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Article

Eliciting and Correcting Science Education Undergraduates Misconceptions about Electrolysis in Rivers State Nigeria through Drama: An Imperative for 21st Century Chemistry Education in the Post-Covid-19 Era

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Abstract: This study explores eliciting science education undergraduates' misconceptions about electrolysis in Rivers State, Nigeria and correcting these misconceptions using drama strategy. Mixed method design was adopted. The sample comprised 94 first year science education undergraduates in Ignatius Ajuru University of Education. Three research questions and two hypotheses guided the study. The instruments were a four-tier Misconceptions Diagnostics Test with reliability coefficient of 0.88 and interview schedule. Research questions were answered using percentages and graphs while hypotheses were tested at 0.05 level of significance using ANCOVA. Results revealed high extents of misconceptions about electrolysis with regards to identifying anode and cathode, cation and anions, ions selectively discharged at the electrodes, reactions at electrodes, and writing half- cell and overall chemical equations for electrolysis among science education undergraduates. These misconceptions were corrected on the use of drama strategy in teaching as the high extents were remarkably reduced after treatment confirming its effectiveness. There was a significant difference in extents of misconceptions of the learners taught electrolysis with drama approach and those with lecture method. No significant gender related differences was established. It was recommended among others that proper blend of drama and other teaching strategies should be adopted to assist students relate abstract concepts to real life phenomenon.

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1. Introduction

The adverse effect of the global pandemic popularly called COVID-19 which ravaged the whole world between 2019 and 2020 has been so tremendous in almost all sectors of the economy in the world. The attendant uncontrollable death rate shifted government, cooperate bodies and individuals' attention towards providing vaccine that could prevent and possibly cure the sickness as a means of saving human lives. Despite the fact that the spread and effect has been drastically reduced with the provision of COVID- 19 protective vaccine, the aftermath of this pandemic has ushered every sector in the period of recovery characterized by restructuring and reformation. The education sector is involved in the ongoing reformation taking into consideration issues related to the teaching and learning of science concepts to cushion the adverse effect.

The concept of electrolysis involves movement of electrons and interaction between particles in the form of atoms, ions and molecules which exist at microscopic level of chemical phenomenon and is not only invisible but cannot be touched nor felt in the physical sense (Johnstone & Johnstone, 1991). This makes the concept abstract in nature as they are different from the daily experiences in the natural world. Proper understanding of the process of electrolysis requires higher order and critical thinking ability to establish proper links between the microscopic, macroscopic and the symbolic levels of chemical phenomena to be able to translate the chemical process into chemical equations and symbols (Li Bong, 2016; Osman & Lee, 2014).

Misconception is "the old, the bad, and the ugly" of prior knowledge, ideas, or conceptions that learners have. It can be viewed as existent knowledge of the students that regulate the reception of new information heaping to a bigger pile of faulty learning (Lamichhane et al., 2018). Students are emotionally and intellectually attached to misconceptions embedded in their cognitive structures and are resistant to change. these deeply-rooted misconceptions create 'cognitive conflicts' while students acquire new knowledge in the learning, process and impedes a healthy learning process when students tend to reject them with hesitancy (Chen et al.2020; Wartono et al., 2018; Unal et al., 2010).

Many factors contribute to the students' misconceptions in electrolysis. language usage, either in the textbook or in the teaching process is a potential source of misconceptions about scientific concepts. Ideally, chemical terms are unique to the members of the scientific community since the words and terms are not general terms familiar to students in their daily life. Therefore, presentation of chemistry concepts to the students usually sound strange even when repeated over since available knowledge is insufficient to support the explanation of the concept presented (Li Bong, 2016).

Simplification of electrolysis concept is a major source of students' misconceptions in chemistry. Students present understanding of chemical knowledge has been considered before coming to the classroom has been found to be grossly inadequate to explain concepts in a way that is generally suitable by the scientific community (Etokeren & Abosede, 2021). Therefore, teachers in a bid to facilitate understanding in students resort to over-simplification of concepts which constitute a potential source of misconceptions among students**.** It is often difficult to explain something which is not visible and has little or no accurate resemblance reality. In attempting to illustrate a chemical bond between two atoms, two spheres are erroneously connected together by a line which represent a bond (Lamichhane et al., 2018).

