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UTILIZATION OF ALGEBRAIC EQUATION METHOD IN TEACHING BALANCING CHEMICAL EQUATIONS

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University of Saint Louis
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Title: UTILIZATION OF ALGEBRAIC EQUATION METHOD IN TEACHING BALANCING CHEMICAL EQUATIONS

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Abstract:

In the University of Saint Louis Tuguegarao – Junior High School Unit, Chemistry is taught as a subject of Grade 9 students, unlike most schools which introduce chemistry in Junior High School as early as Grade 7 since they observe the spiral curriculum. Balancing chemical equations is one of the recurring difficulties of students in chemistry. This study aimed to improve students' knowledge and skills on balancing chemical equations using an algebraic equation method and determine the effectiveness of the said intervention among Grade 9 students at the University of Saint Louis Tuguegarao. The study utilized the randomized pre-test/post-test design quasi-experimental approach to determine the effectiveness of the algebraic equation method. The respondents constituted 165 students of Grade 9 Patience, Honesty, Generosity, and Friendship of the University of Saint Louis Tuguegarao. Grade 9 Patience and Grade 9 Generosity were part of the control group, whereas Grade 9 Honesty and Friendship constituted the experimental group. The teachers administered a pre-test and a post-test relative to the introduction of the algebraic equation method. The pre-test and post-test were administered to the students face-to-face in their respective classrooms during their science class. The program was implemented in February 2024. The results revealed that there is a significant difference between the pre-test scores of the experimental group and control group. There is also a significant difference between the post-test scores of the experimental group and control group. These results suggest that the intervention method is effective in enhancing students' capacity in balancing chemical equations.

Keywords: Algebraic equation method, balancing chemical equation, chemistry, stoichiometry

INTRODUCTION

Interest in a subject matter is crucial in the student's achievement of the set learning objectives and in the retention of acquired knowledge and skills over a longer period (Harackiewicz, et.al, 2016). Science, as a subject, is perceived differently by students. Students favor certain sciences over others and their interest in the sciences vary according to numerous factors such as age, strategies used by teachers, perceived difficulty, and contextualization (Blankenburg et. al., 2015; Van Griethuijsen et. al., 2015).

Interest in the subject matter is influenced by their difficulty as perceived by the students. Science is perceived as a hard and discouraging subject in school by most students (Aschbacher et.al., 2010). Chemistry, for instance, is one of the natural sciences that is often described as difficult by students. Chemistry is seen as difficult, complex, abstract, and would require too much effort to be understood (Candellini, 2012). The declining interest is attributed to the idea of the inclusion of mathematics as a tool in understanding subjects such as chemistry and physics (Oon and Subramanian, 2010).

Chemistry is an important field of study which influences our understanding of several fields of science such as biology, geology, meteorology, among others. Therefore, the success of students in their chemistry subject is imperative in their learning achievement in other fields of sciences that they will encounter in their succeeding year levels. Chemistry teachers must elicit a positive attitude among students towards learning the subject by utilizing strategies that will make the lessons appear less inherently difficult, particularly on lessons that involve problem solving, mathematical or non-mathematical. In the University of Saint Louis Tuguegarao – Junior High School Unit, Chemistry is taught as a subject of Grade 9 students, unlike most schools which introduce chemistry in Junior High School as early as Grade 7 since they observe the spiral curriculum.

Balancing chemical equations is one of the most basic requirements in chemistry. Helmenstine (2010) defined balanced chemical equation as "an equation in which the number of atoms for each element in the reaction and the total charge is the same for both the reactants and the products". This emphasizes the relationship of the reactants and products in a chemical reaction. Balancing chemical equations requires basic skills in mathematics to solve the stoichiometric coefficients of the reaction, which is regarded as a mathematical problem. The inability to balance chemical equations and use of inconsistent stoichiometric relationships are some of the recurring difficulties in stoichiometry problem solving among students (Shadreck & Enunuwe, 2018). Thus, there is a need for chemistry educators to implement appropriate problem-solving pedagogical techniques to address the difficulties of students in stoichiometry problem-solving. A major challenge for teachers is the selection of appropriate problem – solving techniques or models as there will entail new relationships and insights as a phenomenon or concept is presented (Cardellini, 2012; Treagust, et.al, 2018).

