

AVAILABILITY AND UTILIZATION OF INSTRUCTIONAL MATERIALS FOR TEACHING CHEMISTRY IN SECONDARY SCHOOLS: A REVIEW

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ABSTRACT

With the right use of instructional materials, mastering chemistry can make even the most esoteric concepts clearly understandable. The use of teaching resources is essential to the teaching and learning of chemistry. It might motivate teachers and students to exchange resources. It can also reduce the degree to which students misunderstand specific chemical concepts. The goal of this review is to examine the availability and utilization of instructional materials as well as their significance in the teaching and learning of chemistry in secondary schools. The review paper also focuses on the issues that inhibit teachers and students from using the available instructional materials when studying and teaching chemistry. This paper reviewed 16 publications published between 2016 and 2024 that focused on availability as well as utilization of instructional materials in teaching chemistry. The articles are gathered from the ERI database, Web of Science, and Google Scholar searches. The availability, definition, and impact of instructional materials for teaching chemistry, as well as their efficacy in terms of student learning achievement, are all summarized in this review for the benefit of chemistry educators and researchers. [*African Journal of Chemical Education—AJCE 14(2), May 2024*]

INTRODUCTION

A country's scientific education is its engine. The advancement of a nation is contingent upon the caliber of science instruction as well as the credentials and skills of its educators. In order to achieve self-realization, cultivate a sense of national identity, and fight for the advancement of socioeconomic, political, scientific, cultural, and technological spheres, science education is a crucial tool [1]. The environment we live in is filled with chemistry. It is in the food we eat, clothes we wear, water we drink, pharmaceuticals, air purifiers etc . It is frequently referred to as the “central science” since it links the physical sciences, which include chemistry, with the biological sciences and applied sciences like engineering and medicine [2]. Therefore, learning the fundamentals of chemistry is a methodical process of gaining knowledge about the cosmos. Since education is currently one of the most important tools for promoting participation, empowerment, cultural preservation, social mobility, and equity, it also addresses the social goal of sustainable development [3]. According to [4], students' performance in chemistry on open tests has been declining over time across Africa. In order to improve instruction and learning outcomes, chemistry instruction nowadays should concentrate on standards of teaching practice. When students are at the center of instructional decisions, effective teaching happens.

A multitude of reasons contribute to the low achievement of students in chemistry. These elements include inadequate teaching strategies, the absence of a chemistry lab, and the lack or improper utilization of instructional materials, all of which have a significant impact on students' low performance in scientific classes [5, 6]. [7] Noted that it might be exceedingly challenging to provide accurate and engaging science instruction in secondary schools without making appropriate choices and utilization of instructional resources. Integration of instructional materials is crucial to the efficacy of teaching and learning science courses, especially ones that call for theoretical and practical components, like chemistry. A collection of resources known as instructional materials is what teachers can utilize in the classroom to give their students access to a wider variety of vicarious experiences [8]. Teaching and learning can be made more effective by the use of available instructional materials. Teachers want to convey their ideas to their pupils in the most straightforward, meaningful, and useful way possible ([9].

When imparting knowledge, instructional materials act as a conduit between the teacher and the pupils. It is used to divert pupils' attention and get rid of boredom. Teachers rely on instructional materials in every aspect of teaching. For background knowledge on the subject they are teaching, they require instructional materials [10]. Teachers also need to use these materials to assess their students. By offering a range of relevant and first-hand experiences, these resources give students

the chance to increase their knowledge [11]. Utilizing instructional resources to teach and learn can have a favorable impact on students' performance [12]. Accordingly, learners may do poorly if instructional resources are not used because there may be less interaction and comprehension during the learning process [13]. Since teachers play a pivotal role in the educational process, it is imperative that they replicate their instructional techniques and set the highest bar for instruction based on internationally recognized best practices in order to raise students' academic performance.

[14] Lists the following key functions of instructional materials in the teaching process:

- i. Raising students' memory levels and simplifying the teaching-learning process.
- ii. Enhancing the rate of accumulation of students.
- iii. Act as instruments that educators employ to rectify misconceptions and illustrate concepts that students find difficult to forget.
- iv. Assist in helping the body of knowledge being discussed make sense of reality.
- v. Provide educators and learners with hands-on opportunities to engage in learning activities that foster the concept of self-evaluation.