Bad chemistry is a product of teachers' lack of good understanding of chemical concepts and principles which itself constitute misconceptions. In most cases, apart from the fact that such teachers are unaware of the misconceptions held by students, they carry with them wrong chemistry concepts without realizing it. Although the constructivist approach to teaching science which lay emphasis on identifying students' misconceptions and inquiry has been widely advocated, it is rarely practiced by teachers. However, conventional lecture method train students to accept whatever is taught with much emphasis on keeping within the frame-work of the syllabus making them to be examination-smart but lack the assurance to look for information appears to be adopted in most schools (Roy & Mohapatra, 2022; Moodley & Gaigher, 2019). Another source of misconception in science is vernacular misconceptions. These are misconceptions that arise as a result of the diversity in culture and language which influences individuals' opinions causing students to differ quite significantly in a learning environment. Generally, the major source of this type of misconceptions is vernacular translations.

Drama as a teaching strategy is widely acknowledged in arts and social sciences. Nevertheless, its application in science teaching is uncommon. Saricayir (2010) defined drama as innovative activity done with the personal skills of individuals. It is one of the most popular forms of art. Apart from the use of drama in teaching basic science concepts at the early stage education, drama is rarely used in teaching science concepts at the secondary or university levels of education. The process of dramatizing scientific ideas is a particular type of modeling. During drama, people create imaginary worlds which allow them to link their own experiences with the unknown outer worlds. This world according to Abed (2016) is the world of image and the world of reality. The essential characteristics of science drama are 'live-ness', fairly independent and careful explanation of mind. It is displayed in the 'present' tense and 'action' of partakers (Abed, 2016).

There are various models of teaching science using drama. Duveen and Solomon (1994) proposed two strategies for teaching science through drama. These are:

1. Social simulations and
2. Physical simulations.

Social simulations have the potential of conveying knowledge through empathy. This helps students to understand the points of view of others and understand students' feelings towards scientific and technological issues. This strategy is useful in engaging students with studying the impact of science and technology on society using some activities, such as role play, debates, and consensus conferences.

Science drama is based on sound scientific notion, irrespective of its kind and precise educational objectives. There are three ways science drama can be used in the classroom. It can be planned as background, giving suitable background for learning, drama making as a process and finally drama as a demonstration which suggest an evaluation prospect (Yoon, 2006). Furthermore, drama making is as learning process which takes into consideration the fact that learning occurs in the course of planning of science drama. Thirdly, drama as an image that offers an assessment prospect.

Drama has a wide range of applications in the teaching and learning of science, mostly abstract concepts. Emphasizing on the relevance of drama in science teaching, Yoon (2004) maintained that the usage of drama in teaching scientific ideas provides undergraduates the opportunity to make their understanding concrete and personal rather than transmitting knowledge from the teacher or textbooks to students. Science drama creates great occasion to students to chat, express, adjust and assess their scientific knowledge and thought resulting in unauthoritative learning environment.

The story of science drama allows empathetic learning while the 'liveness' from existent action of members' aid students' participation and communication with the story as opposed to written texts or multimedia animation. Liveliness of science drama can be likened to investigation or demonstration. Furthermore, the use of drama in teaching science enhances learning of cognitive, affective and technical aims, particularly higher order thinking abilities connecting to analysis, synthesis, and evaluation. The use of drama facilitates significant learning and help chances for 'collaborative dialogue' and student-centered learning. It inculcates high motivation among students as they have the perceptions of empowerment and ownership during the process of dramatizing (Ellington et al., 1981).

Science drama can be classified in many ways. The various categorizations of drama in science teaching permit science teachers to usage any of the aforesaid categories. As such, they can choose one or adapt any educational purpose. For instance, Odegaard (2003) classified science drama via science education dimensions into three: science as a product, the process and nature of science, science as an institution in society. Yoon (2004) based classified science drama into science concept, science character, science history, science debate and science expression. Practical application of science drama in classroom can be carried out in three ways. Firstly, as setting the scene, providing beneficial context for learning. for instance, the performance of short time drama either prepared or unprepared with proper learning actions like dialogue or experiment can be used to stimulate learning activity. Secondly, drama as a learning process meaning that learning happens in the course of preparation of science drama and thirdly, drama can be used for assessment.

Few researches addressed students' misconceptions about electrolysis in chemistry. Findings of the study of Li Bong (2016) reveal students' misconceptions in recognizing the anode and cathode, analyzing the reaction in the electrolysis of molten compounds and aqueous solutions, and writing chemical equations form four secondary school students in Sibu, Sarawak**.** Lack of simple understanding in electrochemistry, language problems, and applying memorization was recognized as reasons behind the students' misconceptions in learning electrochemistry.

