

# Exploring Teachers' Creativity in Improvisation of Instructional Materials in The Teaching and Learning of Chemistry Implication for the 21<sup>st</sup> Century Learners

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DOI: <https://dx.doi.org/10.47772/IJRISS.2024.8120252>

Received: 30 November 2024; Accepted: 13 December 2024; Published: 16 January 2025

## ABSTRACT

Teaching and learning of Chemistry in this 21<sup>st</sup> century is facing a number of unprecedented challenges especially in resource-constrained environments, where the teachers' creativity becomes the main stem for providing instructional materials. This study examined teachers' creativity in improvisation of instructional materials in the teaching and learning of Chemistry in secondary schools. The study was guided by four research questions and employed the descriptive survey research design. The population of the study comprised 34 Chemistry teachers in 30 government approved secondary schools in Nsukka Education zone of Enugu State, Nigeria. A sample of 20 Chemistry teachers used for the study was drawn using simple random sampling technique. One instrument "Chemistry Teachers' Improvisation of Instructional Materials Questionnaire (CTIIMQ)" was used for data collection. Data collected were analyzed using mean and standard deviation to answer all the research questions.

The findings of the study revealed that, the extent of improvisation of instructional materials for the teaching and learning of chemistry was very low. The findings also revealed that using improvised materials during the teaching sessions proved very helpful but was greeted with a number of challenges among which are; lack of creativity and the skill to design, time constraint, limited skills in improvisation, cost of locally sourced materials, lack of support, lack of policy statement to encourage teachers, large class size, among others. Finally, the findings also revealed some possible ways to ameliorate these challenges. Based on these, recommendations were made.

**Keywords:** Chemistry, Teaching and Learning, Instructional Materials, Improvisation and Creativity

## INTRODUCTION

The increasingly complex world of science and technology and enlarged subject contents has given rise to unprecedented challenges for the Chemistry teacher because there is need to impart chemistry knowledge that represents such, as well as enhance the acquisition of knowledge and skills that will enable the 21<sup>st</sup> century learner cope with the ever-changing dynamic world. These challenges are apparently seen in the area of materials and instruments needed by the chemistry teacher to teach the chemistry contents well to the learners. Such include but not limited to; Emerging new teaching facilities such as, laboratory facilities, classroom spaces, storage space for new equipment and materials, contemporary safety equipment and emergency response plans, access to water and electricity.

Textbooks, digital resources and multimedia materials, computers, tablets, or smartphones, insufficient internet connectivity and bandwidth are not left out, availability of fund for educational software and apps as videos, simulations, accessibility to online educational platforms and resources, limited access to training on technology integration, cybersecurity concerns and online safety issues among others. Agoro (2018) asserted that, the absence of these materials and resources in any teaching /learning environment is responsible for the poor performance of students in Chemistry, hence the need to emphasize improvisation where the conventional ones

are not available. Many secondary schools in some states in Nigeria including Enugu State are located in resource constrained areas where some of these facilities are not found or are not supplied by the authorities that run the schools. Internet access is usually poor or not available in such areas. In such situations, for the effective and expressive teaching of Chemistry, the teachers' creativity in improvisation becomes the only option, regrettably, not all the facilities can be easily improvised or substituted. If the teacher possesses extra skill in creativity, the teacher can undertake to attempt creating the semblance of those materials so that even the most difficult concept in Chemistry can be taught and learnt. Rees (2020) quips that if we want to encourage more students to enjoy and engage with Chemistry, we need to do more to emphasize creativity that lies at the heart of scientific endeavor. Creativity is the ability to generate novel and valuable ideas, products, or solutions, often through unconventional means.

In today's rapidly changing world, creativity has become an essential skill for teachers and students to thrive especially in a subject like Chemistry, which require creative thinking to deal with the numerous abstract concepts. Creativity is the ability to bring something new into existence, the development of something new and unique. Biljana et al, (2014) explains creativity as a process of thinking, always accompanied by explicit and deductive reasoning in the verification of a new idea and processes, as a mental activity aimed at defining a problem and its resolution, a complex cognitive activity, which is influenced by motivation, personal factors, environmental conditions and circumstances.

