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Easy Way of Teaching Balancing of Chemical Equations at the Junior, and Senior High Schools and Colleges of Education, Using Activity-Based Approach

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Abstract

Science education is a good foundation for growth and development of every nation. This research tried finding the causes for the poor performances, reported in science, which is desirous of mammoth attention, using observation, interview and test. About 50 teachers and 50 students were interviewed in the process and the findings revealed that both teachers and students are part of the blame for the poor performances of students in science subjects and especially the chemistry component, which is driven largely by chemical equations. The JHS, SHS and Colleges of Education science teachers, students, administrators, curriculum planners, as well as parents and the government, hereby faced with the challenge of creating interest, and providing enabling environment, for the effective and efficient teaching of balancing of chemical equations in particular and the sciences in general to secure the future of the country. Pre and post-intervention processes indicated that there was improvement in the students' performance after the intervention. Adequate teaching and learning materials should be made available for activity-based lessons like 'Balancing of Chemical Equations'.

Keywords: balancing, activity, laboratory; equations, chemical symbols, science, teachers, students, intervention, pre-intervention and post-intervention

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INTRODUCTION

Chemical equations are balanced by adding stoichiometric coefficients to the reactants and products. These additions to both sides of the equations are important, because a chemical equation must obey, the law of conservation of mass and the law of constant proportions, i.e., the same number of atoms of each element must exist on both the reactant and the product sides of the equation. This means that chemical reaction can neither create nor destroy atoms. So, the same kind and number of atoms on both sides of the arrow is paramount (Hamid, 2019). Balancing of the chemical equation is mostly taught in chemistry courses and it is a noteworthy subject of matter for students with vast interest in mathematics, who want to see the linear and simultaneous equation being used (Risteski, 2012).

Chemical reactions in chemistry are fundamental and deserve consideration (Risteski, 2014). Actually, every chemical equation is the story of some chemical reactions, and symbols are used to represent chemical equations of chemical reaction. Chemical equations are relevant in theory as well as practical in chemical industry (Vishwambharrao, *et al*, 2013; Hamid, 2019).

The law of conservation of matter is quite important in science and particularly chemistry education and its applicability is reflected in practice through balanced chemical equations (Charnock, 2016). Every student who has gone through Junior high, Senior high schools and colleges of education is bound to come across ‘‘balancing of chemical equations’’, as a topic especially pure science student.

The substances initially involved in a chemical reaction, e.g. sodium (Na) + chlorine (Cl_2) are called reactants, but the newly formed substance, NaCl from the reaction between Na and Cl_2 is called the product. The products, by their properties are different from the reactants (Risteski, 2009). A chemical equation is balanced, if the numerical strength of each atom is equal at both sides of the equation (Zabadi and Assf, 2017).

Chemical equation can be balanced traditionally by inspection, which is obviously not a predictable process but may be good for simple chemical reactions.

Another common method rarely use by teachers in balancing chemical equations is the arithmetic approach, which is also described as linear or simultaneous equations' approach. In this approach, coefficients are assumed and worked on, using a set of linear or simultaneous equations.

Successful chemical reaction is a natural process and the resulting equation, well written can easily be balanced.

Science education is needed for the development of any nation and that is why it has been given a primary position worldwide (Edomwonyi-Out and Avaa, 2011). Within the framework of science teaching and learning, Chemistry, with chemical equation as a fundamental component, is widely reported based on its relevance (Edomwonyi-Out and Avaa, 2011). It was as a result of the worldwide recognition given to science that it was made a core – subject in the country's education system (Adesoji and Olatunbosun, 2008). It had been a requirement for offering most science-oriented courses until recently, when social studies could replace it, to gain admissions into the Countries tertiary institution (Salifu, 2017).

Science education is supposed to be students centred and practically oriented, to give the required results and this is achievable through motivation, but since the motivation is minimal, there is therefore the need to using the appropriate materials and methods in educating the students (Adesoji and Olatunbosun, 2008). In learning, each child needs to actively construct their own personal awareness and meaning (Usman, 2000). Usman (2006), remarked that the brain is not a passive user of information and to grasp what is learnt, a learner must actively construct meaning of what to be learned and that is why activity-based approach is emphasized here (Edomwonyi-Out and Avaa, 2011). It has been established that the faulty admission processes and requirements, are directly and indirectly weakening the foundation of science in this country by; discouraging students at the JHS, SHS and Colleges of Education from learning all the 'so called difficult topics'(Salifu, 2017).