Findings of Dorsah and Yaayin (2019) in a study to ascertain misconceptions that learners have about electrochemistry notions and how they can be changed using conceptual change texts and quasi-experimental design at Damongo Senior High School Savannah region of Ghana revealed that students have several misconceptions concerning electrochemistry concepts, suggest that conceptual change texts aided students to adjust their prior conceptions or misconceptions for scientifically suitable ones. There was significant difference between percentages of misconceptions of learners in experimental and control clusters after action. Students' misconceptions addressed recognizing the anode and cathode of galvanic cells, functions of the salt bridge, movement of ions in electrochemical cells and reactions occurring at the cells. The outcomes also revealed that for both experimental and control groups no student had sound knowledge of the electrochemistry concepts tested. The investigation also shown that some misconceptions were thought by a significant number of learners even after the teaching using conceptual modification texts. The most significant misconceptions known are; that the function of the salt bridge is to permit electron flow, the anode in an electrochemical cell is always on the left, in an electrochemical cell electrons migrate from one electrode to the other through the salt bridge, in an electrochemical cell anions move from anode to cathode, the cathode in an electrochemical cell is always on the right, and in an electrochemical cell oxidation happens at the cathode and reduction. Taha (2014) found that students held various misconceptions about electrochemistry such as in the course of electrolysis, the electric current yields ions; electrons migrate through the solution from one electrode to the other; the cathode is always the minus pole, the anode the plus pole; and the plus and minus poles carry charges in a study on the effects of inductive teaching method in an electrochemistry class.

Statement of the Problem

Every Learners possess peculiar understanding of every event in the natural world which originate from collaboration with components of the environment and are enumerated in their minds as "personal ideas" and tenaciously maintained not minding the fact that they inadequate and different from generally acceptable point of view. In the course of teaching, these preconceived ideas impede with scientific concepts prompting students to create ideas that are dissimilar from the acceptable point of view called misconceptions. Ideally, misconceptions constitute a major difficulty to teaching and learning of science concepts. Independently from the fact that, misconceptions obstruct assimilation and accommodation of knowledge and provide a barrier to students' conceptual understanding, the problems of perceived concept difficult attitude of students towards sciences have also been attributed to misconception. Furthermore, misconceived ideas usually hinder concepts presented by the teacher and prevent understanding of the concept via students. It is widely acknowledged that learner's misconceptions can originate from a variety of different sources, nevertheless, the way science concepts are shown constitute pedagogic learning obstacles. Also, some teachers who possess different misconceptions about scientific act as potential sources of misconceptions because they transfer these erroneous ideas to the students in the course of teaching. The need to proffer answer to this problem by providing appropriate teaching strategies or methods that could possibly minimize or eliminate misconceptions about scientific concepts has triggers a lot research sciences. Although, there are a good number of studies in chemistry, the concept of electrolysis seems to be under explored as there are limited studies. Likewise, the few available studies focused mainly on secondary school students, without considering Science education undergraduate who are prospective teachers. This creates a gap in knowledge that necessitated the study.

Objectives of the Study

This study considered eliciting the misconceptions held by science education undergraduate about electrolysis and attempting to correct the misconceptions using drama teaching strategy. Specifically, the study predisposes to the:

1. Extent of science education undergraduates' misconceptions about electrolysis in Rivers State.
2. Extent of science education undergraduates' misconceptions about electrolysis when taught with drama strategy and lecture method.
3. Extent of male and female science education undergraduates' misconceptions about electrolysis when taught with drama strategy.

Research Questions

1. To what extent do science education undergraduates hold misconceptions about electrolysis in Rivers State?
2. To what extent do science education undergraduates differ in their misconceptions about electrolysis when taught with drama strategy and lecture method in Rivers State?
3. To what extent do male and female science education undergraduates differ in their misconceptions about electrolysis when taught with drama strategy in Rivers State?

Hypotheses

HO_1: There is no significant difference in the mean misconception scores of students when taught electrolysis with drama teaching strategy and lecture teaching method.

HO_2: There is no significant difference in the mean misconception scores of male and female science education undergraduates when taught electrolysis with drama teaching strategy.