It is accompanied by a corresponding invention of defining a problem and finding a solution to the problem as elements of the creative process. According to Nnoli, (2014) creativity is important in teaching as it helps to cultivate the potential of imaginative thinking and collaboration in every student. Kadyrova (n.d), on the other hand states that creativity in education is a new paradigm that provides the highly conducive environment necessary for an individual to develop innovative ability and intellectual potentials that can lead to solving modern problems. Improvisation on the other hand is the art of creating ideas, materials, actions, or providing solutions in response to scarcity or designing a replica of something to make it function or play the role of the real thing using materials available within an environment. Donald (2021) considers improvisation as the act of producing and using local resources in the absence of the western standardized ones in teaching and learning situations. Ezeano, (2001) explains that, improvisation is the provision of alternatives in place of the conventional materials, a substitute to replace the original teaching aid or instructional materials or any available material that can be used in place of the real material in time of need.

Chemistry is a fundamental science that plays a crucial role in numerous aspects of our daily lives and has significant importance in various fields such as; Agriculture, Medicines, Pharmaceuticals, Biotechnology, Nanotechnology among others. In spite of this, students find the understanding and comprehension of chemistry concepts difficult as evidenced in their performances in Chemistry external examinations. For instance, the Senior School certificate examinations (SSCE) result of Nigerian students for the past ten years has been fluctuating and most times on the decline (Chief Examiner's Report, 2018 to 2021; Hassan, Ali, Salum, Kassim, Elmore, and Amour, (2015)). This has been attributed majorly to the way the contents are taught in abstractness among other reasons.

In this part of the world students are not familiar with most of the terms used in explaining chemistry concepts such as atom, molecules, electrons, current, calorimeter, electrolytic cells and so on. The apparatus used in the chemistry laboratory to carry out experiments are not the traditional wares that are used in their natural environments and settings. The situation becomes worse when there are none of those conventional instructional materials and the teacher is teaching by making instances without a concrete object or instructional material to drive the lesson home and make it more real and concrete. When the teacher is not creative enough to improvise the possible ones with what is within his/her reach, the consequence is not just that the learner is put in disarray but the teaching becomes difficult, understanding, comprehension and application of the knowledge to daily life becomes a mirage.

William (2016) asserted that the field of chemistry encompasses a wide range of scopes, reflecting its interdisciplinary nature and its fundamental importance in understanding the world around us, and to this effect, the effective and expressive teaching and learning of chemistry is paramount. Chemistry teaching being a method as well as strategies used to impart knowledge of chemical principles, concepts, and theories to students,

also involves designing curriculum, delivering lectures, conducting experiments, and assessing learning outcomes to ensure students grasp the fundamentals of chemistry (Manuel, Fabienne & André, 2014). Teaching Chemistry can therefore be challenging in the face of insufficient and inadequate instructional materials. To get a learner actively engaged in the learning process and have opportunities to explore and experiment with scientific concepts and materials, there must be adequate supply of instructional materials. Specifically, instructional materials are those materials used by the teacher to enhance teaching and learning. Any materials used in the classroom or other educational setting that are designed to supplement, support, or enhance teaching and learning is termed instructional material [National Education Association (NEA), 2020]. This definition emphasizes the diverse range of materials that can be considered as afore-mentioned, including textbooks, workbooks, worksheets, digital media, videos, audio recordings among others. NEA stressed the importance of high-quality, relevant, and culturally responsive instructional materials that meet the needs of diverse learners and support the goals of equitable education. NEA further emphasized on the need for educators to have access to a wide range of instructional materials and to have the creative ability and skills to select and use them effectively in order to promote student engagement and learning. The successful implementation of the Chemistry curriculum depends greatly on the quality and availability of such instructional materials for the teacher and students' use, therefore, when the conventional ones are not available the teachers' creative ability to improvise becomes the only option. This could be done using available local materials in the absence of the original or the ideal objects to bring about the same learning effect that the standard materials would have brought. Ugwueze (2020) indicated that improvising some basic instructional materials using locally available materials is observed as a major survival strategy to save chemistry education from unprecedented death in Nigeria. Obi and Obi (2019) investigated the effect of improvised instructional materials on academic achievement of SS1 chemistry students and found out that those students taught acids and bases using improvised materials performed better than those taught without them. Similarly, Mberekpe (2013) investigated the effects of student's improvised instructional materials on students' achievement in Biology and the result revealed that students taught using improvised instructional materials performed better than students taught using conventional materials. Further, Arop, Umanah, Effiong and Ogong (2017); Mechanician, Kampire, Dushi Imana, (2022) all indicated that improvised teaching and learning materials imparts on students' understanding and retention of concepts.