The effectiveness of the educational materials is directly impacted by the caliber of instruction and the caliber of the teacher who organizes and carries out the lesson. One of the hardest things for instructors to do in a classroom is to create the conditions for meaningful learning. It can

be difficult for chemistry teachers to provide their students engaging and relevant learning opportunities in the classroom [15]. The utilization and accessibility of instructional materials will be a part of initiatives to improve chemistry education. According to [5], the majority of scientific teaching resources were neither readily available nor effectively employed in the teaching-learning process. Lack of instructional materials and poor utilization of instruction materials are causes of low academic performance of students in chemistry. The aim of this review paper is to ascertain the extent of instructional materials' availability and use in chemistry classrooms.

Classification and Definition of Educational Resources

The concept of instructional material is used in various ways, such as teaching tools, teaching aids, instructional tools, learning materials, instructional resources etc. [16]. These resources consist of a collection of instructional strategies and techniques that teachers use in their classrooms [17]. According to [18], instructional practices are the actions teachers take to prepare a lesson for their students in the classroom. Physical objects that give auditory, visual or both to the senses while teaching are called instructional materials [6]. Through guided learning or self-teaching, instructional materials can help learners to develop higher learning capacities. Thus, instructional materials are the practical and skill development resource that would facilitate the process of

teaching, learning and evaluation of skills [9]. Instructional materials, according to [19] are materials that streamline the teaching and learning activities to meet lesson objectives and can be grouped into three main types:

Visual aids for teaching

These are educational tools that primarily engage the visual sense. Simple visual aids such as images, film strips, photos, charts, maps, objects, etc. are examples of such materials. These resources are easy to use, remarkable in their presentation, and straightforward.

Audio-visual teaching resources

These are instructional tools that primarily target the auditory sense. Since audio aids primarily appeal to the auditory sense, students must not have hearing impairments in order for them to be effective. Compact Discs (CDs), radios, gramophones, record players, and cassettes are a few examples of audio devices that facilitate the conveyance of content through hearing [20]

Audiovisual teaching resources

These are educational resources with the ability to present both visual and aural elements at the same time. Television, video tape shows and records, sound films, film strips, and synchronized sound-enhanced slides are some examples.

Another scholar, [21] grouped instructional materials into two board groups:

Standard instructional materials

These are the typical laboratory supplies and tools for teaching science that are manufactured in factories or imported from elsewhere [22]. They are standardized because they function the same way under all circumstances and in every application. Examples include science kits, thermometers, test tubes, and Bunsen burners, evaporating Dishes, flasks, funnels, measuring cylinders, models in chemistry, pipettes, spatulas, and other items.

Locally produced/ improvised instructional materials

These are locally created or improvised encompass a wide range of easily accessible educational resources that have a strong local focus and align with the curriculum. There are available and reasonably priced improvised resources in the classroom setting [23]. In order to support efficient teaching and learning, they are created and used by educators and learners utilizing substitute material resources. The use of improvised instructional materials during the teaching and learning may enhance learners' motivation, creativity, critical thinking, and innovation.

As per references [24, 25], instructional materials are educational media that assist teachers in confidently imparting knowledge and help students understand concepts, ideas, and theories. These scholars grouped them into four categories.

Printed media and reading materials

These are educational resources that provide concise knowledge for use in the classroom. Textbooks are one example of this type of material; other examples include images, pictures, pamphlets, journals, figures, generalizations, maps, and charts.

Non-printed media

These include posters, models, wall charts, diagrams, and the like.

Electronic media

Include audio cassettes, video films, computers, projectors, television sets, radio recorders, manipulated objects, and computer-based machines, among other examples.

The communal source

The greater society has access to these kinds of resources. Several of these sources mention locations that are noteworthy local landmarks. Schools, colleges, libraries, government offices, parks, airports, banks, hospitals, and invitations to resource persons are examples of educational facilities.

Guidelines for Selecting Educational Resources

Teachers utilize established curriculum and corresponding instructional materials to direct their preparation and instruction, gain knowledge about reform-oriented methodologies, and make informed pedagogical choices [26]. Selection of adequate educational resources is intricate and influenced by various elements. The most important aspects are the teachers' opinions regarding the subject and instruction, their pedagogical skills and material understanding, and their attitudes toward the instructional strategy. Furthermore, in order to effectively employ the wide variety of materials available, teachers must have a thorough understanding of the curriculum and the learning progress of their students [27]. When choosing instructional materials; teachers need to take into account the following, according to [28].