Significance of the Study

The results of this study will be very useful to chemistry teachers, students and curriculum developers. The results of this study will provide a lead way to teachers in designing appropriate pedagogies that will help to eliminate students' misconceptions about electrolysis. Furthermore, the knowledge of students' preconceived ideas and erroneous connections about chemical concepts will be useful to teachers in planning lessons to achieve conceptual change towards appropriate scientific conceptions. The students stand a better chance of benefiting from these new strategies as it will not only make understanding of concept easy but also improve their performance in examinations. Recommendations of this study will provide curriculum designers useful information in improving on the existing curriculum by making appropriate recommendation for teaching the concept of electrolysis Finally, the findings of this study will be helpful to researchers, and also inform further research on misconceptions and other science concepts.

2. Materials and Methods

Mixed method research design was used in the study. In exploratory mixed method, qualitative method is carried out prior to quantitative method. After analyzing the qualitative data to determine pertinent themes and patterns, the findings are used to design a quantitative questionnaire that could be administered to a larger group of students (Morrell & Carroll, 2010). This design sought to survey the merging of evidence from different approaches that study the same phenomenon and has the advantage of improving validity of results and providing stronger evidence for drawing conclusion through collaboration of findings. The study was conducted during the 2nd semester of

2021/2022 academic session. The sample comprised 94 first year science education undergraduates in Ignatius Ajuru University of Education. The students were randomly assigned experimental and control group. Those in the experimental group were taught with "Drama Teaching Strategy" (DTS) according to the script of drama called "Electrolysis in Action (EIA)". Costumes designed to fit the various terms and process in electrolysis were prepared for the students according to the role they played in the drama. Students were allowed to choose the part they prefer to act and the scripts issued to them.

Several rehearsals were carried out under the teachers' guidance before the final presentation. Undergraduates in the control group were taught with Lecture Teaching Method (LTM). 15 undergraduates comprising of the high medium and average performing levels were interviewed. Clinical approach which involves one –one meeting with researcher and informant was adopted. The tools were: A Four-tier Electrolysis Misconceptions Diagnostic Test" (EMDT) and non- directive interview schedule adapted from Ünal, Bayram and Ayas (2010) and modified by the researcher. Four-tier misconception diagnostic test was chosen since it has benefit over other test by removing errors due to over estimation of students' misconception scores and the correct scores, underestimation of dearth of knowledge proportion, and predicting (Guriel & Eryiimaz, 2015). The reliability coefficient of 0.88 for the electrolysis misconceptions diagnostic test was determined by test retest method using Pearson Product Moment Correlation Coefficient formula. Carefully piloting of the interview schedule was carried out in addition to avoiding discussion and the use of scientific terms in order to ensure the reliability of the interview schedule. The researcher adapted and modified the scoring approach in a three-tier misconception test developed by Sen and Yilmaz (2017).

The misconceptions were also categorized into: Lack of Knowledge" (LK), False Positive (FP) and False Negative (FN) and misconception (MC) according to the classification of Guriel (2015). Misconception was assigned the highest score of 10points and lack of knowledge the least score of 2. Percentages were used to answer the research questions. Misconceptions selected as choice by 20% and above of the total students were considered high extent (HE) while those below were considered low extent (LE). The hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance. The null hypotheses were accepted when the calculated value, (Fcal. $P > 0.05$) is less than the table or critical value and rejected when the calculated value (Fcal. $P<.05$) is greater than the table or critical value. Analysis of Covariance (ANCOVA) as a statistical tool was preferred in this study because the pretests which may affect aspects of the experiment are statistically controlled in the procedures of covariance rather than simply comparing the post test scores.

3. Results

Interview Schedule

Misconception 1 & 2

R1 What do you think electrolysis is in your own idea?

S1 Electrolysis is when a substance decomposes when there is electric current passing

R2 I heard you mention "current passing" where does this current come from?

S2 It is produced at the battery or cell

R3 The how does it get to the electrolytic call?

S3 Through electrodes

R4 From your answer, the electrode is in plural, does it mean we have more than one type of electrode?

S4 Yes

R5 Can you mention them?

S5 Cathode and anode

R6 Are the same charge?

