2	6.1	36.8	28.9	Disagree
	My teacher has shown us elements on the periodic table chart	20.2	32.1	39.4	8.3	Agree
	I hate reaction because it's too difficult to understand	27.8	33.2	18.4	20.6	Agree

Benchmark: Average of SA & A > 50%: Agree; Average of SD & D < 50%: Disagree The result in Table 4 show the percentage of male and female students that identified resources for teaching oxidation-reduction reaction correctly. Out of the 20 questions identified resources for teaching oxidation-reduction reaction, 70% male agreed and 30% disagreed that there are resources for teaching oxidation-reduction reaction. However, 45% female agreed and 55% disagreed that there are resources for teaching oxidation-reduction reaction. The result indicated male students identified resources for teaching oxidation-reduction reaction correctly compared to female students.

Research Question 3:
What are percentage of perceived use of resources by male and female students in oxidation-reduction reactions in the different types of schools?

Table 5: Percentage of perceived use of resources by male and female students in oxidation-reduction reactions in public and private schools

S/N	STATEMENTS	Sex	Response (%)				Remarks
			SA	A	SD	D	
	The oxidation as the removal of hydrogen in a redox reaction	52	19.5	0	28.5	Agree	
	I have seen redox reaction	9	0	54.2	38.6	Disagree	
	The model was used to explain oxidation as the addition of a redox reaction	62.8	26	11.2	0	Agree	
	I have not watched the redox reaction	48	0	45.8	6.1	Disagree	
	The is used to show electronegative elements in redox reactions	31.8	44.4	0	23.8	Agree	
	The model shows how to calculate the oxidation number in a redox reaction	22.7	50.2	0	27.1	Agree	
	A bottle were used as an apparatus to test for oxidizing and reducing agents	6.3	29	47.6	17.1	Disagree	
	iodide is a reducing agent in the laboratory	8.3	41.5	26	9.4	Agree	
	I have watched in video clips	6.3	29	47.6	17.1	Disagree	
	Calcium is an oxidizing agent in the laboratory	41.9	22.7	26	9.4	Agree	
	My teacher illustrated how the oxidation number is calculated only on the board	70.4	17.3	12.3	0	Agree	
	I understood the balancing of redox reactions through the animation display	28.2	6.1	36.8	28.9	Disagree	
	My teacher has shown us elements on the periodic table chart	20.2	32.1	39.4	8.3	Agree	
	I hate reaction because it's too difficult to understand	27.8	33.2	18.4	20.6	Agree	

Benchmark: Average of SA & A > 50%: Agree; Average of SD & D < 50%: Disagree

The result in Table 5 shows the percentage of perceived use of resources by male and female students in oxidation-reduction reactions in the different types of schools. Out of the 20 questions to identified resources for teaching oxidation-reduction reaction in public schools, 65% (13 questions out of 20) male agreed and 35% (7 questions out of 20) disagreed while 50% (10 questions out of 20) female agreed and 50% (10 questions out of 20) disagreed that there are resources for teaching oxidation-reduction reaction. However, in private schools 70% (14 questions out of 20) male agreed and 30% (6 questions out of 20) disagreed while 40% (8 questions out of 20) female agreed and 60% (12 questions out of 20) disagreed that there are resources for teaching oxidation-reduction reaction. The result revealed that male students in public schools identified resources for teaching oxidation-reduction reaction correctly more than the female students in public schools. The result also indicated that male students in private schools identified resources for teaching oxidation-reduction reaction correctly more than female students in private schools.

Hypothesis One: There is no significant relationship between the perceived use of resources and the achievement of students in oxidation-reductions

Table 6: Bivariate Pearson Correlation between perceived use of resources and the achievement of students in oxidation-reductions

S/N	STATEMENTS	N	Pearson Correlation (r)	Strength of Correlation	Nature of Correlation	Sig. Level
1	Potassium iodide is a reducing agent in the laboratory	277	-.634**	Moderate	Negative	0.000
2	I have watched how electrons are transferred in video clips	277	.147*	Weak	Positive	0.016
3	Potassium manganate (VII) is an oxidizing agent in the laboratory	277	-.135*	Weak	Negative	0.025
4	My teacher illustrated how the oxidation number is calculated only on the board	277	.239**	Weak	Positive	0.000
5	I understood the balancing of redox reactions through the animation display	277	-.382**	Moderate	Negative	0.000
6	My teacher has shown us electronegative and electropositive elements on the periodic table chart	277	-.212**	Weak	Negative	0.000
7	I hate redox reaction because it's too difficult to understand	277	.103	Weak	Positive	0.087
8	I cannot write oxidizing agents because I have never seen it	277	.283**	Weak	Positive	0.000
9	I love the oxidation-reduction topic because it's always explained with resource materials	277	-.215**	Weak	Negative	0.000
10	I can explain reduction as the addition of hydrogen because my teacher explained it using the hydrogen model	277	-.207**	Weak	Negative	0.000
11	My chemistry Teacher only copied the oxidation-reduction reaction topic on the Board	277	-.080	Weak	Negative	0.183
12	My chemistry teacher has shown us oxidizing agents in the laboratory	277	-.142*	Weak	Negative	0.018
13	My chemistry teacher explained electron transfer using the electron transfer model	277	-.096	Weak	Negative	0.110

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Benchmark: 0.7 to 1= strong, 0.3 to 0.7= moderate, <0.3= weak, significance at $p<0.05$

Table 6 shows the Bivariate Pearson Correlation between perceived use of resources and the achievement of students in oxidation-reductions test. Out of 20 questions on perceived use of resources and the achievement of students in oxidation-reductions test, question 7, 8 & 12 were significantly ($p<0.05$) moderately ($r = 0.3$ to 0.7) negatively correlated with the achievement of students in oxidation-reductions test. While other questions on perceived use of resources and the achievement of students in oxidation-reductions test showed positive/negative weak ($r = <0.3$) correlation at $p<0.05$ significance. Thirteen (13) out of 20 questions were significantly ($p<0.05$) correlated. The result implies that there is a significant relationship between perceived use of resources and the achievement of students in oxidation-reductions.

Hypothesis Two: There is no significant relationship between the perceived use of resources and the achievement of male and female students in the different types of schools.

Public school

Table 7: Bivariate Pearson Correlation between perceived use of resources and the achievement of male students in oxidation-reductions in public schools

S/N	STATEMENTS	Sex	Response (%)			Remarks
		SA	A	SD	D	
	The oxidation as the removal of hydrogen in a redox reaction	52	19.5	0	28.5	Agree
	I have seen redox reaction	9	0	54.2	38.6	Disagree
	The model was used to explain oxidation as the addition of a redox reaction	62.8	26	11.2	0	Agree
	I have not watched the redox reaction	48	0	45.8	6.1	Disagree
	The is used to show electronegative elements in redox reactions	31.8	44.4	0	23.8	Agree
	The model shows how to calculate the oxidation number in a redox reaction	22.7	50.2	0	27.1	Agree
	A bottle were used as an apparatus to test for oxidizing and reducing agents	6.3	29	47.6	17.1	Disagree
	iodide is a reducing agent in the laboratory	8.3	41.5	26	9.4	Agree
	I have watched in video clips	6.3	29	47.6	17.1	Disagree
	Calcium is an oxidizing agent in the laboratory	41.9	22.7	26	9.4	Agree
	My teacher illustrated how the oxidation number is calculated only on the board	70.4	17.3	12.3	0	Agree
	I understood the balancing of redox reactions through the animation display	28.2	6.1	36.8	28.9	Disagree
	My teacher has shown us elements on the periodic table chart	20.2	32.1	39.4	8.3	Agree
	I hate reaction because it's too difficult to understand	27.8	33.2	18.4	20.6	Agree

Benchmark: 0.7 to 1= strong, 0.3 to 0.7= moderate, <0.3= weak, significance at $p<0.05$

The results in Table 7 shows the Bivariate Pearson Correlation between perceived use of resources and the achievement of male students in oxidation-reductions in public schools. Out of 20 questions on perceived use of resources and the achievement of male students in oxidation-reductions in public schools, question 7, 12, 13 & 16 were significantly ($p<0.05$) moderately ($r = 0.3$ to 0.7) negatively correlated with the achievement of students in oxidation-reductions test. While other questions on perceived use of resources and the achievement of male students in oxidation-reduction test showed positive/negative weak ($r = <0.3$) correlation at $p<0.05$ significance. Six (6) out of 20 questions were significantly ($p<0.05$) correlated. The result implies that there is no significant relationship between perceived use of resources and the achievement of male students in oxidation-reductions in public schools.

Table 8: Bivariate Pearson Correlation between perceived use of resources and the achievement of female students in oxidation-reductions in public schools

S/N	STATEMENTS	N	Pearson Correlation (r)	Strength of Correlation	Nature of Correlation	Sig. Level
1	The oxidation number model shows how to calculate the oxidation number in a redox reaction	50	-.080	Weak	Negative	.583
2	A beaker and test tubes were used as an apparatus to test for oxidizing and reducing agents	50	-.466**	Moderate	Negative	.001
3	Potassium iodide is a reducing agent in the laboratory	50	-.689**	Moderate	Negative	.000
4	I have watched how electrons are transferred in video clips	50	.153	Weak	Positive	.289
5	Potassium manganate (VII) is an oxidizing agent in the laboratory	50	-.244	Weak	Negative	.088
6	My teacher illustrated how the oxidation number is calculated only on the board	50	.347*	Moderate	Positive	.013
7	I understood the balancing of redox reactions through the animation display	50	-.421**	Moderate	Negative	.002
8	My teacher has shown us electronegative and electropositive elements on the periodic table chart	50	-.438**	Moderate	Negative	.001
9	I hate redox reaction because it's too difficult to understand	50	-.167	Weak	Positive	.246
10	I cannot write oxidizing agents because I have never seen it	50	.513**	Moderate	Positive	.000
11	I love the oxidation-reduction topic because it's always explained with resource materials	50	-.258	Weak	Negative	.070
12	I can explain reduction as the addition of hydrogen because my teacher explained it using the hydrogen model	50	-.261	Weak	Negative	.067

13	My chemistry Teacher only copied the oxidation-reduction reaction topic on the board	50	-.214	Weak	Negative	.135

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Benchmark: 0.7 to 1= strong, 0.3 to 0.7= moderate, <0.3= weak, significance at $p<0.05$

The results in Table 8 shows the Bivariate Pearson Correlation between perceived use of resources and the achievement of female students in oxidation-reductions in public schools. Out of 20 questions on perceived use of resources and the achievement of female students in oxidation-reductions in public schools, question 7, 8, 11, 12, 13 & 15 were significantly ($p<0.05$) moderately ($r = 0.3$ to 0.7) negatively/positively correlated with the achievement of female students in oxidation-reductions test. While other questions on perceived use of resources and the achievement of female students in oxidation-reductions test showed positive/negative weak ($r = <0.3$) correlation at $p<0.05$ significance. Six (6) out of 20 questions were significantly ($p<0.05$) correlated. The result implies that there is no significant relationship between perceived use of resources and the achievement of female students in oxidation-reductions in public schools.