One of the fresh methods employed by chemistry teachers to teach stoichiometry is the algebraic equation method. According to Tarmizi and Bayu (2020), "algebraic equation method is a structured approach to problem-solving in mathematics, where equations are systematically formulated and solved to find unknown quantities". This method is particularly emphasized in teaching algebra and serves to develop students' ability to translate real-world problems into mathematical expressions and equations for solution. Students who are taught balancing chemical equations using the Algebraic method performed better than those students taught the same topic using other method, which suggest that when the algebraic method is used in teaching and learning balancing chemical equations, students' performance improves significantly (Chibuye and Mupela, 2017; Bhattacharjee, 2015; Gabriel & Onwuka, 2015). These findings encourage the introduction and implementation of the method to improve the learning skills of the students in certain aspects of stoichiometry, particularly balancing chemical equations.

This study aimed to improve students' knowledge and skills on balancing chemical equations using an algebraic equation method and determine the effectiveness of the said intervention among Grade 9 students at the University of Saint Louis Tuguegarao. The results of this study can be utilized as basis of syllabi and learning plan design on lessons in chemistry, particularly on stoichiometry.

Research Questions

This study aimed to determine the performance of students in balancing chemical equations using algebraic equation method.

Specifically, the study sought to answer the following questions:

1. What is the performance of the students in the pretest and post test scores?
2. Is there a significant difference between the pretest and post test scores of the students?
3. Is there a significant difference between the post test scores of the students in the controlled group and experimental group?

Theoretical Framework

Behaviorism Learning Theory

Behaviorists' understanding of learning was based on cause and effect. In this conceptualization, a behavior was followed by reinforcement. If the behavior was followed by positive reinforcement, then the behavior was more likely to be repeated; if there was negative reinforcement, the behavior was less likely to be repeated.

Two problem-solving methodologies explain the problem-solving process within the behaviorist learning theory framework. One such method is trial and error. This involves attacking the problem with various methods until a solution is found. In their emphasis on trial-and-error learning and habit strength, behaviorists focused on stimulus-response interactions' role in problem-solving. These early conceptions of learning and problem-solving described the observable characteristics of the process and did not seek to elaborate on the cognitive mechanisms of the subject.

Cognitive Heuristic Theory

The heuristics Polya identifies in mathematical problem-solving are discussed within the framework of a four-stage problem-solving model. Some of the heuristics applied within this plan include understanding the unknown, understanding the nature of the goal state, drawing a graph or diagram, thinking of structurally analogous problems, simplifying the problem, and generalizing the problem.

These heuristic methods can be applied to a problem in any content domain; thus, they are considered general problem-solving skills. In addition to the problem-solving processes already discussed, other heuristics have been identified. People often have to make decisions in the face of uncertainty, with sketchy information about the situation, on the basis of suggestive but inconclusive evidence. The reasoning processes used to resolve uncertainty are often called judgment heuristics. One form of judgment heuristic is similarity judgment, where an instance is evaluated based on prior knowledge of a similar instance.

A similar type of judgment is representativeness, where an assumption is made based on the belief that the characteristics of the individual are representative of the group. Another heuristic is the availability heuristic. In this case, judgments are made based on which elements can most easily be retrieved from memory. Analogical reasoning is another heuristic method, where judgment is made by drawing similarities to events that have occurred previously. Still, another judgment heuristic is the development of a mental model (simulation) to predict the outcome of an event. These heuristics are examples of general-purpose thinking skills that apply to many domains. The heuristics approach emphasizes finding a good representation of the problem. While content-specific knowledge is required to solve the problem, math and computer science studies supported the belief that general problem-solving skills were also valuable.

Theory of Cognitive Development

Bruner summarizes the research on domain-specific problem solving: “Expertise, these studies suggest, relies on highly organized, domain-specific knowledge that can arise only after extensive experience and practice in the studies in domain-specific problem-solving expertise also introduce the underlying principle of metacognition. Metacognition is the ability to think about thinking, the self-awareness of problem-solving, and monitor and control one’s mental processing.

The ability to solve problems successfully depends on several factors related to the human information-processing (IP) system. This higher-order learning theory elaborates on the cognitive processes of problem-solving. Regardless of the content domain, six attributes define expert-novice differences in problem-solving skills within the IP framework. The preceding review of research in general problem-solving methods and domain-specific problem-solving characteristics has concluded with a summary of the characteristics of expert problem-solving. The discussion of both general and content-specific problem-solving attributes leads to the conclusion that content knowledge and general problem-solving skills are necessary for expert problem-solving. ge is best gained through a process of action, reflection and construction. (Brau, 2018).