- A. The lesson's substance and the learners' ages and abilities: It is crucial that the teacher takes the pupils' ages and skill levels into account.
- B. The lesson objectives must be connected to the instructional materials. Any educational resource that is not designed to support the students in achieving the lesson goals should not be included in the class.
- C. The availability of current information and helpful services. Any educational resource that is appropriate for use in a classroom setting must be up to date and applicable.

THE METHODOLOGY USED IN THIS REVIEW

The literature review method was employed in this review to select prior research on the availability and utilization of instructional resources for chemistry teaching. Searching linked publications on Google Scholar, Web of Science, and Science Direct is one way to find such pertinent studies. The identifying process took almost two months to complete, and the following procedures are followed.

Finding Articles That Are Relevant

Gathering pertinent articles regarding the availability and utilization of instructional resources for teaching chemistry was one of this phase's main tasks. As a result, the study's search was limited to full-text publications. I started by conducting a preliminary search using the science direct, web of science, and Google Scholar database. I used a variety of keywords, like availability, utilization, teaching, chemistry, and effect.

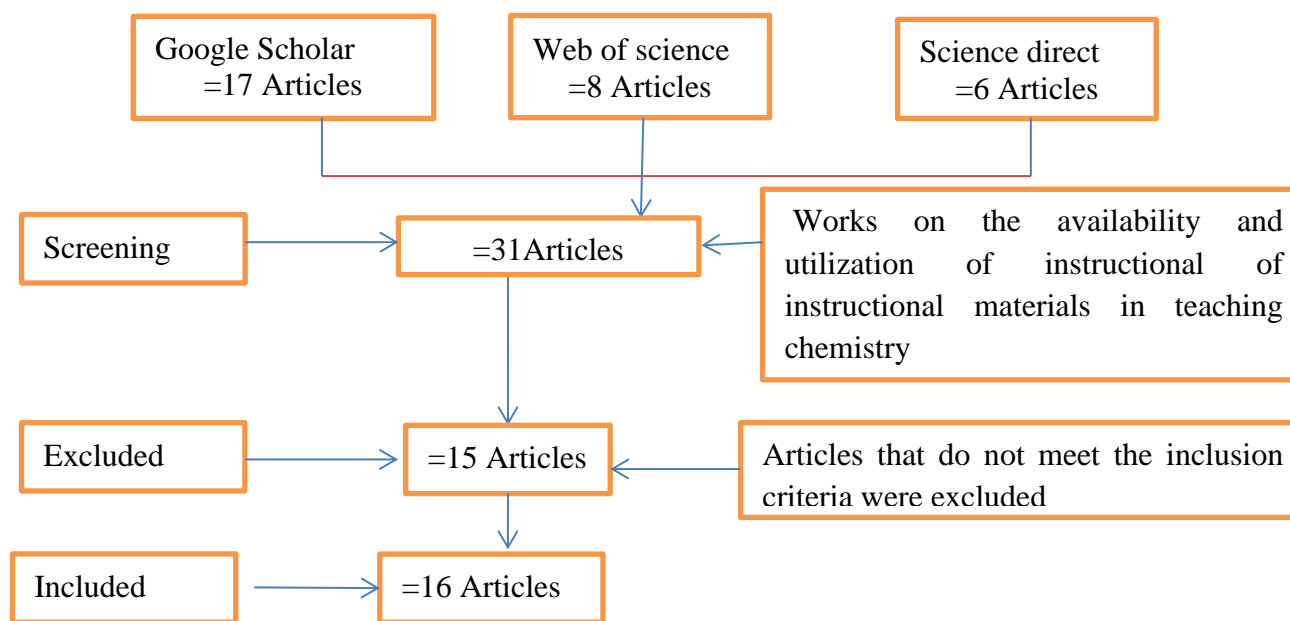
Evaluating the Research Quality

These studies were retrieved from globally renowned databases (Google Scholar, Web of Science, and Science Direct) in order to guarantee the caliber of this review. Potential primary studies were identified using inclusion and exclusion criteria. Publications regarding the availability

and utilization of educational resources for teaching chemistry make up this review. The following inclusion criteria were applied while choosing the articles for this review:

1. Articles about instructional materials' accessibility and use in chemistry education.
2. The publications were published between 2016 and 2024
3. The articles were published in respectable journals with an international index.