Private School

Table 9: Bivariate Pearson Correlation between perceived use of resources and the achievement of male students in oxidation-reductions in private schools

S/N	STATEMENTS	Sex	Response (%) SA	A	SD	D	Remarks
	The oxidation as the removal of hydrogen in a redox reaction		52	19.5	0	28.5	Agree
	I have seen redox reaction		9	0	54.2	38.6	Disagree
	The model was used to explain oxidation as the addition of a redox reaction		62.8	26	11.2	0	Agree
	I have not watched the redox reaction		48	0	45.8	6.1	Disagree
	The is used to show electronegative elements in redox reactions		31.8	44.4	0	23.8	Agree
	The model shows how to calculate the oxidation number in a redox reaction		22.7	50.2	0	27.1	Agree
	A bottle were used as an apparatus to test for oxidizing and reducing agents		6.3	29	47.6	17.1	Disagree
	iodide is a reducing agent in the laboratory		8.3	41.5	26	9.4	Agree
	I have watched in video clips		6.3	29	47.6	17.1	Disagree
	Calcium is an oxidizing agent in the laboratory		41.9	22.7	26	9.4	Agree
	My teacher illustrated how the oxidation number is calculated only on the board		70.4	17.3	12.3	0	Agree
	I understood the balancing of redox reactions through the animation display		28.2	6.1	36.8	28.9	Disagree
	My teacher has shown us elements on the periodic table chart		20.2	32.1	39.4	8.3	Agree
	I hate reaction because it's too difficult to understand		27.8	33.2	18.4	20.6	Agree

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Benchmark: 0.7 to 1= strong, 0.3 to 0.7= moderate, <0.3= weak, significance at $p<0.05$

The results in Table 9 shows the Bivariate Pearson Correlation between perceived use of resources and the achievement of male students in oxidation-reductions in private schools. Out of 20 questions on perceived use of resources and the achievement of male students in oxidation-reductions in private schools, question 6, 7, 8, & 12 were significantly ($p<0.05$) moderately ($r = 0.3$ to 0.7) negatively correlated with the achievement of male students in oxidation-reductions test. While other questions on perceived use of resources and the achievement of male students in oxidation-reductions test showed positive/negative weak ($r = <0.3$) correlation at $p<0.05$ significance. Six (6) out of 20 questions were significantly ($p<0.05$) correlated. The result implies that there is no significant relationship between perceived use of resources and the achievement of male students in oxidation-reductions in private schools.

Table 10: Bivariate Pearson Correlation between perceived use of resources and the performance of female students in oxidation-reductions in private schools

S/N	STATEMENTS	N	Pearson Correlation (r)	Strength of Correlation	Nature of Correlation	Sig. Level
1	The hydrogen model was used to explain oxidation as the removal of hydrogen in a redox reaction	74	.063	Weak	Positive	.217
2	I have seen video clips of redox reaction	74	-.138	Weak	Negative	.242
3	The oxygen model was used to explain oxidation as the addition of oxygen in a redox reaction	74	.044	Weak	Positive	.711
4	I have not watched animations of the redox reaction	74	.027	Weak	Positive	.820
5	The electronegative model is used to show electronegative elements in redox reactions	74	-.179	Weak	Positive	.126
6	The oxidation number model shows how to calculate the oxidation number in a redox reaction	74	-.198	Weak	Negative	.091
7	A beaker and test tubes were used as an apparatus to test for oxidizing and reducing agents	74	-.379**	Moderate	Negative	.001
8	Potassium iodide is a reducing agent in the laboratory	74	-.515**	Moderate	Negative	.000
9	I have watched how electrons are transferred in video clips	74	.158	Weak	Positive	.180
10	Potassium manganate (VII) is an oxidizing agent in the laboratory	74	-.252*	Weak	Negative	.031
11	My teacher illustrated how the oxidation number is calculated only on the board	74	.113	Weak	Positive	.340
12	I understood the balancing of redox reactions through the animation display	74	-.362**	Moderate	Negative	.002

13	My teacher has shown us electronegative and electropositive elements on the periodic table chart	74	-.175	Weak	Negative	.135

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Benchmark: 0.7 to 1= strong, 0.3 to 0.7= moderate, <0.3= weak, significance at p<0.05

The results in Table 10 shows the Bivariate Pearson Correlation between perceived use of resources and the achievement female students in oxidation-reductions in private schools. Out of 20 questions on perceived use of resources and the achievement of female students in oxidation-reductions in private schools, question 7, 8, & 12 were significantly (p<0.05) moderately (r = 0.3 to 0.7) negatively correlated with the achievement of female students in oxidation-reductions test. While other questions on perceived use of resources and the achievement of male students in oxidation-reductions test showed positive/negative weak (r = <0.3) correlation at p<0.05 significance. Six (6) out of 20 questions were significantly (p<0.05) correlated. The result implies that there is no significant relationship between perceived use of resources and the achievement of female students in oxidation-reductions in private schools.

Hypothesis Three: The contribution of sex, type of school, and level of perceived use of resources to students' achievement in oxidation-reduction reaction will not be significantly different.

Table 11: Relative contribution of sex, type of school, and level of perceived use of resources to students' achievement in oxidation-reduction reaction

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	7.041	.754		9.333	.000
	Sex	.200	.209	.052	.956	.340
	Type of School	.355	.208	.093	1.708	.089
	Perceived use of Resources	-1.896	.230	-.444	-8.247	.000

a. Dependent Variable: Oxidation-Reduction Test

Table 11 shows the contribution of sex, type of school, and level of perceived use of resources to students' achievement in oxidation-reduction reaction. The result showed that sex did not contribute to the achievement of students' in oxidation-reduction reaction, since it was significant (t = 0.956, p>0.05). School type did not contributed to the achievement of students in acid-base titration, since it was significant (t = 1.708, p>0.05). Perceived use of resources contributed to the performance of students in oxidation-reduction test since the hypothesis tested was not significant (t = -8.247, p<0.05).

Discussion of Findings

The findings of this study are discussed under the following headings:

- The percentage perception of students' use of resources in oxidation-reduction reactions
- The percentage of male and female students that identified resources for teaching oxidation-reduction reactions correctly
- The percentage of perceived use of resources identified by male and female students in the different types of schools
- The relationship between perceived use of resources and the achievement of students in oxidation-reduction reactions
- The relationship between perceived use of resources and the achievement of male and female students in the different types of schools
- The contribution of sex, type of school, and level of perceived use of resources to students' achievement in oxidation-reduction reactions

The percentage perception of students' use of resources in oxidation-reduction reactions

The findings of this study revealed that majority of the students are well acquainted with the resources used in oxidation-reduction reactions. This is corroborated with Aworor and Helen (2023) opinions that postgraduate students have a positive perception on the use of serial materials, that is materials that carry current information on a variety of subject areas; materials that are essential for researchers and students; materials that contains the facts and figures needed for research; materials that present reports of current research findings more quickly than any other publication; and materials that represents various author's ideals on a variety of subjects. Similarly, Yunus and Ali (2013) study posited that majority of the students had a positive attitude towards learning chemistry when they conducted chemistry experiments in the laboratory, majority of the students are also well acquainted with laboratory practices and as well, majority of the students also showed positive attitudes towards the teachers; teaching styles.

The percentage of male and female students that identified resources for teaching oxidation-reduction reactions correctly

The findings of this study revealed that male students identified resources for teaching oxidation-reduction reaction correctly compared to female students. This is inline with the study by Chang et.al. (2009) who opined that boys showed higher learning interest in sustainability issues and performance in scientific topics in chemistry than girls. Another study by Bonah (2015) stated that there was a statistical difference in the performance of male and female students exposed to chemistry laboratory exercises and that male students identified laboratory apparatus and performed better than their female counterparts.

The percentage of perceived use of resources identified by male and female students in the different types of schools

The findings of this study revealed that male students in public schools identified resources for teaching oxidation-reduction reaction correctly more than the female students in public schools. The result also indicated that male students in private schools identified resources for teaching oxidation-reduction reaction correctly more than female students in private schools. This is in line with the study by Ahmad, et.al. (2017) who explore whether the use of teachers' demonstrations significantly improves students' understanding of redox reactions and it was revealed that male students showed more understanding of the subject better than the female students, likewise, the experimental groups achievements and understanding of the subject were statistically significantly better than those of their control groups counterparts.

The relationship between perceived use of resources and the achievement of students in oxidation-reduction reactions

The findings of this study revealed that there is a significant relationship between perceived use of resources and the achievement of students in oxidation-reductions. The findings of this study are in line with Dahar and Faize (2011) research study on the effect of availability and the use of instructional material on academic performance of science students, who asserted that the availability and the use of teaching guide are significantly related with the academic performance of the students. This was equally in line with Adebola and Ademola (2011) whose result showed a significant relationship between instructional materials and achievement of students in mathematics.