However, this is greeted with a number of unprecedented challenges. Adeyemo (2020) affirms that lack of resources, inadequate training, and insufficient time for preparation are some of the challenges faced by teachers in improvising locally sourced instructional materials. Mberekpe (2013) is of the opinion that human factors are problems associated with the teachers' professional commitments, creative ability, technical skill, ingenuity and competence. This informs why it is important to explore the teachers' creativity in improvisation of instructional materials for the teaching and learning of chemistry in secondary schools, and the challenges that goes with it with the view of highlighting the implication for the 21<sup>st</sup> century learners.

### **Purpose of the Study**

The general purpose of this study is to find out teachers' creativity in improvisation of instructional materials in the teaching and learning of chemistry in Secondary Schools. Specifically, the study sought to find out the:

1. extent to which chemistry teachers improvise instructional materials used during the teaching and learning of chemistry.
2. extent to which the improvisation of instructional materials aids the effective teaching and learning of chemistry.
3. challenges faced by teachers in improvisation of instructional materials for the teaching and learning of chemistry.
4. possible ways to ameliorate the challenges faced by teachers towards improvisation of instructional materials for the teaching and learning of chemistry.

### **Research Questions**

The following are the guiding research questions for this study;

1. To what extent do Chemistry teachers improvise instructional materials used during the teaching and learning of chemistry?
2. To what extent do the improvisation of instructional material aid the effective teaching and learning of chemistry?
3. What are the challenges faced by teachers in improvisation of instructional materials for the teaching and learning of chemistry?
4. What are the possible ways to ameliorate the challenges faced by teachers in improvisation of instructional materials for the teaching and learning of chemistry?

### **Significance of the Study**

The findings of this study will have both theoretical and practical significance. Theoretically, this study strengthens Piaget's Constructivist Theory (1950) and Lave and Wenger's Situated Learning Theory (1991). According to Piaget's Constructivist Theory, (1950), learning is a process of constructing knowledge through active participation and manipulation of the learning environment. In line with constructivist theory, Chemistry teachers' improvisation and involvement of the students in improvisation of some instructional materials will facilitate their knowledge construction, thus, the current study validates this theory. The Lave and Wenger's Situated Learning Theory posits that learning occurs best in authentic learning environments that allow students to engage actively and meaningfully in the learning process.

According to Lave and Wenger, learning is a social process that occurs within a specific context, and that real knowledge is acquired through participation in authentic experiences. In essence, Chemistry teachers should use locally sourced instructional materials that are relevant to the students' environment and their experiences for effective teaching and learning of Chemistry. This approach helps to increase students' engagement in the learning process, making chemistry more meaningful and relevant to them. Furthermore, the study holds some practical significance to the 21<sup>st</sup> century learners, parents and various stakeholders in the education sector including teachers. Firstly, the findings of this study can inform teacher training programs, contributing greatly to the existing body of knowledge. By emphasizing the importance of creativity in improvisation of instructional material for both teachers and students, a more interactive and effective learning environments is created which can enhance student motivation and interest. The finding of this study can significantly contribute to the development of innovative instructional strategies that could foster critical thinking, creativity, and problem-solving skills in the 21<sup>st</sup> century learner. Also practically, the findings of this study could help educators to prepare the 21<sup>st</sup> century learner to survive in an ever-changing world with increasing complexity and dynamism if improvisation is incorporated into the school curriculum.

### **Scope of the Study and Design**

The study is delimited to finding out teachers' creativity in improvisation of instructional materials in the teaching and learning of chemistry. The study will be conducted with the Chemistry teachers in Senior Secondary Schools in Nsukka Education Zone of Enugu state, Nigeria. It also looks at the extent to which the improvisation of instructional materials aids the effective teaching of chemistry in this 21<sup>st</sup> century, the challenges they face and possible ways to ameliorate the challenges faced by teachers in improvising instructional materials for the teaching of chemistry. Descriptive survey research design was adopted for the study.