S6 No, the cathode is positive while the anode is negative
R7 Why do you think so?
S7 I don't know, but I just feel it should be so
R8 You earlier mentioned "current passing through" in one of your one of your answers, through which of them does it enter and leave the electrolytic cell?
S8 I think it move in through the cathode and leaves through the cathode
R9 Why do you think so?
S9 but I have told you before that I cannot truly describe, but I know I am correct

From the students' replies above, the students have a good knowledge of the basic terms and principles of the process of electrolysis (S1-S5). However, the student lack of proper understanding of the charges on the cathode and anode. It is his personal own idea; the cathode is positive while the anode is negative(S6). Also, the student was unable to identify the movement of electric current(S8). This could be due to the fact that the concepts were memorized (S7 and S9) and not personalized possible because dearth of proper understanding of the concept as reflected in their response when asked the reason *(R7 and R9).*

Conceptions 3, 4, 5 and 7

R1 What do you think is responsible for the flow of electric current, throughout the electrolyte?
S1 Sir, you know ions are produced during electrolysis where electrons are released into the solution, they circulate the electric current around the electrolyte to the electrons
R2 Why do you think so?
S2 Yes electric current is always carried by the movement of electrons because they are free to move. is the way it works.
R3 Now, in one of your responses, you said that "ions are produced during electrolysis and they circulate around" what really happens to the ions during electrolysis?
S3 Sir, I don't understand? Because I told you, they are in random motion and have no rest
R4 Which direction do the ions move to, and what happens when they get there
S4 Are you talking of positive ions and negative ions?
R5 Yes
S5 Sir, I think negative ions move to the cathode and Positive ions move to the anode,
R6 What are your reasons?
S6 Sir, the cathode is positive and negative ions are attracted, while the anode is negative and attracts the positive ion. This what decides their movement. They all loss or gain electron to change to the element.
R7 what really happened as ions arrive?
S7 Sir, I don't really know what happen, but I think they react and settle down at that cathode or anode by giving out or receiving electrons. I think so…
R8 You said "giving out and receiving electrons", which ion give out the electrons and which one accept the electrons
S6 negative ions loses electrons to form the element while positive ions gain electrons to form element

Students' responses above suggests lack of the basic understanding of what is responsible for circulating electric current throughout the electrolyte during electrolysis. In his conception, electrons are responsible instead of the actual movement of ions(S2) Also, although the basic understanding of electron gain by cations and electron loss by anions as the requirement for discharge or deposit of element at the electrode, proper knowledge of direction of flow of ions during electrolysis is lacking. The student seems to be confused as reflected in interchanging the direction of movement of ions. The basic understanding of the terminologies of electrolysis notwithstanding, the student answers seem to be a guess work since the question is direct.

Conception 6, 9

R1 what do we call the ions that migrate towards the cathode and the one to the anode?

S1 They are called cations and anions

R2 What are their charges?

S2 cations are negative ions and anions are positive ions?

R3 in your answer you also said they "react". Can you mention the type of reaction that occurs at the cathode and anode respectively?

S3 I think cathode is oxidation and anode reduction.

R4 consider electrolysis of dilute tetraoxoxsulphate (vi) acid otherwise called electrolysis of acidified water. Represent the reaction at the cathode and anode with balanced chemical.

S4 the half-cell equations for electrolysis of acidified water are:
cathode $O^{2-} + e \rightarrow O_2$, Anode $H+ + e- \rightarrow H_2$

R5 Write the overall redox equation for the
Overall redox equation is $O_2 + H_2 \rightarrow H_2O$

The responses of students above show poor knowledge of the direction of movement of ions during electrolysis and the charges on the ions respectively as well as the reactions occur at the anode and cathode respectively (S1, S2 and S3)

Research Question 1

To what extent do science education undergraduates hold misconceptions about electrolysis in Rivers State Tertiary Institutions?

Table 1: Science education undergraduates' misconceptions about chemical bonding in percentage (%)

S/N	Misconceptions	%	Decision
1	The anode is negative electrode and the cathode is positive electrode.	64.4	HE
2	Electric current enters the electrolytic cell through the cathode and leaves through the anode	10.2	LE
3	The negative terminal of the battery is connected to the anode and the positive terminal to the cathode.	13.3	HE
4	Electric currents through the electrolyte is carried by the flow of electrons in the electrolyte	90.55	HE
5	The negative ions move to the cathode where they lose their electrons to form the element.	72.1	HE
6	Oxidation reaction happens at the cathode while reduction reaction occurs at the anode	69.3	HE
7	Positive ions move to the anode, where they gain electrons to form the element	72.1	HE
8	The half-cell equation for electrolysis of acidified water are: cathode $O2- + e \rightarrow O_2$, Anode $H+ + e- \rightarrow H_2$	60.2	HE
9	Cation are negative ions while anions are positive ions	68.9	HE
10	Overall redox equation is $O_2 + H_2 \rightarrow H_2O$	94..4	HE