The relationship between perceived use of resources and the achievement of male and female students in the different types of schools

The findings in this study revealed that there is no significant relationship between perceived use of resources and the achievement of male students in oxidation-reductions in public schools. The study further revealed that there is no significant relationship between perceived use of resources and the achievement of female students in oxidation-reductions in public schools. Furthermore, the study revealed that there is no significant relationship between perceived use of resources and the achievement of male students in oxidation-reductions in private schools. Likewise, the study revealed that there is no significant relationship between perceived use of resources and the achievement of female students in oxidation-reductions in private schools. The findings from this study are in line with Emmanuel et.al. (2012) opinions showing that there is no significant relationship between male and female students' performance in a test of practical and theoretical knowledge in chemistry in Senior secondary school two students from Government grant-aided schools and privately owned schools, and their performance in MOCK-SSCE Chemistry theory and practical examinations. Similarly, Nja and Cecilia (2021) study showed a non-significant relationship between the use of home materials in the teaching of thermochemistry and their performance in thermochemistry in SS1 chemistry students in public and private schools. Their study further opined that there was no significant relationship in the type of school environment and sex of the students.

The contribution of sex, type of school, and level of perceived use of resources to students' achievement on-reduction reactions

The findings in this study revealed that there was no significant difference in the contribution of sex and school type on the achievement of students in oxidation-reduction reaction. This indicated that sex and school ownership did not make any contribution to the achievement of students in oxidation-reduction reaction. The study also revealed that there was a significant difference in the contribution of perceived use of resources to the achievement of students in oxidation-reduction reaction. This indicated that perceived use of resources contributed to the achievement of students in oxidation-reduction reaction. The findings of this study corroborate with that of Musibau (2010) as he opined that school ownership, sex, and location of schools had no significant influence on students' academic performance. Another study by Tsobaza and Njoku (2021) stated that gender did not significantly influence students' acquisition of practical skills in public and private secondary schools in Kogi state. Thus, a study by Cecilia et.al. (2019) showed that student's different learning styles and preferences were significant to their academic performance. Also, Ojelade, Aregbesola, and Akinola (2017) stated that the webbing instructional method of teaching redox reactions in secondary school, contributed and enhanced the performance of students in chemistry.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

In this chapter, the summary and recommendation of the study are presented as follows:

Summary

The study investigated the relationship between chemistry students' perceived use of resources and achievement in oxidation-reduction reaction in Urban areas of Ovia-North East LGA, Edo state. The study also examined the percentage perception of students' use of resources in oxidation-reduction reactions, the percentage of male and female students that identified resources for teaching oxidation-reduction reactions correctly, the percentage of perceived use of resources identified by male and female students in the different types of schools, the relationship between perceived use of resources and the achievement of students in oxidation-reduction reactions, the relationship between perceived use of resources and the achievement of male and female students in the different types of schools, the contribution of sex, type of school, and level of perceived use of resources to students' achievement in oxidation-reduction reactions. Based on this, six research questions were raised and three were hypothesized and tested at 0.05 alpha level of significance.

The researcher adopted a survey research design incorporating ex-post facto. The population consists of four hundred and seventy-nine (479) chemistry students in public and private secondary schools in urban areas of Ovia North East LGA, Edo state. Meanwhile, two hundred and seventy-seven (277) chemistry students were selected for the study through purposive random sampling. An instrument titled Perceived use resource inventory and achievement test was used to collect data from the students in the study. The instruments had three sections; section A is the demographic data, section B is a questionnaire on a 4-point Likert scale to access the students on the resources used in oxidation-reduction reactions, and section C is a theoretical test on oxidation-reduction reactions. The instrument was face and content validated by expert judgment of the researcher's supervisor, a lecturer in Chemistry Department, and a chemistry teacher in secondary school. The reliability of the questionnaire was tested by using Cronbach Alpha Statistics and a coefficient value of 0.830 was derived. The achievement test was tested using Kuder Richardson (KR-20) and a coefficient value of 0.731 was obtained. Hence the instrument was deemed reliable. The instrument was administered by the researcher with the chemistry teacher. The instruments were retrieved from the students immediately after they were completed. The data collected from the students were analyzed using, percentages, Pearson product moment correlation, and multiple regression.

The results from the study showed that majority of the students were well acquainted with the resources used in oxidation-reduction reactions. The result from the study also showed that male students identified resources for teaching oxidation-reduction reaction correctly compared to female students. Furthermore, the results showed that male students in public schools identified resources for teaching oxidation-reduction reaction correctly more than the female students in public schools. Likewise, male students in private schools identified resources for teaching oxidation-reduction reaction correctly more than female students in private schools. The result also revealed that there was a significant relationship between perceived use of resources and the achievement of students in oxidation-reductions. It was also revealed from the result that there was no significant relationship between perceived use of resources and the achievement of male and female students in oxidation-reductions in public schools and private schools. The result further revealed that perceived use of resources significantly contributed to the achievement of the students in oxidation-reduction reaction, whereas, sex and school ownership did not significantly contribute to the achievement of the students.

Summary of Findings

The following findings were observed in the study.

1. Majority of the students were more acquainted with the resources used in oxidation-reduction reactions
2. Male students identified resources for teaching oxidation-reduction reaction correctly compared to female students.
3. Male students in public and private schools identified resources for teaching oxidation-reduction reaction correctly more than the female students in public schools and private schools.
4. There was a significant relationship between perceived use of resources and the achievement of students in oxidation-reductions.
5. There was no significant relationship between perceived use of resources and the achievement of male and female students in oxidation-reductions in public schools and private schools.

6. Perceived use of resources significantly contributed to the achievement of the students in oxidation-reduction reaction, whereas, sex and school ownership did not significantly contribute to the achievement of the students.

Conclusion

The study has shown that students' conceptual difficulties in the form of alternative conceptions and other conceptual difficulties (such as reduction half involves loss of electrons, oxidation half involves decrease in oxidation state, oxidised substances decrease in oxidation number, and reduced substances loss oxygen to result in loss of electrons) exist in learning of oxidation-reduction reactions. This is consistent with the findings of Adu-Gyamfi et al. (2015) who showed that students' alternative conceptions exist on the introduction of H2O, H+, and OH- into balancing of oxidation-reduction reactions. The current study has added to the literature on students' alternative conceptions and other conceptual difficulties on oxidation-reduction reactions with the use of the four models (oxidation number, electron transfer, addition and removal of oxygen, and addition and removal of hydrogen) approach. Studies on oxidation-reduction reactions have shown that students have difficulty in conceptualising oxidation-reduction reactions using the concept of electron transfer and the difficulty with electron transfer is conceptualising the direction of flow of electrons. Students have an appeal for conceptualising oxidation-reduction reaction using the loss and gain of oxygen. The current study has added that not only is the oxygen transfer model appealing to students but the hydrogen model is also appealing to students as they conceptualise oxidation-reduction reaction in terms of transfer of hydrogen atom even when the hydrogen atom has no direct influence on the formation of new substance. Students' alternative conceptions and other conceptual difficulties on oxidation-reduction reactions using the oxidation number model are due to the difficulty in deducing correctly the oxidation.

Recommendations

The following recommendations were made from the findings of the study:

1. The government should organize seminars and training for the in-service chemistry teachers on the effective design and implementation of research-based instruction and assessment-based instruction to enhance the learning of difficult topics in senior high school chemistry
2. Female chemistry students should be encouraged to participate more effectively in both assessment- and research-based instruction
3. Assessment-based instruction should be used often in both private and public schools, as it has the most impact on students' performance in difficult chemistry topics
4. Public schools should adopt more research-based instruction to widen the scope of learning of the difficult chemistry topics among students and to help them focus their attention on those topics.

Contribution to Knowledge

The study has contributed to knowledge in the following ways.

1. This study has been able to show that majority of the students were more acquainted with the resources used in oxidation-reduction reactions
2. This study has been able to show that male students identified resources for teaching oxidation-reduction reaction correctly compared to female students.
3. This study has been able to establish that male students in public and private schools identified resources for teaching oxidation-reduction reaction correctly more than the female students in public schools and private schools.
4. This study has been able to establish that there was a significant relationship between perceived use of resources and the achievement of students in oxidation-reductions.
5. This study has been able to establish that there was no significant relationship between perceived use of resources and the achievement of male and female students in oxidation-reductions in public schools and private schools.
6. This study have been able to establish that perceived use of resources significantly contributed to the achievement of the students in oxidation-reduction reaction, whereas, sex and school ownership did not significantly contribute to the achievement of the students.

Suggestions for Further Research

Based on the findings and limitations of this study, research of this sort should be carried out in other Local Government Areas and other states to allow for a wider generalization of the findings. It is necessary to conduct further studies to examine modern resources used in teaching specific areas of chemistry curriculum like thermodynamics.

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APPENDIX A

PERCEIVED USE RESOURCES INVENTORY AND ACHIEVEMENT TEST DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY, FACULTY OF EDUCATION, UNIVERSITY OF BENIN, BENIN CITY EDO STATE.

Dear Respondents,

I am **Elizabeth EDELEGBA**, a student of the above department. I am carrying out a study on the 'Relationship between chemistry students' perceived use of resources and actual achievement in oxidation-reduction reaction'.