The poor performance in science and for that matter, Integrated Science, leading to replacement of it for social studies has continued to be a major concern for science tutors in the training colleges and other analogous institutions since every country grows through science and

technology. The poor performance of students in Integrated Science at JHS and SHS levels has the potential to jeopardize students' chances of admissions into the tertiary institutions (Salifu, 2017). The recurrence of Integrated Science problems, challenging both students and teachers have been ascribed to a good number of factors and these factors include; students' attitude towards science; substituting social studies for science for admissions into the higher institution of learning, particularly the Colleges of Education; inadequate teaching and learning resources, writing of paper practical in the class rooms instead of real practical in the laboratory, for end of semester examinations, and poor teaching methodology which makes it difficult for students to understand basic concepts in balancing chemical equation. However, it is clear that lot of students struggle to understand the concept of balancing chemical equations because they do not understand how to write chemical formulae and equations of chemical reactions.

Considering these factors, assumed to be reasons why students' performance in science continues to drop, this study investigated the performance drop in balancing of chemical equations in chemistry and science in particular. This work aimed at improving the performance of science by using activity-oriented method to tackle one of the difficult topics, ''balancing of chemical equations''. The study therefore is to achieve the following:

- identifying the main causes of the students' inability to balance simple chemical equation problem.
- using an activity method as one of the interventions to help solve the problem.
- teaching students how to write chemical formulae and balance chemical equations

METHODOLOGY

A comprehensive and purposeful interview was used for this work. Fifty integrated science teachers and fifty students, across the JHS, SHS and Colleges of Education within Sagnarigu Municipality and Tamale Metropolis in the Northern Region of Ghana were interviewed. Questions associated with teacher attitudes, qualification, students' choice of discipline, students' attitudes and factors within the environment were asked and their responses documented and examined.

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Inspection method of balancing chemical equations, which is sometimes described as traditional method is obviously not a reliable process and does not produce a systematic evaluation of the assumed coefficients in the balancing process. Another common method of balancing chemical equations is the approach, using linear or simultaneous equations. This method treated coefficients as unknown variables and they were solved using linear or simultaneous equations (Hamid, 2019). Three intervention processes such as pre-intervention, intervention and post-intervention were adopted to improve learning of 'balancing of simple chemical equation'. Thirty (30) students volunteered to take part in both pre- and post-intervention stages of the exercise.

Steps in Writing Chemical Formulas of Compounds or Molecules

1. Know the chemical symbol of the atom of an element
2. Know the valency of each atom of an element of the compound
3. Write the valances of the atoms of elements on the atoms
4. Interchange their valences and write them at the subscript of the atoms of elements as seen in the following examples.
5. When the valences of the atoms of elements are the same, they cancel each other

Example 1: $Cl^1Na^1 \rightarrow Na^1Cl^1 \rightarrow Na_1Cl_1 \rightarrow NaCl$

Na is chemical symbol for sodium and has valency of 1; Cl is chemical symbol for chlorine with valency of 1. NaCl is chemical formular for sodium chloride

Example 2: $Na^1 (CO_3)^2 \longrightarrow Na^1 (CO_3)^2 \longrightarrow Na_2CO_3$

CO_3 is carbonate with a valency of 2

Example 3: Write down the chemical formular for Aluminum Oxide

$Al^3 O^2 \longrightarrow Al^3 O^2 \longrightarrow Al_2O_3$

Al is a chemical symbol for Aluminum with a valency of 3

O is a chemical symbol for oxygen with a valency of 2

Al_2O_3 is the required formular for aluminum oxide (Meredith, *et al.*,2021)

How to Write Balance Chemical Equations Using Activity-Based Approach

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1. Chemical symbols are used to write and balance **chemical equations**. Consider a chemical reaction between methane molecule (CH_4) and oxygen molecules (O_2). This reaction yields carbon dioxide (CO_2) and water (H_2O) molecules. The chemical equation representing this reaction and its molecular models presentation is seen in Figure 1.