The articles listed below have finally been chosen for a final examination.



RESULTS

Availability and Utilization of Educational Materials

The effectiveness of teaching and learning of chemistry impacts on the availability and the utility of instructional materials. It helps and motivates students to comprehend concepts [29]. Even while instructional resources are important for teaching and learning, their inadequate use and lack of quality prevents lessons from being taught in the classroom effectively [30]. Whatever the circumstances, a competent teacher should be able to access and adapt the materials for students. The teachers should inherently be interested to access instructional materials on their own without depending heavily on the school or education department to provide them. In doing so, they will expose the learners to various teaching tools which will enable the learners to understand Life Sciences and increase their academic achievement [31].

Since today's kids are growing up in a digital age of mass information, good teachers should use all available resources, including images, illustrations, radio, television, and a variety of other digital audio-visual materials, in their daily lessons. Low educational quality can be linked to a wide range of factors. One of them is the lack of availability and poor use of instructional materials. Researchers found that many secondary schools, particularly those in rural areas, lack access to instructional materials for teaching basic science, or that the ones that are available are expensive

and difficult for teachers to use for a variety of other reasons. As a result, it's critical to assess how instructional materials are used in basic science instruction at the secondary school level [32].

According to research findings, secondary schools have access to some laboratory chemicals and equipment needed to teach chemistry, but not all audio-visual instructional materials [6]. The majority of secondary schools only have two-dimensional teaching materials, such as consumables (chemicals) and non-consumables (equipment), and these audio-visual resources are not available [5]. [33] Revealed that most instructional materials needed to teach science courses are not available in most schools and where they are available they are non-functional. The findings of [34] also support this idea. [6] Also showed that while the laboratory equipment (Apparatus and chemicals) were utilized to law extent, the electronic instructional materials were not utilized by chemistry teachers. Most secondary school chemistry teachers do not utilize the few available materials such as consumables and audio-visual instructional materials in teaching science subjects. According to [5], the majority of secondary schools lack ICT resources, and the ones that do exist are not being effectively used by the teachers. Instructional material can actively use to facilitate the teaching and learning process in most of the developed countries. However, this circumstance is not common in most of the developing countries. In the first instance, schools are only given educational materials that are of inferior quality and in smaller quantities. In the second instance, educators lack enough

training when it comes to using teaching resources Thirdly teachers do develop poor interest in use of instructional materials [35].

By grouping into four categories, [36, 37, 38] examined the extent of availability and utilization of instructional materials for teaching chemistry.

Laboratory Equipment and Apparatus (General)-

These materials include Balances for weighing, Beakers, Burettes, conical flask, Evaporating Dishes, Electricity Supply, flasks, filter paper, Funnels, Fire extinguishers, Gas/Bunsen burners, holder and rack, litmus paper, measuring cylinder, Models in Chemistry, periodic tables, Pictures, Pipettes, spatulas, science kits, Wall Charts, thermometers, Test Tubes and Water Supply etc.

Chemicals

Indicators, reagents, sample metals, salts, acids and bases etc.

Audio materials

Cell Phones, Loudspeakers, Microphones, Radio sets, Record Players, Tape recorders etc.

Audio -Visual materials

Education software, Flash Drivers/CD – ROM, Film projectors/Film strips, Lap top computers, Overhead projector/power point presentation, Satellite dishes/internet, Television sets, Video machines/CD plates.

These results therefore showed that teaching material such wall charts, pipettes, beakers, indicators, test tubes, spatulas, funnels, measuring cylinders, litmus paper, filter paper, test tube holders and racks, and wash bottles are available to less extent in most secondary schools. These studies also reported that audio material and audio -Visual materials are available to a few extents for the teaching of chemistry in secondary schools. It suggests that a sizable portion of instructional materials for teaching chemistry are unavailable in most secondary schools.

According to [6], most secondary schools have a variety of laboratory supplies and equipment, but teachers rarely make good use of them. This study also found that a deficiency of audiovisual instructional resources, improvised materials, and models may be the reason for students' poor comprehension of Chemistry topics. [39] Supports this idea. [40] Found that teachers and students in the majority of secondary schools in developing nations do not use the instructional materials.

The mean rating of teachers and students on the extent of utilization of available instructional materials by Chemistry teachers in secondary schools is shown in the table given below [32, 37, and 40].