Hypotheses

There is no significant difference between the pre-test and post-test scores of the students in the controlled group and experimental group.

There is no significant difference between the pre-test scores of the students in the controlled group and experimental group.

There is no significant difference between the post-test scores of the students in the controlled group and experimental group.

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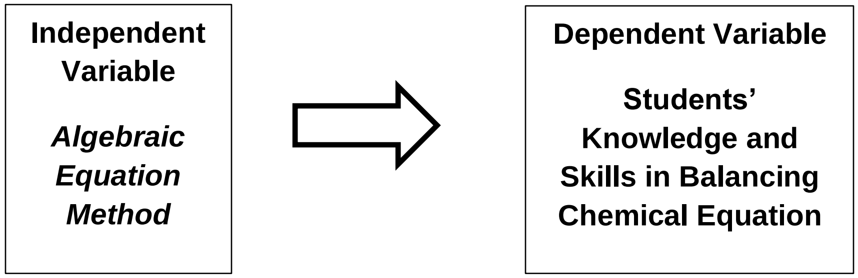
Research Paradigm



The paradigm shows how the study was conducted. The independent variable which the researchers utilized in this study is the intervention program – Algebraic Equation Method which aimed to improve the knowledge and skills of Grade 9 students in balancing chemical equation while the dependent variable is the test scores of the respondents. The respondents were given a pretest prior to the utilization of the intervention program then their scores were compared after the post-test. The difference in the post-test scores of the two groups served as the parameter in measuring the effectiveness of the intervention program introduced and used.

METHODS

Research Design

The study utilized the **randomized pre-test/post-test design** quasi-experimental approach to determine the effectiveness of the intervention program – Algebraic Equation Method to the students' knowledge and skills in balancing chemical equations.

Participants

The respondents constituted 165 students of Grade 9 Patience, Honesty, Generosity, and Friendship of the University of Saint Louis Tuguegarao. Grade 9 Patience and Grade 9 Generosity were part of the control group, whereas Grade 9 Honesty and Friendship constituted the experimental group. The respondents all belong to the Science Curriculum, and all their lessons and assessments are given face-to-face and through the university's Learning Management System - GENYO.

Locale of the Study

The study was conducted among students of the University of Saint Louis Tuguegarao, one of the biggest universities in the Cagayan Valley Region located specifically in the City of Tuguegarao.

Research Instruments

The teachers administered a pre-test and a post-test (Appendix D) relative to the introduction of the intervention method. The pre-test and post-test were administered to the students face-to-face in their respective classrooms during their science class. The target lesson was delivered using the trial-and-error method in both the experimental and control groups prior to the pre-test with the use of a worksheet (Appendix A) and a slide presentation (Appendix B). A worksheet was used by the teachers in the delivery of the lesson in the experimental group using the algebraic equation method (Appendix C).

Data Gathering Procedure

The research followed three phases of data gathering:

a. Pre-treatment Phase

The researchers sought the permission from the Vice President for Academics through the Basic Education School Principal for the conduct of the study. The researchers requested the Junior High School teachers teaching the Chemistry with Research subject of Grade 9 – Patience, Grade 9 – Honesty, Grade 9 – Generosity, and Grade 9 – Friendship to employ the trial-and-error method to teach the lesson on “Balancing Chemical Equations” on February 19, 2024, and to administer the 20-item pre-test on February 20, 2024. The test was administered within 30 minutes.

b. Treatment Phase

The lesson what retaught to the experimental group (Grade 9 – Honesty and Grade 9 – Friendship) on February 21, 2024, with the teachers using the design intervention program involving algebraic equation method. The control group which included Grade 9 – Patience and Grade 9 – Generosity was also retaught with the lesson by the teachers, using the same trial and error method.

c. Post-treatment Phase

After the intervention program, the same test was administered to the experimental and control group on February 22, 2024, within 30 minutes. Their scores were evaluated and compared to determine if there is any significant difference.

Data Analysis

The results of the pretest and the posttest (Appendix E) were compared to determine whether the intervention program is effective or not. The scores of both groups in the pretest and the post-test were taken and coded, tallied, and statistically treated using mean and standard deviation to describe the level of performance of the students in the tests. The paired sample t-test was used to determine the significant difference between the pre-test and post-test results of the students.