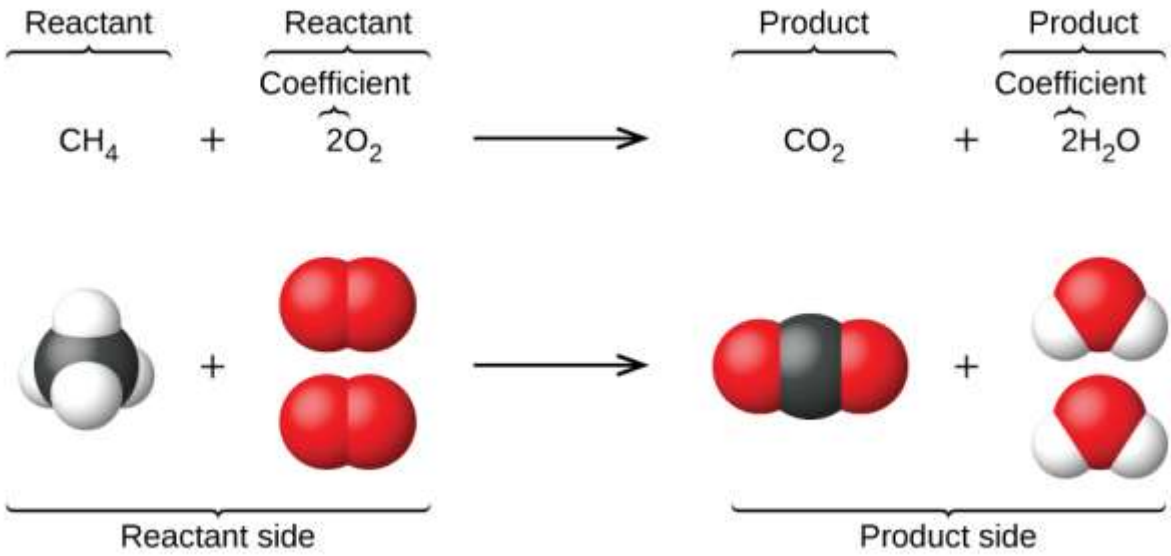

Figure1**.** Carbon dioxide and water obtained from a chemical reaction between methane and oxygen (*Stoichiometry of Chemical Reactions*)

This example in Figure 1, exemplifies the basic features of any chemical equation:

a. The formulas of substances to the left of the chemical equation are called **reactants**.
b. The formulas of substances generated to the right sight of the equation are called **products**.
c. Individual reactant and product formulas are separated, using, + and an arrow (⟶) separates the reactant and products of the equation.

2. The number of moles of each species is written in front of each formula.

Using Activity Method to Demonstrate How to Balance Chemical Equations Using Bottle Tops

$N_2 + H_2 \rightarrow NH_3$**:** That is (Reactants) + (Yield) → (Product)

Bottle tops can be used to demonstrate to pupils as to how this equation can be balanced as shown below:

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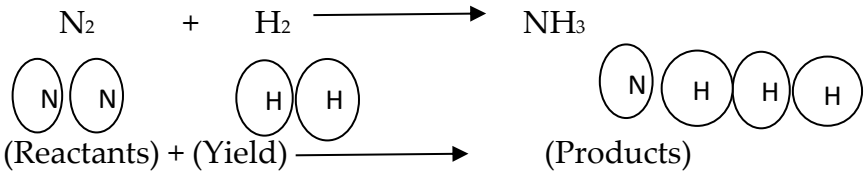
a. Write symbols of atoms of elements of reactants and products. Represent the atoms as bottle tops.

b. Represent nitrogen (N) as red bottle tops and hydrogen (H) as green bottle tops. As shown below:



c. Count the number of different bottle tops on the reactants and products side. As shown below;

Reactants	Products
$N_2 = 2$ (N N)	$N = 1$ (N)
$H_2 = 2$ (H H)	$H_3 = 3$ (H H H)

In the above table the students realized that, they had two (2) red bottle tops as nitrogen (N) in the reactants side and two (2) green bottle tops as hydrogen (H). Also, they realized that, they had one (1) red bottle top as nitrogen (N) in the product side and three (3) green bottle tops as hydrogen (H). The students also realized that, the equation is not balance because the number of nitrogen (N) and hydrogen in the reactant side is not equal to the number nitrogen (N) and hydrogen in the product side.