### **Population of the Study**

The population for this study consists of 34 Chemistry teachers in 30 government approved Secondary Schools in Nsukka Education Zone of Enugu State, Nigeria for 2023/2024 academic session. (Source: Office of the Chief Supervising Principal, Post Primary School Management Board (PPSMB), Nsukka).

### **Sample and Sampling Technique**

The sample size for this study consists of 20 Chemistry teachers drawn from the above population. The sample was drawn using the simple random sampling technique. Simple random sampling by balloting with

replacement was used to select ten secondary schools out of the thirty 30 government approved secondary schools in Nsukka Education Zone of Enugu State from which the 20 Chemistry teachers were taken.

### Instruments for Data Collection/ Validation of the Instrument

The instrument used for data collection was developed by the researcher: titled "Chemistry Teachers' Improvisation of Instructional Materials Questionnaire (CTIIMQ)". The Instrument was validated by three experts in the Department of Science Education, University of Nigeria, Nsukka. The CTIIMQ instrument was trial tested on an equivalent group of 10 teachers from other schools in Nsukka Education Zone of Enugu State, Nigeria. The internal consistency was established using Cronbach Alpha reliability method and reliability coefficient for each cluster 0.95, 0.95, 0.96, and 0.96, were obtained.

### Method of Data Collection and Data Analysis

The instrument was distributed to the teachers and the teachers were given enough time to respond to the questionnaire items before instant retrieval. This method of administration was adopted to ensure high response rate and 100% return of the instrument. In analyzing the data, the researchers used mean and standard deviation to answer all the research questions. The real limit for cluster one and two is 2.50, each item that attained 2.50 and above shows a high extent (HE). For cluster three and four, 2.50 was also used and each item that attained a response mean of 2.50 and above was considered agreement on the item statement, otherwise, it is considered disagreement.

## RESULTS

### Research Question One:

To what extent do Chemistry teachers improvise instructional materials used during the teaching and learning of chemistry?

Table 1: Mean Ratings and Standard Deviation of Responses of Teachers on the Extent Chemistry Teachers Improvise Instructional Materials during Chemistry Lessons

S/N	Item Statements	Mean	Std. Deviation	Decision
1	Bunsen burner	3.55	0.51	He
2	Beakers	1.8	0.7	Vle
3	Petri dish	3.1	0.72	He
4	Measuring cylinder	1.35	0.49	Vle
5	Spatula	3.65	0.49	He
6	Test tube holder	1.45	0.51	Vle
7	Watch glasses	1.6	0.5	Vle
8	Reagent bottle	3.35	0.49	He
9	Indicator	1.55	0.83	Vle
10	Trough	2.05	0.6	Le
11	Conical flask	1.75	1.21	Vle
12	Dropper	1.8	0.7	Vle



13	Funnel	3.65	0.49	He
14	Filter paper	1.75	0.79	Vle
15	Retort stand	3	0.56	He
16	Stirring rod	3.55	0.76	He
17	Test tube	1.5	0.51	Vle
18	Wash bottle	1.7	0.47	Vle
19	Wire gauze	2.6	0.99	Le
20	Pipette	1.3	0.47	Vle
21	Oilsor saponification	3.7	0.47	He
22	Sodium hydroxide	1.35	0.49	Vle
23	Burette	1.3	0.47	Vle
24	Tripod stand	1.65	0.49	Vle
25	Acid	1.6	0.82	Vle
—	<b>Overall Mean</b>	<b>2.23</b>		<b>Le</b>

Table 1 shows the mean ratings and standard deviation of responses of teachers on the extent Chemistry teachers improvise instructional materials used during the teaching and learning of chemistry. Table 1 shows that out of the twenty-five (25) items listed, chemistry teachers provide eight (8) items to a High Extent (HE), two (2) items to a Low Extent and fifteen (15) items to a Very Low Extent (VLE). From the table, Bunsen burner, petri dish, spatula, reagent bottle, funnel, stirring rod, test tubes are improvised by chemistry teachers to a High Extent (HE). From the table also, Trough and Wire Gauze are improvised by chemistry teachers to a Low Extent (LE). Beakers, Measuring Cylinders, Test tubes and Test tube holder, watch glasses, indicator, conical flask, dropper, filter paper, wash bottle, pipette, sodium hydroxide, burette, tripod stand and acid are improvised by chemistry teachers to a Very Low Extent (VLE). The cluster mean is 2.23 which means that chemistry teachers responded that they improvise instructional materials used during the teaching and learning of chemistry to a Low Extent (LE).