You are kindly requested to provide answers to the questions that follow. All responses will be treated with confidentiality. Thanks for your anticipated cooperation.

yours faithfully,

Elizabeth EDELEGBA

Researcher

Section A: Biodata

Sex: Male ( ) Female ( )

School Ownership: Public ( ), Private ( )

Section B: Resource materials used in oxidation-reduction

S/N	STATEMENTS	SA	A	SD	D
1	The hydrogen model was used to explain oxidation as the removal of hydrogen in a redox reaction				
2	I have seen video clips of redox reaction				
3	The oxygen model was used to explain oxidation as the addition of oxygen in a redox reaction				
4	I have not watched animations of the redox reaction				
5	The electronegative model is used to show electronegative elements in redox reactions				
6	The oxidation number model shows how to calculate the oxidation number in a redox reaction				
7	A beaker and test tubes were used as an apparatus to test for oxidizing and reducing agents				
8	Potassium iodide is a reducing agent in the laboratory				
9	I have watched how electrons are transferred in video clips				
10	Potassium manganate (VII) is an oxidizing agent in the laboratory				
11	My teacher illustrated how the oxidation number is calculated only on the board				
12	I understood the balancing of redox reactions through the animation display				
13	My teacher has shown us electronegative and electropositive elements on the periodic table chart				
14	I hate redox reaction because it's too difficult to understand				
15	I cannot write oxidizing agents because I have never seen it				
16	I love the oxidation-reduction topic because it's always explained with resource materials				
17	I can explain reduction as the addition of hydrogen because my teacher explained it using the hydrogen model				
18	My chemistry only copied the oxidation-reduction reaction topic on the board				
19	My chemistry teacher has shown us oxidizing agents in the laboratory				
20	My chemistry explained electron transfer using the electron transfer model				

Section C: Oxidation-Reduction Reaction Test

1. **Which reaction is NOT a redox reaction?**
   A. $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
   B. $CH_4+O_2\rightarrow CO_2+H_2O$
   C. $Li+Cl_2\rightarrow LiCl$ D. $NaClO_3\rightarrow NaCl+O_2$
2. The oxidation number of chromium in $Cr_2O_7^{2-}$ is
   A. +4
   B. +5
   C. +6
   D. +7
3. Chlorine water is used as a bleaching agent because it is
   A. A reducing agent
   B. An oxidizing agent
   C. An acidic solution
   D. An alkaline solution
4. The oxidation number of sulphur is +4 in
   A. $Na_2S_2O_3$
   B. H_2SO_4
   C. H_2SO_3
   D. SO_3
5. Reduction is the process of
   A. A loss of electron
   B. Lost of hydrogen
   C. Lost of oxygen
   D. Addition of electronegative element
6. Promoters in chemical reactions
   A. Improve the speed of chemical reaction
   B. Improve the efficiency of the catalyst
   C. Improve the stability of the product
   D. Improve the stability of the reactants
7. The oxidation reaction may be defined as the following except A. An oxidation reaction is one in which an electron is lost
   B. An oxidation reaction is one in which there is an increase in oxidation number
   C. An oxidation reaction is one in which oxygen is gained
   D. An oxidation reaction is one in which hydrogen is gained

8. From the reaction. $2I^- + 2Fe^{3+} \rightarrow I_2$ + $2Fe^{2+}$ Which is the reducing agent

A. I^- B. $2Fe^{3+}$ C. I_2

D. $2Fe^{2+}$

9. In balancing the above redox equation, the value of x is given as $MnO_4^- + 8H^+ + X \rightarrow Mn^{2+} + 4H_2O$

A. 10e

B. 2e C. 5e

D. 4e

10. $2H_2 + O_2 \rightarrow 2H_2O$. In this reaction, the oxidation number of hydrogen changes from

A. +2 to +1

B. +4 to +1

C. 0 to +1

D. +1 to +2

11. The oxidation state of Sulphur in tetraoxosulphate (VI) is

A. +5

B. +6

C. +2

D. +4

12. What is the function of manganese (IV) oxide in the reaction represented by the following equation?

$MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

A. Catalyst

B. Dehydrating agent

C. Oxidizing agent

D. Reducing agent

13. In an electrochemical cell, does reduction always occur?

A. At the cathode

B. At the anode

C. In the electrolyte

D. None of the above

14. The rate of chemical reaction of solids is not affected by

A. Catalyst

B. Pressure

C. Particle size

D. Temperature

15. $Cl_2 + 2KBr \rightarrow 2KCl + Br_2$

In the above equation, chlorine is

E. An oxidizing agent
F. A reducing agent
G. An electron donor
H. An acid

APPENDIX B

Answers for Oxidation-Reduction Reaction Test

1. A
2. C
3. B
4. C
5. C
6. B
7. D
8. A
9. C
10. C
11. B
12. C
13. A
14. B
15. B

APPENDIX C

The population of public SS2 Chemistry students in Urban Area of Ovia North East LGA

S/N	NAME OF SCHOOL	MALE	FEMALE	TOTAL
1	AMRY DAY S/S, EKENWAN	18	15	33
2	AMRY DAY S/S, ISIOHOR	14	9	23
3	EKOSODIN S/S, EKOSODIN	16	11	27
4	EZOMO COLLEGE, ORA	10	8	18
5	IGUADOLOR S/S, IGUADOLOR	8	7	15
6	IGUEDAIKEN G/S, EKIADOLOR	10	5	15
7	NIFOR S/S, NIFOR	14	2	16
8	OGUA S/S, OGUA	7	5	12
9	OKOKHUO S/S, OKOKHUO	5	4	9
10	ST. DAVID BOYS M/S/S, EVONIKA	9	7	16
11	UTOKA G/S, UTOKA	5	5	10
	TOTAL	**116**	**78**	**194**

RESEARCHER'S FINDINGS (2023)

APPENDIX D

Population of private SS2 Chemistry students in Urban Area of Ovia North East LGA

S/N	NAME OF SCHOOL	MALE	FEMALE	TOTAL
1	Apex Academy Sec Sch	11	7	18
2	Bethany Christian Academy Sec Sch	5	7	12
3	Christian Edu Center (Sec Sch)	12	9	21
4	Chrisidia Educational Centre	4	7	11
5	Conerstone Demostration Coll	6	4	10
6	Eghosa Christain Academy	6	8	14
7	Ehigiator Sec. Sch.	8	12	20
8	Evidence College Benin City	5	3	8
9	Exceence Sec Sch	4	5	9
10	Generationext Sec Sch	3	4	7
11	Good Success Sec Sch	7	5	12
12	Hannah High School	10	12	22
13	Higher Wisdom Academy	9	8	17
14	Hope Alive Sec Sch	8	7	16
15	Igbinosa Sec Sch Iguosa	8	6	14
16	Intellect Sec Sch	9	7	16
17	Jubilee Academy Sec Sch	8	10	18
18	Mayor College	6	6	12
19	Nifor Academy High Sch	4	6	10
20	Regina Mundi	6	3	9
21	Wisdom Gate International College	5	4	9
Total		**145**	**140**	**285**

RESEARCHER'S FINDINGS (2023)

APPENDIX E

Sampled public and private chemistry students

S/N	NAME OF SCHOOL	MALE	FEMALE	TOTAL
1	Army Day Secondary School, Ekehuan	18	15	33
2	EKOSODIN S/S, EKOSODIN	16	11	27
3	Army Day Secondary School, Isiohor	14	9	23
4	Ezomo College	10	8	18
5	Iguedaiken G/S, Ekiadolor	10	5	15
6	Nifor Secondary School	14	2	16
7	Apex Academy Sec Sch	11	7	18
8	Bethany Christian Academy Sec Sch	5	7	12
9	Christian Edu Center (Sec Sch)	12	9	21
10	Chrisidia Educational Centre	4	7	11
11	Eghosa Christain Academy	6	8	14
12	Ehigiator Sec. Sch	8	12	20
13	Evidence College Benin City	5	3	8
15	Exceence Sec Sch	4	5	9
15	Igbinosa Sec Sch Iguosa	8	6	14
16	Jubilee Academy Sec Sch	8	10	18
	Total	**153**	**124**	**277**

Researcher's Findings (2023)

APPENDIX F

Reliability For Percieved Use Resources in Oxidation-Reduction Reaction

Scale: Percieved Use Resources

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
. 830	20

APPENDIX G

Reliability for achievement test in oxidation-reduction reaction

Scale: Achievement Test in oxidation-reduction reaction

Kuder-Richardson	
K	15
∑Pq	1.59
Variance (σ2)	5.00
KR-20	**0.731**

APPENDIX H

(A)

Percentage of perception of students' use of resources in oxidation-reduction reactions

```
CROSSTABS
  /TABLES=st1 st2 st3 st4 st5 st6 st7 st8 st9 st10 st11 st12 st13 st14 st15
st16 st17 st18 st19 st20 BY Respondent
  /FORMAT=AVALUE TABLES
  /CELLS=COLUMN
  /COUNT ROUND CELL.
```