d. To balance the equation, write co-efficient in front of the reactants or product where necessary to make all atoms in both reactants and product equal. This is shown below:

$$N_2 + 3H_2 \longrightarrow 2NH_3$$

(Reactants) (Yield) (Product)

Now the equation is balanced because three (3) is placed in front of hydrogen (H) and whole number two (2) in front of nitrogen in both reactants and product to make the equation equal. Hence balance as shown below:

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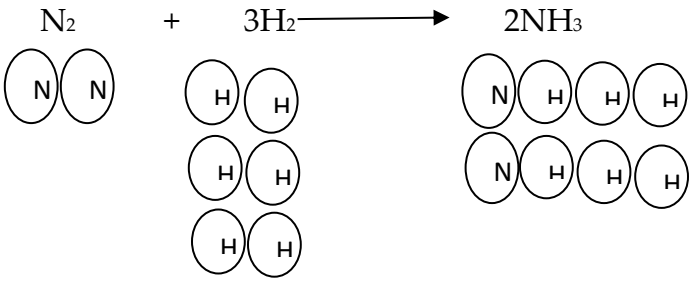

The above illustrations show that nitrogen (N) which represents red bottle tops, hydrogen(H) which represent green bottle top have six (6) green bottle tops in the reactants side as well as product side. This shows that the above chemical equation is balanced. The above demonstration could be carried out severally with different equations. After which you give students exercise to try their hands on the activity.

Methods of Balancing Chemical Equations

1. *Balancing Chemical Equation by Inspection*

Owen and Jim (2017) noted that, "for an equation to be balanced accurately, the same number of each type of atom must appear on both sides of the equation''. They also state that for a "Chemical equation to balance the same number of each element present before the reaction take place must also be present on the product side of the equation". Numbers are placed in front of chemical formulas to express their number of moles for the reaction to occur. These numbers of moles can be altered to ensure a balance at both sides of the chemical equation.

Consider the chemical change that occurs inside a photographic flash bulb, when magnesium (Mg) burns in air, it reacts with the oxygen (O) to yield magnesium oxide. This type of reaction is used in camera flash bulb, forming bright white flash of light. Several steps will convert this chemical statement into a balance equation.

Convert the chemical statement of the whole reaction into symbols for the reactants and products. As shown below

$$Mg + O_2 \longrightarrow MgO$$

(Reactants) (Yield arrow) (Product)

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Now to balance the equation, there is one (1) atom of magnesium (Mg) each at both sides of the equation; but two (2) oxygen (O) atoms on the left- hand side and one (1) atom of oxygen (O) on the right- hand side. Balancing the equation requires adding by multiplying coefficients, in front of chemical formulas. If two (2) is placed in front of magnesium (Mg) on the left-hand side of the equation, same must be done to magnesium (Mg) on the right- hand side, which means doubling the number of oxygen (O) atoms on the right- hand side of the equation too since you may not change the ratio of atoms within a molecule, because it will change the identity of the substance. The new chemical equation (balanced) is shown below (Helmenstine, 2021).

$$2Mg + O_2 \longrightarrow 2\,MgO$$

(Reactants) (Yield arrow) (Product)

Steps to Follow in Balancing Chemical Equations by Inspection

Martin Silberberg (1996) proposed that, the following steps can be used to balance a chemical equation. He used a problem to explain the steps one after the other. The problem he used was that, hydrocarbon octane (C_8H_{18}), with oxygen from air burns in car's cylinder to form carbon (IV) oxide (O_2) and water vapor. The balance chemical equation for the problem can be written following the steps below.

i. Transform the statement into a chemical equation, using chemical symbols. Octane and oxygen are reactants. Carbon (IV) oxide and water vapor are produced.

$$C_8H_{18} + O_2 \longrightarrow CO_2 + H_2O$$

ii. Most complex substance (C_8H_{18}) should be balanced first and balance oxygen last. Thus;

CO_2 contains one atom of carbon so eight (8) molecules of CO_2 are needed to balance the carbon atoms in each C_8H_{18}.

$$C_8H_{18} + O_2 \longrightarrow 8CO_2 + H_2O$$

Eighteen (18) hydrogen (H) atoms in C_8H_{18} require nine (9) moles of H_2O.

$$C_8H_{18} + O_2 \longrightarrow 8CO_2 + 9H_2O$$

Placing the co-efficient 25/2 before O_2 balances the oxygen to the right hand side

$C_8H_{18} + 25/2CO_2 \longrightarrow 8CO_2 + 9H_2O$

iii. Martin Silberberg (1996) in the third step adjusted the co-efficient by multiplying through by two (2).