**Research Question Two:**

To what extent does the improvisation of instructional material aid the effective teaching and learning of chemistry?

Table 2: Mean Ratings and Standard Deviation of Responses of Chemistry Teachers on the extent the improvisation of instructional material aids the effective teaching and learning of chemistry

S/N	Item Statements	Mean	Std. Deviation	Decision
26	Using improvised materials in chemistry helps me to coordinate activities	3	1.26	He
27	My students pay more attention when I use improvised materials	3.25	0.85	He

28	Improvised materials help my students remember chemistry concepts better than traditional textbooks	3.25	0.85	He
29	Improvisation allows me as a teacher to tailor the lessons to the specific needs and interests of the students	3.25	1.33	He
30	The cost-effectiveness of improvised materials makes chemistry learning more accessible to students from all backgrounds	3.25	0.85	He
31	Teaching with improvised instructional materials helps develop my problem-solving skills	3.5	0.51	He
32	My students participate actively when I use improvised instructional materials for chemistry lessons	3	1.26	He
33	Improvised instructional materials enhance my practical skills in chemistry experiments	3.5	0.51	He
34	Students' retention of chemistry knowledge is improved whenever I use improvised instructional materials	3.5	0.89	He

A = Agreed and D = Disagreed. Cut-off mean = 2.50

Table 2 shows the mean ratings and standard deviation responses of chemistry teachers on the extent the improvisation of instructional material aids the effective teaching and learning of chemistry. It shows that the teachers responded that all the nine (9) item statements on the improvisation of instructional material aid the effective teaching and learning of chemistry to a High Extent (HE). For instance, the teachers agreed that using improvised materials in chemistry helps them to coordinate activities, students pay more attention when they use improvised materials, improvised materials help their students remember chemistry concepts better to a high extent.

### Research Question Three:

What are the challenges faced by teachers in improvisation of instructional materials for the teaching and learning of chemistry?

Table 3: Mean Ratings and Standard Deviation of Responses of Chemistry teachers on the challenges faced by teachers in improvisation of instructional materials for the teaching and learning of chemistry

S/N	Item Statements	Mean	Std. Deviation	Decision
35	Improvisation of instructional materials is time-consuming	3.1	1.29	A
36	Limited skills in improvisation of instructional materials	3.15	0.81	A
37	Improvisation of locally sourced instructional materials can be cost-effective	3.25	0.85	A
38	Lack of support from school authorities to assist teachers	3	1.26	A

39	Lack of policy statement to encourage teachers	3.55	0.69	A
40	Improvisation is usually difficult because of lack of creativity	3.35	0.49	A
41	Large class size prevents the effective use of improvised instructional materials	2.5	1.15	A
42	Lack of cooperation and understanding among teachers on appropriate materials to improvise for Chemistry topics	3.6	0.5	A
43	Insufficient time allocated for Chemistry on the school timetable to use locally improvised materials	3.25	0.85	A

A = Agreed and D = Disagreed. Cut-off mean = 2.50

Table 3 shows the mean ratings and standard deviation of responses of chemistry teachers on the challenges faced by teachers in improvisation of instructional materials for the teaching and learning of chemistry. It shows that all the nine (9) items exceeded the criterion mean of 2.50. This implies that chemistry teachers agreed that improvisation of instructional materials is time consuming, large class size prevents the effective use of improvised instructional materials, lack of cooperation and understanding among teachers on the appropriate materials to improvise on a particular topic in Chemistry, are challenges faced by teachers in improvisation of instructional materials for the teaching and learning of chemistry.

**Research Question Four:**

What are the possible ways to ameliorate the challenges faced by teachers in improvisation of instructional materials for the teaching and learning of chemistry?