		Total
The hydrogen model was used to explain oxidation as the removal of hydrogen in a redox reaction	disagree	28.5%
	agree	19.5%
	strongly agree	52.0%
Total		100.0%
I have seen video clips of redox reaction	disagree	36.8%
	strongly disagree	54.2%
	strongly agree	9.0%
Total		100.0%
The oxygen model was used to explain oxidation as the addition of oxygen in a redox reaction	strongly disagree	11.2%
	agree	26.0%
	strongly agree	62.8%
Total		100.0%
I have not watched animations of the redox reaction	disagree	6.1%
	strongly disagree	45.8%
	strongly agree	48.0%
Total		100.0%
The electronegative model is used to show electronegative elements in redox reactions	disagree	23.8%
	agree	44.4%
	strongly agree	31.8%
Total		100.0%
The oxidation number model shows how to calculate the oxidation number in a redox reaction	disagree	27.1%
	agree	50.2%
	strongly agree	22.7%
Total		100.0%
A beaker and test tubes were used as an apparatus to test for oxidizing and reducing agents	disagree	9.4%
	strongly disagree	20.2%
	agree	46.2%
	strongly agree	24.2%
Total		100.0%
Potassium iodide is a reducing agent in the laboratory	disagree	28.9%

	strongly disagree	21.3%
	agree	41.5%
	strongly agree	8.3%
Total		100.0%
I have watched how electrons are transferred in video clips	disagree	17.1%
	strongly disagree	47.6%
	agree	29.0%
	strongly agree	6.3%
Total		100.0%
Potassium manganate (VII) is an oxidizing agent in the laboratory	disagree	9.4%
	strongly disagree	26.0%
	agree	22.7%
	strongly agree	41.9%
Total		100.0%
My teacher illustrated how the oxidation number is calculated only on the board	strongly disagree	12.3%
	agree	17.3%
	strongly agree	70.4%
Total		100.0%
I understood the balancing of redox reactions through the animation display	disagree	28.9%
	strongly disagree	36.8%
	agree	6.1%
	strongly agree	28.2%
Total		100.0%
My teacher has shown us electronegative and electropositive elements on the periodic table chart	disagree	8.3%
	strongly disagree	39.4%
	agree	32.1%
	strongly agree	20.2%
Total		100.0%
I hate redox reaction because it's too difficult to understand	disagree	20.6%
	strongly disagree	18.4%
	agree	33.2%
	strongly agree	27.8%
Total		100.0%
I cannot write oxidizing agents because I have never seen it	disagree	14.1%
	strongly disagree	12.3%
	agree	30.3%
	strongly agree	43.3%
Total		100.0%
I love the oxidation-reduction topic because it's always explained with resource materials	disagree	28.5%
	agree	36.5%
	strongly agree	35.0%
Total		100.0%
	disagree	62.8%

I can explain reduction as the addition of hydrogen because my teacher explained it using the hydrogen model	strongly disagree	17.0%
	agree	9.0%
	strongly agree	11.2%
Total		100.0%
My chemistry Teacher only copied the oxidation-reduction reaction topic on the board	disagree	19.5%
	strongly disagree	19.5%
	agree	45.5%
	strongly agree	15.5%
Total		100.0%
My chemistry teacher has shown us oxidizing agents in the laboratory	disagree	27.8%
	strongly disagree	63.2%
	strongly agree	9.0%
Total		100.0%
My chemistry explained electron transfer using the electron transfer model	disagree	54.5%
	strongly disagree	29.6%
	strongly agree	15.9%
Total		100.0%

(B)

Percentage of male and female students who identified resources for teaching oxidation-reduction reaction correctly

```
CROSSTABS
  /TABLES=st1 st2 st3 st4 st5 st6 st7 st8 st9 st10 st11 st12 st13 st14 st15
st16 st17 st18 st19 st20 BY Sex
  /FORMAT=AVALUE TABLES
  /CELLS=COLUMN
  /COUNT ROUND CELL.
```

The hydrogen model was used to explain oxidation as the removal of hydrogen in a redox reaction * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
The hydrogen model was used to explain oxidation as the removal of hydrogen in a redox reaction	disagree	29.4%	27.4%	28.5%
	agree	19.6%	19.4%	19.5%
	strongly agree	51.0%	53.2%	52.0%
Total		100.0%	100.0%	100.0%

I have seen video clips of redox reaction * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
I have seen video clips of redox reaction	disagree	37.3%	36.3%	36.8%
	strongly disagree	51.0%	58.1%	54.2%
	strongly agree	11.8%	5.6%	9.0%
Total		100.0%	100.0%	100.0%

The oxygen model was used to explain oxidation as the addition of oxygen in a redox reaction * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
The oxygen model was used to explain oxidation as the addition of oxygen in a redox reaction	strongly disagree	11.8%	10.5%	11.2%
	agree	24.2%	28.2%	26.0%
	strongly agree	64.1%	61.3%	62.8%
Total		100.0%	100.0%	100.0%

I have not watched animations of the redox reaction * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
I have not watched animations of the redox reaction	disagree	7.2%	4.8%	6.1%
	strongly disagree	43.8%	48.4%	45.8%
	strongly agree	49.0%	46.8%	48.0%
Total		100.0%	100.0%	100.0%

The electronegative model is used to show electronegative elements in redox reactions * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
The electronegative model is used to show electronegative elements in redox reactions	disagree	22.9%	25.0%	23.8%
	agree	43.1%	46.0%	44.4%
	strongly agree	34.0%	29.0%	31.8%
Total		100.0%	100.0%	100.0%

The oxidation number model shows how to calculate the oxidation number in a redox reaction * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
The oxidation number model shows how to calculate the oxidation number in a redox reaction	disagree	26.8%	27.4%	27.1%
	agree	49.7%	50.8%	50.2%
	strongly agree	23.5%	21.8%	22.7%
Total		100.0%	100.0%	100.0%

A beaker and test tubes were used as an apparatus to test for oxidizing and reducing agents * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
A beaker and test tubes were used as an apparatus to test for oxidizing and reducing agents	disagree	7.8%	11.3%	9.4%
	strongly disagree	21.6%	18.5%	20.2%
	agree	47.7%	44.4%	46.2%
	strongly agree	22.9%	25.8%	24.2%
Total		100.0%	100.0%	100.0%

Potassium iodide is a reducing agent in the laboratory * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
Potassium iodide is a reducing agent in the laboratory	disagree	28.8%	29.0%	28.9%
	strongly disagree	21.6%	21.0%	21.3%
	agree	41.8%	41.1%	41.5%
	strongly agree	7.8%	8.9%	8.3%
Total		100.0%	100.0%	100.0%

I have watched how electrons are transferred in video clips * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
I have watched how electrons are transferred in video clips	disagree	16.4%	17.9%	17.1%
	strongly disagree	46.6%	48.8%	47.6%
	agree	29.5%	28.5%	29.0%
	strongly agree	7.5%	4.9%	6.3%
Total		100.0%	100.0%	100.0%

Potassium manganate (VII) is an oxidizing agent in the laboratory * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
Potassium manganate (VII) is an oxidizing agent in the laboratory	disagree	7.8%	11.3%	9.4%
	strongly disagree	24.2%	28.2%	26.0%
	agree	22.9%	22.6%	22.7%
	strongly agree	45.1%	37.9%	41.9%
Total		100.0%	100.0%	100.0%

My teacher illustrated how the oxidation number is calculated only on the board * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
	strongly disagree	13.1%	11.3%	12.3%

My teacher illustrated how the oxidation number is calculated only on the board	agree	19.0%	15.3%	17.3%
	strongly agree	68.0%	73.4%	70.4%
Total		100.0%	100.0%	100.0%

I understood the balancing of redox reactions through the animation display * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
I understood the balancing of redox reactions through the animation display	disagree	28.1%	29.8%	28.9%
	strongly disagree	36.6%	37.1%	36.8%
	agree	7.2%	4.8%	6.1%
	strongly agree	28.1%	28.2%	28.2%
Total		100.0%	100.0%	100.0%

My teacher has shown us electronegative and electropositive elements on the periodic table chart * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
My teacher has shown us electronegative and electropositive elements on the periodic table chart	disagree	10.5%	5.6%	8.3%
	strongly disagree	40.5%	37.9%	39.4%
	agree	28.1%	37.1%	32.1%
	strongly agree	20.9%	19.4%	20.2%
Total		100.0%	100.0%	100.0%

I hate redox reaction because it's too difficult to understand * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
I hate redox reaction because it's too difficult to understand	disagree	20.3%	21.0%	20.6%
	strongly disagree	17.0%	20.2%	18.4%
	agree	34.0%	32.3%	33.2%

	strongly agree	28.8%	26.6%	27.8%
Total		100.0%	100.0%	100.0%

I cannot write oxidizing agents because I have never seen it * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
I cannot write oxidizing agents because I have never seen it	disagree	17.0%	10.5%	14.1%
	strongly disagree	12.4%	12.1%	12.3%
	agree	30.1%	30.6%	30.3%
	strongly agree	40.5%	46.8%	43.3%
Total		100.0%	100.0%	100.0%

I love the oxidation-reduction topic because it's always explained with resource materials * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
I love the oxidation-reduction topic because it's always explained with resource materials	disagree	31.4%	25.0%	28.5%
	agree	34.6%	38.7%	36.5%
	strongly agree	34.0%	36.3%	35.0%
Total		100.0%	100.0%	100.0%

I can explain reduction as the addition of hydrogen because my teacher explained it using the hydrogen model * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
I can explain reduction as the addition of hydrogen because	disagree	60.8%	65.3%	62.8%
	strongly disagree	15.7%	18.5%	17.0%
	agree	11.1%	6.5%	9.0%

my teacher explained it using the hydrogen model	strongly agree	12.4%	9.7%	11.2%
Total		100.0%	100.0%	100.0%

My chemistry Teacher only copied the oxidation-reduction reaction topic on the board * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
My chemistry Teacher only copied the oxidation-reduction reaction topic on the board	disagree	17.0%	22.6%	19.5%
	strongly disagree	19.0%	20.2%	19.5%
	agree	47.7%	42.7%	45.5%
	strongly agree	16.3%	14.5%	15.5%
Total		100.0%	100.0%	100.0%

My chemistry teacher has shown us oxidizing agents in the laboratory * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
My chemistry teacher has shown us oxidizing agents in the laboratory	disagree	28.1%	27.4%	27.8%
	strongly disagree	63.4%	62.9%	63.2%
	strongly agree	8.5%	9.7%	9.0%
Total		100.0%	100.0%	100.0%

My chemistry explained electron transfer using the electron transfer model * Sex Crosstabulation

% within Sex

		Sex		Total
		Male	Female	
My chemistry explained electron transfer using the electron transfer model	disagree	56.9%	51.6%	54.5%
	strongly disagree	28.1%	31.5%	29.6%
	strongly agree	15.0%	16.9%	15.9%

Total	100.0%	100.0%	100.0%

(C)

Percentage of perceived use of resources by male and female students in oxidation-reduction reactions in public and private schools

```
CROSSTABS
  /TABLES=Sex BY st1 st2 st3 st4 st5 st6 st7 st8 st9 st10 st11 st12 st13 st14
st15 st16 st17 st18 st19 st20 BY School
  /FORMAT=AVALUE TABLES
  /CELLS=COLUMN
  /COUNT ROUND CELL.
```