$2C_8H_{18} + 25O_2 \longrightarrow 16CO_2 + 18H_2O$

iv. Check that the equation is balanced.

Reactants [carbon (C) 16, hydrogen (H) 36 and oxygen (O) 50]

v. Finally specify the state of matter.

C_8H_{18} is a liquid; O_2 and H_2O are vapor gases

$2C_8H_{18(l)} + 25O_{2(g)} \longrightarrow 16CO_{2(g)} + 18H_2O_{(g)}$

The chemical equation, thus, is balanced as indicated above

How to Improving students' Performance in Balancing Simple Chemical Equations

The teacher and students all have roles to play in activity method base lesson.

The both have a number of roles to play before, during and after the lesson.

The activity method is important to the teacher and the students., for instances, the teacher does not make lengthy talks in activity method and the students also discover facts without the interference of the facilitator or the teacher. It also has a number of disadvantages, example, difficulty in time management.

Balancing Chemical Equation Using Linear and Simultaneous equation

Consider and balance the following chemical equation using linear equation approach

$N_2 + H_2 \rightarrow NH_3$

a. Make sure the chemical equation is correctly written
b. Assume the coefficient of one of the reactants, exampleN_2 to be one (1) and assign variables (x and y) to the coefficient of the remaining reactants and products and solve for them as;

$$N_2 + xH_2 \rightarrow yNH_3$$

c. Establish linear equations for each atom of elements. That is

N: 2 + 0 = y……..Equation 1

H: 0 + 2x = 3y……Equation 2

d. Solve for x and y

Y = 2 and x = 3

e. Substitute x and y into the chemical equation gives

$$N_2 + 3H_2 \rightarrow 2NH_2$$

Consider and balance the following chemical equation using linear equation approach

$$C_8H_{18} + 0_2 = CO_2 + H_2O$$

a. Make sure the chemical equation is correctly written

b. Assume the coefficient of one of the reactants, example0_2 to be one (1) and assign variables (x and y and z) to the coefficient of the remaining reactants and products and solve for them as

$$xC_8H_{18} + 0_2 = yCO_2 + zH_2O$$

c. Establish linear equations for each atom of elements. That is

i. C: 8x + 0 = y + 0……. Equation3

ii. H: 18x + 0 = 0 + 2z……. Equation4

iii. O: 0 + 2 = 2y + z ……. Equation5

d. Solve for x, y and z

X = 2/25 Y =16/25 and x = 18/25

e. Substitute x and y and z into the chemical equation gives

$$2/25C_8H_{18} + 0_2 = 16/25CO_2 + 18/25H_2O$$

Multiply through by 25, gives a balanced equation as presented below

$$2C_8H_{18} + 250_2 = 16CO_2 + 18H_2O.$$

FINDINGS

Interviews:

Teachers' Attitudes: The revelation was that, teaching is a stepping stone for most professional teachers.

Comments:

Some of the interesting comments made by the teachers include;

a. "No better alternative jobs; we are just praying and hoping to leave this job" said by a professional teacher and this is clear indication of lack of commitment to handle the science subjects better.
b. "I have been teaching for long but my heart is somewhere". Another unprofessional comment from a teacher. This comment can lead to poor input, there by influencing efficiency of the teacher negatively.

Students' attitude: It was also discovered that some students at the SHS did not choose to do science but for want of admission, they were pushed into doing science.

The following were said by some students;

a. "Sometimes I fail integrated science largely because of the chemistry in it, especially the chemical equations issues''.
b. "It is difficult to understand Balancing of chemical equations, so I don't have much time for the subject";
c. "I did not like it too much, I prefer the biology components to the chemistry components because of the balancing of chemical equations";
d. "Sometimes when it gets to the chemistry components of science, the way the teacher handles it, always scare me".