S.No	Instructional materials Utilization	Decision	
		Availability	Utilization
1	Mobile learning technology e.g cell phone with internet, iPad	Very low extent	low extent
2	Computers and internet facilities/resources	Very low extent	Very low extent
3	Disc materials e.g. VCD/DVD/MP3	Very low extent	low extent
4	Software e.g. Power Points, Spreadsheet Programs, computer simulations	Very low extent	low extent
5	Televisions	low extent	Very low extent
6	Projectors	Very low extent	low extent
7	Models and graphics e.g molecular models, charts	Very low extent	low extent
8	Local materials (fruits, ashes, flowers)	Very low extent	low extent
9	Apparatus and equipment	Very low extent	low extent
10	Chemicals	low extent	low extent

Effect of Instructional Materials on the Teaching and Learning of Chemistry

The utilization of instructional materials is essential in teaching and learning chemistry. It might motivate teachers and students to share resources. It can also reduce the degree to which students misunderstand certain chemistry concepts. Instructional materials support educational efficiency by promoting quality of teaching and learning [41]. It encourages cooperative learning activities among students as well as between teachers and students. For instance, audio-visual teaching aids such as smartboards and other can help teachers effectively teach a subject in a packed classroom. In a similar vein, [42] noted that the usage of instructional resources by teachers

contributes to meaningful and successful science instruction. As a result, it is crucial to emphasize the use of instructional materials in teaching and learning. Utilizing educational resources can assist teachers in imparting knowledge that could aid students in acquiring and improving their learning abilities.

According to [19], instructional materials gave students access to a variety of learning skills and helped them consolidate their knowledge to develop unique teaching and learning capacities. This makes teachers to use instructional materials to teach Sciences so that the learners can be engaged in the teaching-learning process and becoming active participants. Findings of various research demonstrated that the utilization of instructional materials motivated the learners to study and added life to learning. They also disclosed that the utilization of educational materials by teachers in the classroom could perhaps help them to better explain new concepts. This could help the learners to better understand the concepts and the subject matter [43]. Students were engaged in the teaching and learning process and did better when teachers used instructional materials specially the audio-visuals and improvised ones according to a study conducted in Sudan by [44]. Another study by [45] in South Africa and by [46] in Ethiopia revealed that students receiving instruction in languages other than their mother tongue and using instructional materials in those languages received helpful assistance in the science classroom. As a result, the students performed better

because they comprehended the material and challenging terms in chemistry better [45]. This proved that if there are language barriers, the learners could not understand the subject and their academic achievements might be lowered. Additionally, the use of instructional materials helps students retain the subject and gives them the advantage of producing high-quality work [47].

The utilization of instructional materials makes chemistry teaching and learning more realistic. The integration of several instructional sources of instruction can facilitate effective communication and the transmission of concepts [48]. By using these resources, instruction becomes more engaging and fosters stronger relationships between teachers and students in the classroom [49]. On the other hand, improper usage of instructional resources can lead to confusion among the teachers and the pupils in communication and in the delivery of the lesson. The students would not comprehend the material and might lose motivation, which would lead to subpar academic performance [50]. Using tangible and physical objects as teaching aids is an effective way to support the teaching of basic sciences. These resources conceptualize the subject being taught and make learning engaging, efficient, and meaningful [51]. Instructional materials help both the teacher and students in learning general rules and concepts. Thus, there is a need to always use instructional materials when teaching chemistry in secondary schools.

Furthermore, studies have indicated that whether or not teachers use pertinent instructional materials has a substantial impact on students' academic practical success in basic science. As a result, using appropriate instructional materials is advised to get good results. Additionally, teachers can improve very well in both their performance and mastery of the subject matter when they endeavor to acquire, learn and understand modern tools, or else provide by improvising teaching aids locally were necessary [52]. When teaching basic science in secondary schools, instructional materials are used to create lesson plans, assess students' knowledge, give teachers advice on how to administer tests, and come up with original and creative ways to assess students' performance. This suggests that using instructional resources effectively is crucial for both teachers and students when teaching and studying basic science in secondary schools [32].