Sex * The hydrogen model was used to explain oxidation as the removal of hydrogen in a redox reaction * School ownership Crosstabulation

% within The hydrogen model was used to explain oxidation as the removal of hydrogen in a redox reaction

School ownership			The hydrogen model was used to explain oxidation as the removal of hydrogen in a redox reaction			Total
			disagree	agree	strongly agree	
Public School	Sex	Male	63.2%	61.5%	61.8%	62.1%
		Female	36.8%	38.5%	38.2%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	51.2%	50.0%	47.4%	49.0%
		Female	48.8%	50.0%	52.6%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	57.0%	55.6%	54.2%	55.2%
		Female	43.0%	44.4%	45.8%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%

Sex * I have seen video clips of redox reaction * School ownership Crosstabulation

% within I have seen video clips of redox reaction

School ownership			I have seen video clips of redox reaction: disagree	strongly disagree	strongly agree	Total
Public School	Sex	Male	65.3%	56.3%	83.3%	62.1%
		Female	34.7%	43.7%	16.7%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	47.2%	48.1%	61.5%	49.0%
		Female	52.8%	51.9%	38.5%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	55.9%	52.0%	72.0%	55.2%
		Female	44.1%	48.0%	28.0%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%

Sex * The oxygen model was used to explain oxidation as the addition of oxygen in a redox reaction * School ownership Crosstabulation

% within The oxygen model was used to explain oxidation as the addition of oxygen in a redox reaction

School ownership			The oxygen model was used to explain oxidation as the addition of oxygen in a redox reaction: strongly disagree	agree	strongly agree	Total
Public School	Sex	Male	60.0%	58.8%	63.9%	62.1%
		Female	40.0%	41.2%	36.1%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	56.3%	44.7%	49.5%	49.0%
		Female	43.8%	55.3%	50.5%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	58.1%	51.4%	56.3%	55.2%
		Female	41.9%	48.6%	43.7%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%

Sex * I have not watched animations of the redox reaction * School ownership Crosstabulation

% within I have not watched animations of the redox reaction

School ownership			I have not watched animations of the redox reaction: disagree	strongly disagree	strongly agree	Total
Public School	Sex	Male	75.0%	58.3%	64.1%	62.1%
		Female	25.0%	41.7%	35.9%	37.9%

	Total		100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	55.6%	47.8%	49.3%	49.0%
		Female	44.4%	52.2%	50.7%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	64.7%	52.8%	56.4%	55.2%
		Female	35.3%	47.2%	43.6%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%

Sex * The electronegative model is used to show electronegative elements in redox reactions * School ownership Crosstabulation

% within The electronegative model is used to show electronegative elements in redox reactions

School ownership			The electronegative model is used to show electronegative elements in redox reactions			Total
			disagree	agree	strongly agree	
Public School	Sex	Male	58.1%	59.3%	69.0%	62.1%
		Female	41.9%	40.7%	31.0%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	48.6%	48.4%	50.0%	49.0%
		Female	51.4%	51.6%	50.0%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	53.0%	53.7%	59.1%	55.2%
		Female	47.0%	46.3%	40.9%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%

Sex * The oxidation number model shows how to calculate the oxidation number in a redox reaction * School ownership Crosstabulation

% within The oxidation number model shows how to calculate the oxidation number in a redox reaction

School ownership			The oxidation number model shows how to calculate the oxidation number in a redox reaction			Total
			disagree	agree	strongly agree	
Public School	Sex	Male	61.1%	60.6%	66.7%	62.1%
		Female	38.9%	39.4%	33.3%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	48.7%	49.3%	48.5%	49.0%
		Female	51.3%	50.7%	51.5%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	54.7%	54.7%	57.1%	55.2%
		Female	45.3%	45.3%	42.9%	44.8%

Total	100.0%	100.0%	100.0%	100.0%

Sex * A beaker and test tubes were used as an apparatus to test for oxidizing and reducing agents * School ownership Crosstabulation

% within A beaker and test tubes were used as an apparatus to test for oxidizing and reducing agents

			A beaker and test tubes were used as an apparatus to test for oxidizing and reducing agents				
School ownership			disagree	strongly disagree	agree	strongly agree	Total
Public School	Sex	Male	50.0%	66.7%	65.6%	56.3%	62.1%
		Female	50.0%	33.3%	34.4%	43.8%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	42.9%	51.7%	49.3%	48.6%	49.0%
		Female	57.1%	48.3%	50.7%	51.4%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	46.2%	58.9%	57.0%	52.2%	55.2%
		Female	53.8%	41.1%	43.0%	47.8%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%

Sex * Potassium iodide is a reducing agent in the laboratory * School ownership Crosstabulation

% within Potassium iodide is a reducing agent in the laboratory

			Potassium iodide is a reducing agent in the laboratory				
School ownership			disagree	strongly disagree	agree	strongly agree	Total
Public School	Sex	Male	63.2%	64.3%	60.0%	63.6%	62.1%
		Female	36.8%	35.7%	40.0%	36.4%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	47.6%	48.4%	51.7%	41.7%	49.0%
		Female	52.4%	51.6%	48.3%	58.3%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	55.0%	55.9%	55.7%	52.2%	55.2%
		Female	45.0%	44.1%	44.3%	47.8%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%

Sex * I have watched how electrons are transferred in video clips * School ownership Crosstabulation

% within I have watched how electrons are transferred in video clips

School ownership			I have watched how electrons are transferred in video clips: disagree	strongly disagree	agree	strongly agree	Total
Public School	Sex	Male	59.1%	57.4%	64.9%	75.0%	60.9%
		Female	40.9%	42.6%	35.1%	25.0%	39.1%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	45.8%	49.3%	46.3%	55.6%	48.2%
		Female	54.2%	50.7%	53.7%	44.4%	51.8%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	52.2%	53.1%	55.1%	64.7%	54.3%
		Female	47.8%	46.9%	44.9%	35.3%	45.7%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%

Sex * Potassium manganate (VII) is an oxidizing agent in the laboratory * School ownership Crosstabulation

% within Potassium manganate (VII) is an oxidizing agent in the laboratory

School ownership			Potassium manganate (VII) is an oxidizing agent in the laboratory: disagree	strongly disagree	agree	strongly agree	Total
Public School	Sex	Male	50.0%	55.9%	63.3%	67.9%	62.1%
		Female	50.0%	44.1%	36.7%	32.1%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	42.9%	47.4%	48.5%	51.7%	49.0%
		Female	57.1%	52.6%	51.5%	48.3%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	46.2%	51.4%	55.6%	59.5%	55.2%
		Female	53.8%	48.6%	44.4%	40.5%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%

Sex * My teacher illustrated how the oxidation number is calculated only on the board * School ownership Crosstabulation

% within My teacher illustrated how the oxidation number is calculated only on the board

School ownership			My teacher illustrated how the oxidation number is calculated only on the board: strongly disagree	agree	strongly agree	Total
Public School	Sex	Male	68.8%	65.2%	60.2%	62.1%
		Female	31.3%	34.8%	39.8%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%

Private School	Sex	Male	50.0%	56.0%	47.1%	49.0%
		Female	50.0%	44.0%	52.9%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	58.8%	60.4%	53.3%	55.2%
		Female	41.2%	39.6%	46.7%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%

Sex * I understood the balancing of redox reactions through the animation display * School ownership Crosstabulation

% within I understood the balancing of redox reactions through the animation display

School ownership			I understood the balancing of redox reactions through the animation display				Total
			disagree	strongly disagree	agree	strongly agree	
Public School	Sex	Male	60.5%	61.2%	75.0%	62.2%	62.1%
		Female	39.5%	38.8%	25.0%	37.8%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	47.6%	49.1%	55.6%	48.8%	49.0%
		Female	52.4%	50.9%	44.4%	51.2%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	53.8%	54.9%	64.7%	55.1%	55.2%
		Female	46.3%	45.1%	35.3%	44.9%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%

Sex * My teacher has shown us electronegative and electropositive elements on the periodic table chart * School ownership Crosstabulation

% within My teacher has shown us electronegative and electropositive elements on the periodic table chart

School ownership			My teacher has shown us electronegative and electropositive elements on the periodic table chart				Total
			disagree	strongly disagree	agree	strongly agree	
Public School	Sex	Male	73.3%	60.9%	57.6%	66.7%	62.1%
		Female	26.7%	39.1%	42.4%	33.3%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	62.5%	50.0%	42.9%	53.7%	49.0%
		Female	37.5%	50.0%	57.1%	46.3%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	69.6%	56.9%	48.3%	57.1%	55.2%

		Female	30.4%	43.1%	51.7%	42.9%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%

Sex * I hate redox reaction because it's too difficult to understand * School ownership Crosstabulation

% within I hate redox reaction because it's too difficult to understand

School ownership			I hate redox reaction because it's too difficult to understand				Total
			disagree	strongly disagree	agree	strongly agree	
Public School	Sex	Male	59.3%	58.3%	63.6%	64.9%	62.1%
		Female	40.7%	41.7%	36.4%	35.1%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	50.0%	44.4%	50.0%	50.0%	49.0%
		Female	50.0%	55.6%	50.0%	50.0%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	54.4%	51.0%	56.5%	57.1%	55.2%
		Female	45.6%	49.0%	43.5%	42.9%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%

Sex * I cannot write oxidizing agents because I have never seen it * School ownership Crosstabulation

% within I cannot write oxidizing agents because I have never seen it

School ownership			I cannot write oxidizing agents because I have never seen it				Total
			disagree	strongly disagree	agree	strongly agree	
Public School	Sex	Male	73.7%	62.5%	60.0%	59.6%	62.1%
		Female	26.3%	37.5%	40.0%	40.4%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	60.0%	50.0%	50.0%	44.4%	49.0%
		Female	40.0%	50.0%	50.0%	55.6%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	66.7%	55.9%	54.8%	51.7%	55.2%
		Female	33.3%	44.1%	45.2%	48.3%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%