Table 4: Mean Ratings and Standard Deviation of Responses of chemistry teachers on the possible ways to ameliorate the challenges faced by teachers in improvisation of instructional materials for the teaching and learning of chemistry

S/N	Item Statements	Mean	Std. Deviation	Decision
44	Teachers should create enough time to improvise their instructional materials	3.15	1.31	A
45	There should be workshops for training teachers on the development of improvisation skills	3.1	0.79	A
46	School administration should support teachers in creating instructional materials	3.25	0.85	A
47	Relevant authorities should assist schools with the cost implications of improvisation	2.95	1.23	A
48	Teachers should be given incentives to motivate effective use of locally sourced instructional materials	3.55	0.69	A



49	Class size should be reduced to ensure the effective utilization of instructional materials in the classroom	3.35	0.49	A
50	Teachers should develop their creative ability in improvisation skills	3.05	1.05	A
51	Teachers should collaborate in sourcing appropriate instructional materials for Chemistry topics	3.65	0.49	A
52	More time should be allocated on the timetable to allow for improvisation	3.2	0.83	A

A = Agreed and D = Disagreed. Cut-off mean = 2.50

Table 4 shows the mean ratings and standard deviation of responses of chemistry teachers on the possible ways to ameliorate the challenges faced by teachers in improvisation of instructional materials for the teaching and learning of chemistry. It shows that all the nine (9) items exceeded the criterion mean of 2.50. This implies that chemistry teachers agreed that teachers should create enough time to improvise their instructional materials, there should be workshop for training of teachers on the skills of improvisation and to develop their creative ability and school administration should support the teachers in creating instructional materials.

### Summary of Major Findings of the Study

After the analyses and interpretations of the data, the following were found:

1. Chemistry teachers improvise instructional materials used during the teaching and learning of chemistry to a Low Extent (LE).
2. The teachers agreed among others that using improvised materials in chemistry helps them to coordinate activities, students pay more attention when they use improvised materials, improvised materials help their students remember chemistry concepts better than traditional textbooks etc. to a high extent.
3. Chemistry teachers agreed among other things that improvisation of instructional materials is time consuming, large class size prevents the effective use of improvised instructional materials, lack of cooperation among teachers on the appropriate materials to improvise on a particular topic in Chemistry.
4. Chemistry teachers agreed among others that teachers should create enough time to improvise their instructional materials, there should be workshop for training of teachers on the skills of improvisation, school administration should support the teachers in creating instructional materials.

### DISCUSSION OF FINDINGS

The findings of the study revealed that the extent Chemistry teachers improvise instructional materials such as Beakers, Measuring Cylinders, Test tubes and Test tube holders, watch glasses, indicator, conical flask, wash bottle, pipette, measuring cylinder, burette, tripod stand among others is low. It may be that; the teachers do not have the creative skills for improvisation or they lack the zeal and support from the school administrators to carry on improvisation. Some of these apparatuses could easily be improvised if the teacher has the creative ability. The findings are in line with Achor, (2013); Umoren & Ogong, (2017) who revealed that most Chemistry teachers in secondary schools in Nigeria do not make use of varieties of instructional materials that can help them cope with teaching some specific difficult concepts such that both the teacher and the learners struggle with the understanding of many simple Chemistry concepts. The extent Chemistry teachers improvise instructional materials used during the teaching and learning of chemistry is low in spite of the importance of improvisation of these instructional materials.

The findings of the study also revealed that the extent to which improvised materials aids the effective teaching

and learning of chemistry is high. The study revealed that the use of instructional materials can significantly improve students' academic performance in Chemistry and that improvisation of instructional materials had a positive impact on students' learning outcomes, with students showing better understanding and retention of chemistry concepts. However, the findings of this study contradict the findings of Ibrahim (2012) that students taught Basic Science with improvised instructional materials did not perform significantly better than those taught with the conventional instructional materials. But, Arop, et al, (2015) found out that the use of instructional materials has a favorable effect on students' achievement in science concepts. Matazu, (2022) also suggested that utilization of locally sourced instructional materials in teaching helps in correcting some confusion caused for students due to content disorientation as well as helping to illustrate ideas in the content to students.