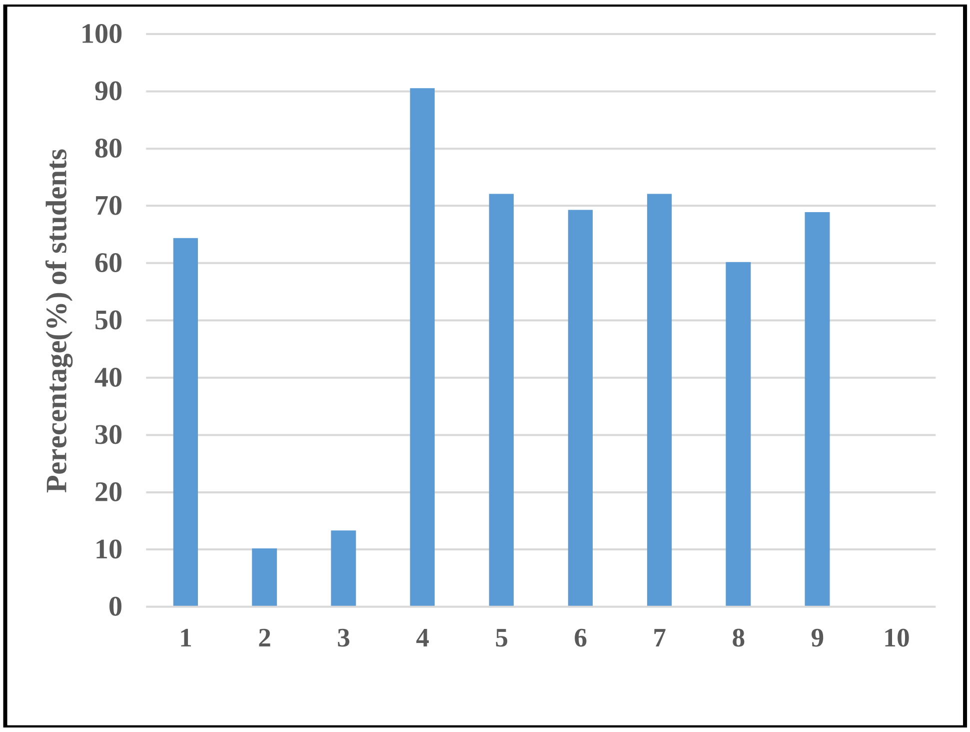

Figure 1: Science education undergraduates' misconceptions about electrolysis

From table 1 and figure 1, science education undergraduates to a high extent held misconceptions that: the anode is the negative electrode and the cathode is positive electrode. (64.4%), electric currents through the electrolyte is carried by the flow of electrons in the electrolyte (90.6%), the negative ions move to the cathode where they lose their electrons to form the element. (72.1%), oxidation reaction occurs at the cathode while reduction reaction occurs at the anode 69.3%, positive ions move to the anode, where they gain electrons to form the element (72.1%,) the half-cell equations for electrolysis of acidified water are:
cathode O^{2-} + e → O_2, Anode H+ + e- → H_2 60.2%, Cation are negative ions while anions are positive ions 689%, overall redox equation is $O_2 + H_2 \rightarrow H_2O$, 94.4%. But, misconceptions that electric current enters the electrolytic cell through the cathode and leaves through the anode 10.2%, the negative terminal of the battery is connected to the anode and the positive terminal to the cathode.13.3%, were held to a low extent.

Research Question 2

To what extent do science education undergraduates differ in their misconceptions about electrolysis when taught with drama strategy and lecture method in Rivers State?

Table 2: Pretest and Post test misconceptions of science education undergraduates about electrolysis in percentage (%)

S/N	Misconceptions	Pretest LTM	Pretest DTS	Posttest LMT	Posttest DTS
1	The anode is the negative electrode and the cathode is positive electrode.	67.6	61.2	60.4	15.3
2	Electric current enters the electrolytic cell through the cathode and leaves through the anode	11.1	9.4	9.1	2.1
3	The negative terminal of the battery is connected	16.4	10.	12.9	1.3
5	The negative ions move to the cathode where they lose their electrons to form the element.	78.8	65.4	68.8	2.8
6	Oxidation reaction occurs at the cathode while reduction reaction occurs at the anode	45.8	32.7	40.2	12.6
7	Positive ions move to the anode, where they gain electrons to form the element	78.8	65.6	73.8	18.6
8	The half-cell equation for electrolysis of acidified water are: cathode O2- + e ˅ O_2, Anode H+ + e- ˅ H_2	65.8	54.6	61.6	12.8
9	Cation are negative ions while anions are positive ions	69.2	67.4	64.5	2.4
10	Overall redox equation is $O_2 + H_2$ ˅ H_2O	93.2	96.4	91.5	0.5

LTM =Lecture Teaching Method, DTS = Drama Teaching Strategy.