Frequency and percentage were used to interpret the pre-test and post-test scores of the participants using the following range.

Range	Qualitative Description
20	Excellent
17-19	Very Good
14-16	Good
11-13	Fair
10 and below	Poor

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RESULTS AND DISCUSSION

The following are the results and analysis of the data gathered.

A. Pre-test and Post-test Scores of the Participants

Table 1 shows the results of the Pre-test Scores of Participants in the Control and Experimental Groups

Table 1

Mean Scores	QD	Control Group		Experimental Group	
		N	%	N	%
20		0	.00	0	.00
17-19		2	2.40	0	.00
14-16		8	9.80	12	14.60
11-13		36	43.90	50	61.00
10 and below		36	43.90	20	24.40
Mean Scores		**10.88**		**11.28**	

The test scores show that the students under the control group got a Pre-test mean score of 10.88, which suggests the most students performed fairly in the pre-test given. 43.90% of the participants of the control group got a fair score ranging from 11-13. Also, 43.90% of the participants performed poorly. Participants of the experimental group got a mean score of 11.28 in which 61% got a score ranging from 11 to 13. Both the control group and experimental group have FAIR mean scores suggesting similarities in knowledge and skills of both groups in balancing chemical equation after the first session using the trial-and-error method, and prior to the implementation of the algebraic equation method to the experimental group.

Table 2 shows the results of the Post-test Scores of Participants in the Control and Experimental Groups

Table 2

Mean Scores	QD	Control Group		Experimental Group	
		N	%	N	%
20		0	.00	25	30.50
17-19		1	1.20	42	51.20
14-16		7	8.50	14	17.10
11-13		47	57.30	1	1.29
10 and below		27	32.90	0	.00
Mean Scores		**11.43**		**18.28**	

The test scores show that the students under the control group got a Post-test mean score of 11.43, which suggests the most students performed fairly in the post-test given. 57.30% of the participants of the control group got a fair score ranging from 11-13. Participants of the experimental group got a mean score of 18.28 with 51.20% of the participants getting a score ranging from 17 to 19.

B. Significant Difference in the Pre-test and Post-Test Scores of Participants in the Control and Experimental Groups

Table 3 shows the results of the T-Test of paired samples of the pre-test and post-test scores of both groups to determine whether there is a significant difference.

Table 3

Test	Groups	Mean Scores	Mean Difference	t-value	P-value	Decision
Pre-Test	Control	10.88	.40244	1.083	.280	**Accept Ho**
	Experimental	11.28				
Post-Test	Control	11.43	6.85366	25.321	.001	**Reject Ho**
	Experimental	18.28				

The results show that the pre-test scores of the control group are not significantly different with the pre-test scores of the experimental group, with a p-value of .280 at a 0.05 level of significance. This supports the idea that the capacity of the students in the given lesson of both groups is very similar. On the other hand, the null hypothesis is rejected when the significant difference between the post-test scores of the controlled group and experimental group is examined. There is a significant difference between post-test scores of the participants in the controlled group and the experimental group.

C. Significant Difference Between the Scores of Participants in the Control and Experimental Groups

Table 4 shows the results of the T-Test of paired samples of the post-test scores between two groups to determine whether there is a significant difference.

Groups	Test	Mean Scores	Mean Difference	t-value	P-value	Decision
Control	Pre-Test	10.88	-.54878	-2.564	.012	**Significant**
	Post-Test	11.43				
Experimental	Pre-Test	11.28	-7.0000	-24.970	.001	**Significant**
	Post-Test	18.28				

Based on the results shown in the table above, the null hypothesis is rejected considering a level of significance of 0.05 in both the experimental and control group. There is a significant difference between the pre-test and post test scores in the control group. The same is observed in the experimental group.

Teaching practices should address the difficulties experienced by students for better students' achievement of learning. One of the primary concerns that limits students' understanding of chemistry lessons is the choice of teaching method. The methodology used by the chemistry teacher is crucial in ensuring learning achievement through ensuring retained interest and targeting critical thinking skills (Kousa et. al, 2018; Utami et.al, 2017). Balancing chemical equations is one of the recurring difficulties of students in chemistry (Shadreck and Enunuwe, 2018). This is supported by the low student achievement shown in the results. Most students had a score below seventy-five percent in the pre-test in both groups, and in the post-test of the control group.