Sex * I love the oxidation-reduction topic because it's always explained with resource materials * School ownership Crosstabulation

% within I love the oxidation-reduction topic because it's always explained with resource materials

School ownership			I love the oxidation-reduction topic because it's always explained with resource materials: disagree	agree	strongly agree	Total
Public School	Sex	Male	71.1%	53.3%	61.9%	62.1%
		Female	28.9%	46.7%	38.1%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	47.1%	51.8%	47.3%	49.0%
		Female	52.9%	48.2%	52.7%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	60.8%	52.5%	53.6%	55.2%
		Female	39.2%	47.5%	46.4%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%

Sex * I can explain reduction as the addition of hydrogen because my teacher explained it using the hydrogen model * School ownership Crosstabulation

% within I can explain reduction as the addition of hydrogen because my teacher explained it using the hydrogen model

School ownership			I can explain reduction as the addition of hydrogen because my teacher explained it using the hydrogen model: disagree	strongly disagree	agree	strongly agree	Total
Public School	Sex	Male	60.2%	59.1%	75.0%	66.7%	62.1%
		Female	39.8%	40.9%	25.0%	33.3%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	47.3%	44.0%	61.5%	56.3%	49.0%
		Female	52.7%	56.0%	38.5%	43.8%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	53.4%	51.1%	68.0%	61.3%	55.2%
		Female	46.6%	48.9%	32.0%	38.7%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%

Sex * My chemistry Teacher only copied the oxidation-reduction reaction topic on the board * School ownership Crosstabulation

% within My chemistry Teacher only copied the oxidation-reduction reaction topic on the board

School ownership			My chemistry Teacher only copied the oxidation-reduction reaction topic on the board				Total
			disagree	strongly disagree	agree	strongly agree	
Public School	Sex	Male	54.3%	66.7%	65.5%	60.0%	62.1%
		Female	45.7%	33.3%	34.5%	40.0%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	36.8%	40.7%	52.1%	57.1%	49.0%
		Female	63.2%	59.3%	47.9%	42.9%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	48.1%	53.7%	57.9%	58.1%	55.2%
		Female	51.9%	46.3%	42.1%	41.9%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%

Sex * My chemistry teacher has shown us oxidizing agents in the laboratory * School ownership Crosstabulation

% within My chemistry teacher has shown us oxidizing agents in the laboratory

School ownership			My chemistry teacher has shown us oxidizing agents in the laboratory			Total
			disagree	strongly disagree	strongly agree	
Public School	Sex	Male	62.2%	62.7%	58.3%	62.1%
		Female	37.8%	37.3%	41.7%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	50.0%	48.9%	46.2%	49.0%
		Female	50.0%	51.1%	53.8%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	55.8%	55.4%	52.0%	55.2%
		Female	44.2%	44.6%	48.0%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%

Sex * My chemistry explained electron transfer using the electron transfer model * School ownership Crosstabulation

% within My chemistry explained electron transfer using the electron transfer model

School ownership			My chemistry explained electron transfer using the electron transfer model	Total

			disagree	strongly disagree	strongly agree	
Public School	Sex	Male	66.7%	56.4%	57.1%	62.1%
		Female	33.3%	43.6%	42.9%	37.9%
	Total		100.0%	100.0%	100.0%	100.0%
Private School	Sex	Male	49.4%	48.8%	47.8%	49.0%
		Female	50.6%	51.2%	52.2%	51.0%
	Total		100.0%	100.0%	100.0%	100.0%
Total	Sex	Male	57.6%	52.4%	52.3%	55.2%
		Female	42.4%	47.6%	47.7%	44.8%
	Total		100.0%	100.0%	100.0%	100.0%

(D)

Bivariate Pearson Correlation between perceived use of resources and the achievement of students in oxidation-reductions

```
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Correlations

		Oxidation-reduction test
The hydrogen model was used to explain oxidation as the removal of hydrogen in a redox reaction	Pearson Correlation	.105
	Sig. (2-tailed)	.080
	N	277
I have seen video clips of redox reaction	Pearson Correlation	-.134*
	Sig. (2-tailed)	.026
	N	277
The oxygen model was used to explain oxidation as the addition of oxygen in a redox reaction	Pearson Correlation	.069
	Sig. (2-tailed)	.250
	N	277
I have not watched animations of the redox reaction	Pearson Correlation	.158**
	Sig. (2-tailed)	.008
	N	277
The electronegative model is used to show electronegative elements in redox reactions	Pearson Correlation	-.079
	Sig. (2-tailed)	.190
	N	277
	Pearson Correlation	-.095

The oxidation number model shows how to calculate the oxidation number in a redox reaction	Sig. (2-tailed) N	.116 277
A beaker and test tubes were used as an apparatus to test for oxidizing and reducing agents	Pearson Correlation Sig. (2-tailed) N	-.391** .000 277
Potassium iodide is a reducing agent in the laboratory	Pearson Correlation Sig. (2-tailed) N	-.634** .000 277
I have watched how electrons are transferred in video clips	Pearson Correlation Sig. (2-tailed) N	.147* .016 269
Potassium manganate (VII) is an oxidizing agent in the laboratory	Pearson Correlation Sig. (2-tailed) N	-.135* .025 277
My teacher illustrated how the oxidation number is calculated only on the board	Pearson Correlation Sig. (2-tailed) N	.239** .000 277
I understood the balancing of redox reactions through the animation display	Pearson Correlation Sig. (2-tailed) N	-.382** .000 277
My teacher has shown us electronegative and electropositive elements on the periodic table chart	Pearson Correlation Sig. (2-tailed) N	-.212** .000 277
I hate redox reaction because it’s too difficult to understand	Pearson Correlation Sig. (2-tailed) N	-.103 .087 277
I cannot write oxidizing agents because I have never seen it	Pearson Correlation Sig. (2-tailed) N	.283** .000 277
I love the oxidation-reduction topic because it’s always explained with resource materials	Pearson Correlation Sig. (2-tailed) N	-.215** .000 277
I can explain reduction as the addition of hydrogen because my teacher explained it using the hydrogen model	Pearson Correlation Sig. (2-tailed) N	-.207** .001 277
My chemistry Teacher only copied the oxidation-reduction reaction topic on the board	Pearson Correlation Sig. (2-tailed) N	-.080 .183 277
My chemistry teacher has shown us oxidizing agents in the laboratory	Pearson Correlation Sig. (2-tailed) N	-.142* .018 277
My chemistry explained electron transfer using the electron transfer model	Pearson Correlation Sig. (2-tailed) N	-.096 .110 277
Oxidation-reduction test	Pearson Correlation Sig. (2-tailed) N	1 277

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Hypothesis Two: There is no significant relationship between the perceived use of resources and the achievement of male and female students in the different types of schools.

Private Schools

Female

```
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Correlations

		Oxidation-reduction test
The hydrogen model was used to explain oxidation as the removal of hydrogen in a redox reaction	Pearson Correlation	.217
	Sig. (2-tailed)	.063
	N	74
I have seen video clips of redox reaction	Pearson Correlation	-.138
	Sig. (2-tailed)	.242
	N	74
The oxygen model was used to explain oxidation as the addition of oxygen in a redox reaction	Pearson Correlation	.044
	Sig. (2-tailed)	.711
	N	74
I have not watched animations of the redox reaction	Pearson Correlation	.027
	Sig. (2-tailed)	.820
	N	74
The electronegative model is used to show electronegative elements in redox reactions	Pearson Correlation	-.179
	Sig. (2-tailed)	.126
	N	74
The oxidation number model shows how to calculate the oxidation number in a redox reaction	Pearson Correlation	-.198
	Sig. (2-tailed)	.091
	N	74
A beaker and test tubes were used as an apparatus to test for oxidizing and reducing agents	Pearson Correlation	-.379**
	Sig. (2-tailed)	.001
	N	74
Potassium iodide is a reducing agent in the laboratory	Pearson Correlation	-.515**
	Sig. (2-tailed)	.000
	N	74
I have watched how electrons are transferred in video clips	Pearson Correlation	.158
	Sig. (2-tailed)	.180
	N	74
Potassium manganate (VII) is an oxidizing agent in the laboratory	Pearson Correlation	-.252*
	Sig. (2-tailed)	.031
	N	74
My teacher illustrated how the oxidation number is calculated only on the board	Pearson Correlation	.113
	Sig. (2-tailed)	.340
	N	74
I understood the balancing of redox reactions through the animation display	Pearson Correlation	-.362**
	Sig. (2-tailed)	.002

	N	74
My teacher has shown us electronegative and electropositive elements on the periodic table chart	Pearson Correlation Sig. (2-tailed) N	-.175 .135 74
I hate redox reaction because it's too difficult to understand	Pearson Correlation Sig. (2-tailed) N	-.251* .031 74
I cannot write oxidizing agents because I have never seen it	Pearson Correlation Sig. (2-tailed) N	.196 .094 74
I love the oxidation-reduction topic because it's always explained with resource materials	Pearson Correlation Sig. (2-tailed) N	-.089 .452 74
I can explain reduction as the addition of hydrogen because my teacher explained it using the hydrogen model	Pearson Correlation Sig. (2-tailed) N	-.247* .034 74
My chemistry Teacher only copied the oxidation-reduction reaction topic on the board	Pearson Correlation Sig. (2-tailed) N	.038 .748 74
My chemistry teacher has shown us oxidizing agents in the laboratory	Pearson Correlation Sig. (2-tailed) N	-.139 .238 74
My chemistry explained electron transfer using the electron transfer model	Pearson Correlation Sig. (2-tailed) N	-.146 .214 74
Oxidation-reduction test	Pearson Correlation Sig. (2-tailed) N	1 74