Figure 2: Pretest and posttest misconception in percentages

From Table 2, before treatment, the pretest results show that science education undergraduates in the drama and lecture group held high extents of various misconception about electrolysis. Nevertheless, after treatment, the high extents of students' misconceptions in the drama class was remarkably reduced to low extents while that of the undergraduates in lecture method class persisted at high extents as shown in the post test scores.

Research Question 3

To what extent do male and female science education undergraduates hold misconceptions about electrolysis on teaching with drama strategy in Rivers State.

Table 3: Pretest and Posttest misconceptions of male and female science education undergraduates about electrolysis in percentage (%)

S/N	Misconceptions	Pretest Male	Pretest Female	Posttest Male	Posttest Female
1	The anode is negative electrode and the cathode is positive electrode.	68.8	59.4	12.1	10.3
2	Electric current enters the electrolytic cell through the cathode and leaves through the anode	11.9	8.7	1.4	3.1
3	The negative terminal of the battery is connected to the anode and the positive terminal to the cathode.	17.5	9.1	0.9	0.4
4	Currents are carried by the flow of electrons in the electrolyte	96.8	84.3	12.0	14.2
5	The negative ions move to the cathode where they lose their electrons to form the element.	81.0	63.2	1.3	3.6
6	Oxidation reaction occurs at the cathode while reduction reaction occurs at the anode	39.0	39.5	14.2	10.9

7	Positive ions move to the anode, where they gain electrons to form the element	62.0	82.4	10.2	18.6
8	The half-cell equation for electrolysis of acidified water are: cathode O2- + e- → O_2, Anode H+ + e- → H_2	73.5	46.7	9.3	16.5
9	Cation are negative ions while anions are positive ions	66.7	19.5	1.3	3.5
10	Overall redox equation is $O_2 + H_2 \rightarrow H_2O$	94.7	91.4	1.1	0.9

Figure 3: Pretest and posttest misconception of male and female Science education undergraduates

From Table 3 and figure 3a and3b before treatment, results of the pretest show that male and female science education undergraduates in the drama group held high extents of various misconception about electrolysis. Nevertheless, after treatment, the high extents of both male and female students' misconceptions about electrolysis was significantly reduced to low extents as shown in the post test scores.

Hypothesis 1

There is no significant difference in the mean misconception scores of students about electrolysis when taught with drama strategy and lecture method

Table 4: Analysis of Covariance (ANCOVA) of the mean misconception scores of students on teaching electrolysis with drama teaching strategy and also with lecture teaching method

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	13521.254	2	9801.645	86.923	.000
Intercept	3726.529	1	2546.356	43.567	.000
Pretest	6531.776	1	6384.654	65.124	.000
Treatment	6127.218	1	7234.231	48.345	.002
Error	12367.892	91	134.789		
Total	357645.112	94			
Corrected Total	33472.345	93			

Table 4 shows that $F(1,91) = 48.345$, $P<.05$, the null hypothesis which states that there is no significant difference in the mean misconception scores of students about electrolysis when taught with drama strategy and lecture method is rejected. This infer that there is a significant difference in the misconception of students about electrolysis when taught with drama strategy and lecture method

Hypothesis 2

There is no significant difference in the mean misconceptions of male and female students about electrolysis when taught with drama strategy

Table 5: Analysis of Covariance (ANCOVA) of mean misconception scores of male and female students about electrolysis when taught with drama strategy

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2569.270[a]	2	1978.701	17.210	.000
Intercept	175320.890	1	17367.496	141.912	.000
Pretest	457.127	1	354.238	2.756	.012
Gender	2358.652	1	1689.312	.987	.008

Error	10743.498	91	167.036
Total	418288.101	94	
Corrected Total	23973.786	93	

Table 5 shows that F (1, 91) = 0.987, $P>.05$. Therefore, the null hypothesis which states that there is no significant difference in the mean misconception scores of male and female students about electrolysis when taught with drama strategy is accepted. This implies that there is no significant difference in the mean misconception scores of male and female students about electrolysis when taught with drama strategy.