Factors Influencing the Utilization of Instructional Materials on the Teaching and Learning of Chemistry

The majority of instructional materials were neither assembled nor utilized in teaching and learning activities. The inaccessibility of educational resources in schools is one of the things that act as a barrier to the use of instructional materials [53]. Insufficient financing for schools is also makes it difficult for administrators to acquire the necessary teaching resources, particularly those

that are audio-visual, and prevents teachers from utilizing them effectively when teaching chemistry. Most crucially, many of the secondary schools in developing countries are not installed with supply of the necessary modern digital tools. This makes it difficult to operate items like computers, televisions, films, semiconductors, and other electrical and digital technology. Given that many African nations are still having difficulty integrating ICT into the educational system, [54] attests that the continent is falling behind in the use of ICT infrastructure. Schools don't have enough teaching materials or kits to teach and learn chemistry [55]. This had an adverse effect on the provision of high-quality education. Therefore, when teachers have access to all the materials they need and know how to use them, students can receive a higher-quality education [42]. Chemistry teachers concurred that inadequate funding, the high cost of instructional materials, mismanagement of educational funds, and inadequate policy implementation are the main obstacles to the effective provision of instructional materials for teaching chemistry [6].

The size of the class and the amount of time allotted to teaching each chemistry topic are other factors that restrict the use of instructional resources. If class sizes are not kept to a minimum, using the preferred teaching resources becomes discouraging [38]. Another barrier to the use of educational materials is the proficiency of teachers in creating and improvising them. The majority of teachers were found to be inept at operating and utilizing educational resources, particularly the

more contemporary and digital resources, which also caused issues with choosing and applying the right resources [56]. The utilization of instructional materials is also hampered by a number of factors, including low technical proficiency, inadequate laboratory technician coverage, a lack of in-service training programs, low teacher motivation, and brief class periods allotted to chemistry [57]. These problems need to be tackled to ensure smooth provision of instructional materials for teaching and learning chemistry.

Research findings that contrasted regarding the issues related to the efficient use of instructional materials in the teaching and learning of Chemistry in secondary schools showed that the problems are not limited time, excessive workloads for teachers, or unworkability of the materials [29, 58]. The results of [59], which discovered that a major barrier to the efficient use of instructional resources could be the science teachers' inability to manage their workloads at odds with this finding.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Many researchers have written about what instructional materials are and how important they are to the teaching and learning process. In order to make learning engaging, effective, and

meaningful as well as to grasp the concepts being taught, it is important to employ tangible, physical objects as teaching aids when studying the basic sciences. Instructional materials help both the teachers and students in learning general rules and concepts. Thus, while teaching chemistry in secondary schools, these resources must always be used. Based on the discussion of research findings it can be concluded that whether or not teachers use pertinent instructional resources, there is a noticeable difference in the academic performance of their students in chemistry.

Therefore, using instructional resources is advised to get good results. According to research findings, the majority of secondary schools lack the instructional materials required to teach chemistry, or if they have, they are non-functional. The findings come to the conclusion that while some instructional materials were available, many of them were not used to teach chemistry. Moreover, locally accessible and audio-visual teaching resources for chemistry were not accessible and used. The results also showed that a number of problems, including a lack of funding, poor use of educational money, a lack of in-service training, and low teacher motivation, prevent instructional resources from being provided and used effectively for teaching chemistry. Therefore, in order to meet the objectives of chemistry education, all relevant parties—including the government, principals, teachers, and students—must devise effective plans to guarantee the availability and effective use of sufficient chemical instructional resources.

The writers believe that there is still more work to be done in closing the gap in the area of teaching and learning. Using standard and improvised instructional materials appears to be the solution. Hence, chemistry teachers, school administrators and government in general should all aware of the role of instructional materials in teaching and learning of chemistry and they equally knew the strategies that will enhance the availability and utilization of such instructional materials in order to achieve production of resourceful teachers.

Recommendations

Based on this paper the following recommendations are made:

1. The teachers should encourage active student's participation in class by adopting instructional materials interactions.
2. Workshops, seminars, conferences or orientation courses on chemistry should be designed to acquaint the teachers with the latest development in the field of chemistry.
3. Chemistry teachers should improvise instructional materials from local material to enhance the teaching and learning process.
4. Teachers should be encouraged to be more resourceful in selecting instructional materials and planning how to use them. This will reduce the cost of procuring the standard instructional

materials. This could be achieved by organizing seminars, workshops, and in-service training for them.

5. Teachers should be encouraged to use instructional materials to teach abstract concepts to improve students' performance.
6. Government should within its lean financial resources ensure equitable distribution of instructional materials to schools in urban and rural areas for effective learning and teaching of science.

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