Non-professionalism: At the JHS level, some of the teacher did not do pure science and they are compelled to use their integrated science background to teach the students. The research discovered non-professional chemistry teachers at the SHS due to lack of adequate chemistry teachers and when it gets to some of the technical areas, like balancing of chemical equations; they do ignore or skip them.

Time Management: Schools with large enrolment, topics that are easy to understand are given to the students to do their own studies so as to reduce the work load on the teacher. One teacher remarked that "if you try doing all in the classroom, most of the time you encroach into another person's period". Other teachers have the view that teaching them how to answer exam questions is sought, because passing the exam is the ultimate. They forget that understanding the concept can give the students the urge to learn and understand some of the topics on their own.

In service training: For quite a number of science teachers interviewed. The new teacher said "I have not attended any workshop since I started teaching chemistry"; other teachers said "I have attended many workshops and it has helped me in teaching".

Class Size: When teachers were asked about the effect of large enrolment on their teaching. Their comments were;

a. "I have an average number of 60 students in a class and I teach several classes, and this influences my efficiency because, managing the whole class is an issue, secondly, I cannot guarantee the understanding or participating of each student in the teaching and learning process".
b. One interviewee said; "I have a total of 80 students in each of the classes I teach, so I use most of the time controlling the class and the actual time for teaching is very small and this negatively influence the student's performances in their final examinations"

Conditions of service: unenviable payment system and remunerations have dampened the spirit of most teachers. Some of them mentioned that they have to combine teaching with "gallamsey" teaching, and other businesses, to take care of other expenses in their families. All these things will negatively impact their performances especially on some topics like how to write chemical formulas, equations and balancing of chemical equations.

Laboratory Availability: Chemistry is a practical subject and laboratory will be the best place to teach it; however, most SHS lack essential facility, the least said about JHS, the better. Student interviewee said "I wanted to be a science student and started offering chemistry, but we have

no lab and no teacher, in fact the only demonstration we did was the use of magnets to attract magnetic substances".

One the students said "I am now about to finish SHS and we have just been introduced to the lab, but I don't enjoy the experiment because the place is not conducive". In the same school, some students who do integrated science said "we doubt whether we have lab".

Some teachers had this to say: "We always go to resource centres in other schools to have our laboratory work, and this lab is not well equipped, the place is not conducive and this scares students during practical lessons"; "we don't conduct practical often, until exams are approaching".

Choice of Programs: Some students interviewees said ''they are into sciences by their own personal choice not by compulsion'', one student proudly said "my parents insisted I must be a science student because all my brothers are arts students and at least one of you must be an engineer".

DISCUSSION

The findings revealed that teaching is used as a stepping stone, teachers don't have teaching at heart and this reflects the way they teach their subjects, and this negatively affects students' output. It is also manifested that students' undesirable attitude towards chemistry led to their inability to appreciate topics like "balancing of chemical equations".

Time constraint is found to be one of the main issues impeding students' progress in science learning causing unwanted results; because course outlines are not covered, practical lessons are not carried out. Lecture methods either than activity method, which is time consuming, are mostly used because of the time limit.

In applying inspection method to balance chemical equation is always a headache and this throws students away from chemistry and integrated science lessons. The times and periods allocated to Integrated science and chemistry per week are inadequate for effectiveness and efficiency of teaching and learning.

Lack of functional laboratories, which is an environmental factor is a very serious damaging factor when it comes to teaching Integrated science and chemistry. The available laboratories

are ill equipped and some students thought practical lessons carried out early enough would be the best way to go. Faroumbi (1998) cited in Edomwonyi-Out and Avaa (2011) argued that students learn better for seeing than hearing. Using laboratories in the teaching of sciences should be the way to go, but lack of functional laboratories is the bone of contention.

Interviewees acknowledged large class size as a major militant against proper teaching and learning. 'Chemistry' and in this case balancing of chemical equations requires getting the students involved, as it demands practical demonstration, but this is frustrating with large class size. The issue of large enrolment agrees with Onocha (1985) and Edomwonyi-Out and, Avaa (2011), who reported that large class size is not conducive for good academic exercise.