4. Discussion

Findings of this study revealed that science education undergraduates' misconceptions about electrolysis in Rivers State, Nigeria can be corrected through drama: an imperative for 21st century Chemistry education in the post-covid-19 era. The use of drama facilitates meaningful scientific learning and promote opportunities for 'interactive dialogue' and student-centered learning. It inculcates high motivation among students as they have the perceptions of empowerment and ownership during the process of dramatizing**.** Results of misconceptions diagnostic test and the interview schedule converged to reveal high extents of science undergraduates' misconceptions about electrolysis such as: the anode is negative electrode and the cathode is positive electrode. (64.4%), electric currents through the electrolyte is carried by the flow of electrons in the electrolyte (90.6%), the negative ions move to the cathode where they lose their electrons to form the element. (72.1%), oxidation reaction occurs at the cathode while reduction reaction occurs at the anode 69.3%, positive ions move to the anode, where they gain electrons to form the element (72.1%,) the half-cell equations for electrolysis of acidified water are:

cathode $O^{2-} + e \rightarrow O_2$, Anode $H+ + e- \rightarrow H_2$ 60.2%, Cation are negative ions while anions are positive ions 689%, overall redox equation is $O_2 + H_2 \rightarrow H_2O$, 94.4%. (Table1 and figure1)

The results corroborate the findings of Li Bong (2016) which revealed form four students' misconceptions with regards to recognizing the anode and cathode, analyzing the reaction in the electrolysis of molten compounds and aqueous solutions, and writing chemical equations of form fours students in Sibu, Sarawak. It further corroborates the findings of Dorsah and Yaayin (2019) which showed that, senior high school students have many misconceptions regarding electrochemistry concepts which centered on identifying the anode and cathode of galvanic cells, functions of the salt bridge, direction of flow of ions in electrochemical cells and reactions occurring at the cells in Damongo Savannah region of Ghana. The results of this study further collaborate that of Taha (2014) who found that students held various misconceptions about electrochemistry such: as during electrolysis, the electric current produces ions; electrons migrate through the solution from one electrode to the other; the cathode is always the minus pole, the anode the plus pole; and the plus and minus poles carry charges.

The results of research question 2 showed that, after treatment, the high extents of students' misconceptions about electrolysis were substantially reduced to low extents when taught with drama strategy while that of the undergraduates taught with lecture method persisted at high extents with minimal reduction (Table 2 and figure 2). Significant reduction of the high extents of undergraduate's misconceptions about electrolysis on teaching with drama strategy depicts a change in students' conception from their preconceived ideas to scientific ideas and confirms the correction of their misconceptions. The students arrived at the conceptual change by constructing new ideas that are consistent with the scientific ones by replacing the preconceived ideas with the new scientific idea or constructing new ideas form preconceived ideas. This is possibly due to that fact that dramatizing electrolysis concept offered the students a replica of what happens during electrolysis which happen at the microscopic level of the chemical phenomenon in a "fun and stress-free" environment which motivate and aroused their interest to study of electrolysis.

These results disagree with that of Dorsah and Yaayin (2019) which revealed persistence of some misconceptions after the instruction by conceptual change texts. The result of research question 3 revealed the significant reduction in, the high extents of both male and female students' misconceptions about electrolysis to low extents as shown (in Table 3 and figure 3). This infer that drama strategy is not gender selective giving credence to the use of the strategy in teaching science concepts as it enhances understanding of concepts, gender notwithstanding. The results of hypothesis 1 revealed a significant difference in students' misconception about electrolysis when taught with drama strategy and lecture method (Table 4). This infer that drama teaching strategy is effective in correcting students' misconceptions on electrolysis. These findings agree with that of Dorsah and Yaayin (2019) which suggest that conceptual change texts helped students to change their preexisting conceptions or misconceptions for scientifically acceptable ones as a significant difference between the percentages of misconceptions of students in the experimental and control groups after treatment at Damongo Senior High School Savannah region of Ghana was found. The results of hypothesis 2 in Table 5 showed that there is no significant difference in the mean misconception of male and female science education undergraduate on electrolysis when taught with drama strategy.

5. Recommendation

1. Teachers should embrace the use of drama in teaching relevant chemistry concepts mostly abstract ones.
2 Teachers should elicit students' misconceptions at the beginning of the lesson and address them using appropriate strategies.
3 Proper blending of drama and other teaching strategies should be adopted to assist students relate abstract concepts to real life phenomenon.

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