The findings of the study revealed a number of challenges faced by teachers in improvisation of instructional materials for teaching Chemistry. Some of the challenges include; lack of creative ability, time factor, limited skills in the knowledge of improvisation of instructional materials, cost-effectiveness of locally sourced materials, lack of support from school administrators, insufficient time allocated for Chemistry on the school timetable, among others. In line with this, Despite the fact that, it is known to these administrators that, the use of instructional materials in teaching Chemistry plays major role in teachers' effectiveness and content delivery, they still fail to support the provision. From this study it was revealed that the challenges faced by teachers in improvisation instructional materials in teaching and learning of Chemistry could be ameliorated in line with the suggestion of John (2015) that all Science subjects' teachers should be exposed to, and trained on the art of improvisation of teaching aids on regular basis so as to make teaching and learning more effective. Ibrahim (2012) also suggested that Chemistry teachers should be trained through workshops on how to effectively design and used improvised materials in teaching Chemistry.

## CONCLUSION

In conclusion, effective chemistry education requires more than just transmitting knowledge; it demands inspiring curiosity, fostering creativity, and cultivating critical thinking. The finding from this study shows that, the extent to which teachers improvise instructional materials where the conventional instructional materials are not available is very low. From the findings, this was associated with a number of identified challenges that handicap teachers' creativity in improvisation of instructional materials for effective teaching and learning of Chemistry. Such challenges were listed as time constraint, lack of creative ability and skills, cost of improvisation among others. The consequence will be grave for the 21<sup>st</sup> century learner who needs proper understanding of Chemistry concepts to have good chemistry knowledge and to be abreast of the Sustainable Development Goals(SDGs) with the following themes; no poverty, zero hunger, good health and well-being, quality education, clean water and sanitation, affordable clean energy, decent work and economic growth, industry, innovation and infrastructure, inclusive economy, enabling environment of peace and security, partnerships among others. Effective teaching will also be with obviously difficulty. Some of these challenges can be ameliorated to make improvisation easy and effective so that learners can actually get the expected learning outcome.

## Educational Implications

This study holds a number of implications to the 21<sup>st</sup> century learners, to the teachers, to school administrators, to the educational stake holders and curriculum development agencies. Teachers' ability to creatively improvise instructional materials for the teaching and learning of Chemistry is expected to enhance the learners' motivation to learn and improve their engagement in classroom activities, improve students' understanding of complex chemistry concepts and enhance their retention of such concepts. If students are made to take part in improvisation of such instructional material it would go a long way to facilitating stronger relationships between teachers and students and helping them develop critical thinking and problem-solving skills. This will invariably improve their academic achievement in chemistry. This process of improvisation by the teacher and the students, will facilitate collaboration and teamwork among students and foster students' own creativity and innovation. To the teachers, their creativity in improvisation of instructional materials allows them to take ownership of their instruction thus can enhance teachers' confidence in their ability to teach chemistry well, ultimately contributing to the improvement of educational practices and outcomes for 21st-century learners. Another

important implication is that, creative improvisation of instructional materials can be tailored to meet the diverse needs of students from various cultural backgrounds, allowing the teacher to cater for different learning styles and abilities. The instructional materials can be designed to accommodate students with disabilities. Improvisation that is adequately done, could prepare students for careers in science, technology, engineering, and mathematics (STEM). Hence can encourage students to think innovatively and develop entrepreneurial skills. There by, preparing students for an ever-changing world and be able to adapt to new situations and challenges in this 21<sup>st</sup> century.

**Based on the findings, the following recommendations are made:**

1. Teachers should encourage themselves to think outside the box and explore innovative ways to present chemistry concepts. Collaborate with colleagues and share ideas and resources with fellow teachers to enhance creativity and improvisation so as to improve or adapt new instructional materials.
2. The Schools and Administrators should provide professional development opportunities. Offer workshops, training sessions, or conferences that focus on creative instructional design and improvisation, encourage teacher autonomy by giving teachers the freedom to design and implement their own instructional materials, promoting creativity and improvisation. Allocate resources periodically for improvisation by providing teachers with the necessary resources, including materials, technology, and time, to support their creative endeavors.
3. The Policymakers should develop policies supporting teacher creativity. Encourage and support policies that promote teacher autonomy, creativity, and improvisation in instructional design. Allocate funding for professional development: Provide funding for teacher professional development programs that focus on creative instructional design and improvisation. Monitor and evaluate effectiveness: Regularly monitor and evaluate the effectiveness of policies and programs supporting teacher creativity and improvisation.

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