A very important issue, worthy of consideration is "who teaches what?" students' performance in sciences and Chemistry is hinged on whether a teacher is a professional or not. Some professional teachers are asked to handle courses they did not do in their professional institutions, especially at the remote communities. This is highly seen in private and Government school at villages. Teachers teaching subjects that they do not have control over are very pervasive and needs to be controlled by Ghana Education Service.

Poor pay framework; a lot of the teachers alluded to the fact of poor salaries and allowances. This poor payment discourages most teachers and their basic duties are neglected and this pushes them into other money-making ventures to support their livelihood. These teachers look for better opportunities and with this mind-set, could not be effectively efficient, hence affecting students output.

Science already is tagged to be "difficult" and this may be due to the way and manner the teachers poorly handle some of the technical and tactical topics in science. For example, "balancing of chemical equations" is very empirical in nature and needs student-centred approach, that is why in this research, activity-based approach was used to explain how to balance chemical equation without much toil. Between inspection or traditional method and the algebraic or linear equation or simultaneous equation approach, the latter is the best as it saves time and labour and give assurance to getting good results than the former. Both methods were used for the intervention process for students to appreciate the efficacy of each method. The

researcher conducted the test before and after intervention to diagnose the extent of the difficulty in balancing simple chemical equation and to determine the effectiveness of the intervention design to addressing the problem. The researcher used this instrument to measure the level of understanding of pupils in balancing simple chemical equation. The test was administered to some of the students at all the levels of education mentioned in this work.

During the study a pre-test was conducted. The result of the test was recorded as shown in Table 1.

Table 1: Pre-intervention Test Scores of Students.

Test Scores	Number of students	Percentages(%)
9-10	0	0.0
7-8	2	4.4
5-6	7	23.3
3-4	15	50.0
0-2	6	20.0
Total	**30**	**100**

From the table above, it is clear that 30 students were tested out of the target 50 students, this is because not all of them were ready to write the test, which is usual of students. It also indicated that 50% of the students with highest frequency had marks between 3-4 marks, which is failure. no student scored between 9-10 marks.

A post-intervention test was also conducted to assess the effectiveness of the measures put in place to help students to learn how to balance simple chemical equation in science. The result of the test was recorded as seen in the Table 2:

Table 2: Post-Intervention Test Scores of Students.

Test Scores	Number of Pupils	Percentages (%)
9-10	19	63.3
7-8	6	20.0
5-6	5	16.7
3-4	0	0.0
0-2	0	0.0
Total	**30**	**100**

From Table 2, no student scored below 5 marks. Thus, the percentages scored of pupils between 0-4 marks is 0% and that is relatively greater improvement.

CONCLUSION

The research revealed that teacher, student and environmental associated elements; attitude, school environment, time management, poor remuneration, issues of defunct laboratories etc., contributed to teaching and learning challenges in "balancing chemical equations" leading to abysmal performance in integrated science and chemistry. These factors directly and indirectly offered opportunities to boost the performance index of students in some core topics, in integrated science and chemistry. Students' participation in science lesson would improve as compared to previous teaching and learning exercise due to practical presentation, on how to balance chemical equations. The activity-based approach coupling with appropriate teaching and learning materials had improved students' performance.

It can also be concluded that the performance of pupils in the pre-intervention test, was very bad. However, there was relatively great improvement at the post-intervention stage and this outcome means that the approach suggested to balancing of chemical equations in this article, when adopted by science teachers could help solve problems in balancing chemical equations among students in JHS, SHS and in Colleges of education.

Considering the impact of the practical approach, with respect to balancing of simple chemical equations, teachers should adopt the good intervention measures, instituted and implemented

here, to give positive impact on the problem at stake as it has reduced the duration and difficulties students encounter, in balancing simple chemical equation.

RECOMMENDATIONS

1. Qualified teachers should be used to teach science
2. Schools infrastructure should be improved to take care of large students enrolment
3. Every school should have a well-equipped and functional laboratory
4. Science teachers and teachers in general should be paid well to retain them in the classrooms
5. Adequate teaching and learning materials should be made available for activity-based lessons like 'balancing of chemical equations'.

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