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Male

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Correlations

		Oxidation-reduction test
The hydrogen model was used to explain oxidation as the removal of hydrogen in a redox reaction	Pearson Correlation Sig. (2-tailed) N	.014 .906 71
I have seen video clips of redox reaction	Pearson Correlation Sig. (2-tailed) N	-.145 .227 71
The oxygen model was used to explain oxidation as the addition of oxygen in a redox reaction	Pearson Correlation Sig. (2-tailed) N	.048 .689 71

I have not watched animations of the redox reaction	Pearson Correlation Sig. (2-tailed) N	.271* .022 71
The electronegative model is used to show electronegative elements in redox reactions	Pearson Correlation Sig. (2-tailed) N	.010 .935 71
The oxidation number model shows how to calculate the oxidation number in a redox reaction	Pearson Correlation Sig. (2-tailed) N	-.060 .620 71
A beaker and test tubes were used as an apparatus to test for oxidizing and reducing agents	Pearson Correlation Sig. (2-tailed) N	-.358** .002 71
Potassium iodide is a reducing agent in the laboratory	Pearson Correlation Sig. (2-tailed) N	-.675** .000 71
I have watched how electrons are transferred in video clips	Pearson Correlation Sig. (2-tailed) N	.125 .308 68
Potassium manganate (VII) is an oxidizing agent in the laboratory	Pearson Correlation Sig. (2-tailed) N	-.019 .877 71
My teacher illustrated how the oxidation number is calculated only on the board	Pearson Correlation Sig. (2-tailed) N	.298* .012 71
I understood the balancing of redox reactions through the animation display	Pearson Correlation Sig. (2-tailed) N	-.412** .000 71
My teacher has shown us electronegative and electropositive elements on the periodic table chart	Pearson Correlation Sig. (2-tailed) N	-.144 .232 71
I hate redox reaction because it's too difficult to understand	Pearson Correlation Sig. (2-tailed) N	-.007 .957 71
I cannot write oxidizing agents because I have never seen it	Pearson Correlation Sig. (2-tailed) N	.287* .015 71
I love the oxidation-reduction topic because it's always explained with resource materials	Pearson Correlation Sig. (2-tailed) N	-.133 .270 71
I can explain reduction as the addition of hydrogen because my teacher explained it using the hydrogen model	Pearson Correlation Sig. (2-tailed) N	-.209 .081 71
My chemistry Teacher only copied the oxidation-reduction reaction topic on the board	Pearson Correlation Sig. (2-tailed) N	-.114 .342 71
My chemistry teacher has shown us oxidizing agents in the laboratory	Pearson Correlation Sig. (2-tailed) N	-.180 .133 71
My chemistry explained electron transfer using the electron transfer model	Pearson Correlation Sig. (2-tailed) N	-.076 .531 71
Oxidation-reduction test	Pearson Correlation Sig. (2-tailed) N	1 71

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Public School

Female

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Correlations

		Oxidation-reduction test
The hydrogen model was used to explain oxidation as the removal of hydrogen in a redox reaction	Pearson Correlation	.166
	Sig. (2-tailed)	.249
	N	50
I have seen video clips of redox reaction	Pearson Correlation	-.137
	Sig. (2-tailed)	.343
	N	50
The oxygen model was used to explain oxidation as the addition of oxygen in a redox reaction	Pearson Correlation	.080
	Sig. (2-tailed)	.582
	N	50
I have not watched animations of the redox reaction	Pearson Correlation	.104
	Sig. (2-tailed)	.471
	N	50
The electronegative model is used to show electronegative elements in redox reactions	Pearson Correlation	-.233
	Sig. (2-tailed)	.103
	N	50
The oxidation number model shows how to calculate the oxidation number in a redox reaction	Pearson Correlation	-.080
	Sig. (2-tailed)	.583
	N	50
A beaker and test tubes were used as an apparatus to test for oxidizing and reducing agents	Pearson Correlation	-.466**
	Sig. (2-tailed)	.001
	N	50
Potassium iodide is a reducing agent in the laboratory	Pearson Correlation	-.689**
	Sig. (2-tailed)	.000
	N	50
I have watched how electrons are transferred in video clips	Pearson Correlation	.153
	Sig. (2-tailed)	.289
	N	50
Potassium manganate (VII) is an oxidizing agent in the laboratory	Pearson Correlation	-.244
	Sig. (2-tailed)	.088
	N	50
My teacher illustrated how the oxidation number is calculated only on the board	Pearson Correlation	.347*
	Sig. (2-tailed)	.013
	N	50
I understood the balancing of redox reactions through the animation display	Pearson Correlation	-.421**
	Sig. (2-tailed)	.002
	N	50
My teacher has shown us electronegative and electropositive elements on the periodic table chart	Pearson Correlation	-.438**
	Sig. (2-tailed)	.001
	N	50
I hate redox reaction because it's too difficult to understand	Pearson Correlation	-.167

	Sig. (2-tailed)	.246
	N	50
I cannot write oxidizing agents because I have never seen it	Pearson Correlation	.513**
	Sig. (2-tailed)	.000
	N	50
I love the oxidation-reduction topic because it's always explained with resource materials	Pearson Correlation	-.258
	Sig. (2-tailed)	.070
	N	50
I can explain reduction as the addition of hydrogen because my teacher explained it using the hydrogen model	Pearson Correlation	-.261
	Sig. (2-tailed)	.067
	N	50
My chemistry Teacher only copied the oxidation-reduction reaction topic on the board	Pearson Correlation	-.214
	Sig. (2-tailed)	.135
	N	50
My chemistry teacher has shown us oxidizing agents in the laboratory	Pearson Correlation	-.098
	Sig. (2-tailed)	.498
	N	50
My chemistry explained electron transfer using the electron transfer model	Pearson Correlation	-.002
	Sig. (2-tailed)	.986
	N	50
Oxidation-reduction test	Pearson Correlation	1
	Sig. (2-tailed)	
	N	50

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Male

```
CORRELATIONS
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Correlations

		Oxidation-reduction test
The hydrogen model was used to explain oxidation as the removal of hydrogen in a redox reaction	Pearson Correlation	.043
	Sig. (2-tailed)	.704
	N	82
I have seen video clips of redox reaction	Pearson Correlation	-.114
	Sig. (2-tailed)	.309
	N	82
The oxygen model was used to explain oxidation as the addition of oxygen in a redox reaction	Pearson Correlation	.103
	Sig. (2-tailed)	.358
	N	82
I have not watched animations of the redox reaction	Pearson Correlation	.216
	Sig. (2-tailed)	.051
	N	82
The electronegative model is used to show electronegative elements in redox reactions	Pearson Correlation	.024
	Sig. (2-tailed)	.833
	N	82
The oxidation number model shows how to calculate the oxidation number in a redox reaction	Pearson Correlation	-.043
	Sig. (2-tailed)	.704
	N	82

A beaker and test tubes were used as an apparatus to test for oxidizing and reducing agents	Pearson Correlation Sig. (2-tailed) N	-.396** .000 82
Potassium iodide is a reducing agent in the laboratory	Pearson Correlation Sig. (2-tailed) N	-.702** .000 82
I have watched how electrons are transferred in video clips	Pearson Correlation Sig. (2-tailed) N	.174 .128 78
Potassium manganate (VII) is an oxidizing agent in the laboratory	Pearson Correlation Sig. (2-tailed) N	-.053 .637 82
My teacher illustrated how the oxidation number is calculated only on the board	Pearson Correlation Sig. (2-tailed) N	.247* .025 82
I understood the balancing of redox reactions through the animation display	Pearson Correlation Sig. (2-tailed) N	-.363** .001 82
My teacher has shown us electronegative and electropositive elements on the periodic table chart	Pearson Correlation Sig. (2-tailed) N	-.335** .002 82
I hate redox reaction because it’s too difficult to understand	Pearson Correlation Sig. (2-tailed) N	-.014 .898 82
I cannot write oxidizing agents because I have never seen it	Pearson Correlation Sig. (2-tailed) N	.227* .041 82
I love the oxidation-reduction topic because it’s always explained with resource materials	Pearson Correlation Sig. (2-tailed) N	-.406** .000 82
I can explain reduction as the addition of hydrogen because my teacher explained it using the hydrogen model	Pearson Correlation Sig. (2-tailed) N	-.134 .229 82
My chemistry Teacher only copied the oxidation-reduction reaction topic on the board	Pearson Correlation Sig. (2-tailed) N	-.116 .301 82
My chemistry teacher has shown us oxidizing agents in the laboratory	Pearson Correlation Sig. (2-tailed) N	-.149 .181 82
My chemistry explained electron transfer using the electron transfer model	Pearson Correlation Sig. (2-tailed) N	-.127 .256 82
Oxidation-reduction test	Pearson Correlation Sig. (2-tailed) N	1 82

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Hypothesis Three: The contribution of sex, type of school, and level of perceived use of resources to students' achievement in oxidation-reduction reaction will not be significantly different.

Relative contribution of sex, type of school, and level of perceived use of resources to students' achievement in oxidation-reduction reaction

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  /DEPENDENT Test
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Regression

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Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Perceived use of Resources, School ownership, Sex[b]	.	Enter

a. Dependent Variable: Oxidation-reduction test

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.457[a]	.209	.201	1.71286

a. Predictors: (Constant), Perceived use of Resources, School ownership, Sex

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	211.945	3	70.648	24.080	.000[b]
	Residual	800.950	273	2.934		
	Total	1012.895	276			

a. Dependent Variable: Oxidation-reduction test

b. Predictors: (Constant), Perceived use of Resources, School ownership, Sex

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	7.041	.754		9.333	.000
	Sex	.200	.209	.052	.956	.340
	School ownership	.355	.208	.093	1.708	.089
	Perceived use of Resources	-1.896	.230	-.444	-8.247	.000

a. Dependent Variable: Oxidation-reduction test