Shadreck and Enunuwe in 2018 found that the use of problem-solving instruction was effective in remedying the identified difficulties of students in chemistry in comparison to the conventional lecture method. Problem-based learning is an effective tool in teaching chemistry. Allowing students to analyze problems is crucial in developing their critical thinking skills and learning achievement overall (Aidoo et. al, 2016). The algebraic equations method employs problem solving skills. As noted by Mathis et al. (2020), algebraic equations are essential in demonstrating real-world scenarios, enabling quantitative analysis and prediction in various fields of study including chemistry. This is supported by the results of this study with revealed that the intervention activity – algebraic equation method, is effective in enhancing the capacity of students in the stoichiometry lesson – balancing chemical equations. The result of this study is congruent with the finding of Chibuye and Mupela (2017) which revealed that students who were taught balancing chemical equations using the Algebraic method performed better than those students taught the same topic using other method, which suggest that when the algebraic method is used in teaching and learning balancing chemical equations, students' performance improves significantly. Other studies (Gabriel & Onwuka, 2015) reveal that algebraic method is important in the learning of balancing of chemical equations because it helps average students and below average students to experience success in balancing, and hence avoiding frustration and failure which might contribute to students' loss of interest in balancing chemical equations.

The methods of the teachers matter significantly in the success of students' learning. Continuous upgrading of teachers' pedagogical and innovative capacity must be observed in schools to identify better strategies in teaching and learning and to identify conventional practices that may not be as effective in the instruction process.

Conclusions

Based on the data gathered and analyzed, the researchers conclude that the Algebraic equation method is an effective intervention to enhance students' knowledge and skills in stoichiometry, particularly in balancing chemical equations.

Recommendations

Based on the above findings and conclusions, the following recommendations are suggested.

1. Further studies exploring the impact of the method on the scientific skills and attitudes of students should be conducted.
2. The inclusion and evaluation of other methodologies and strategies to address difficulties in balancing chemical equations should be explored also.
3. Experimental setup considering more participants should be considered in further studies.

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APPENDICES

Appendix A

Balancing Chemical Equations Worksheet

Trial and Error Method

BALANCING CHEMICAL EQUATIONS

Balancing chemical equations is essential if you want to determine the quantities reactants or products. An unbalanced chemical equation gives only the identity of the beginning reactants and the final products using the appropriate formulas, as well as the temperature, physical state, and pressure conditions under which the reaction is to operate. Quantities involved are indicated until the equation has been balanced. A balanced equation assures that the law of conservation of mass-the total mass of reactants must equal the total mass of products-is obeyed.

- A chemical equation is balanced when there is an equal number of atoms of each element on both sides of the equation.
- To balance equations, coefficients are used.
- Coefficients are whole numbers written in front of the chemical formulas of reactants or products to balance the number of atoms of eve element in a chemical equation.
- Coefficients represent the number of molecules or formula units of the species involved in the reaction.

TRIAL-AND-ERROR METHOD

Although there are many ways to balance an equation, the steps and guidelines that follow describe an intuitive and convenient balancing technique that you can follow in learning the basics of balancing chemical equations. This method is the most basic process of balancing equations through inspection.

1. The numerical subscripts in the formula of a compound are fixed; they cannot be changed to balance an equation.
2. The coefficients should be the smallest whole numbers possible.
3. The coefficient serves as a multiplier to each numerical subscript in the formula to which it is attached.
   Example: $2Na_2SO_4$ indicates the presence of four Na atoms (2x2), two S atoms (2x1), and eight O atoms (2x4).
4. Balance first the elements other than oxygen or hydrogen. Find the compound on either side of the equation that contains the greatest number of atoms of an element other than oxygen or hydrogen.
5. Balance hydrogen or oxygen next. Choose the element that is present in a fewer number of compounds first.
6. Check to see that the number of atoms of all elements are balanced. Additionally, the balanced equation should have the smallest possible whole-number coefficients.

To apply the given procedures above, let us take the following examples.

Sample Problem 1.

- In the Haber process, hydrogen gas reacts with nitrogen gas to produce gaseous ammonia. Represent this reaction in the form of a chemical equation and then balance.

Solution:

- Hydrogen gas, nitrogen gas, and gaseous ammonia are written as $H_{2\,(g)}$, $N_{2\,(g)}$, and $NH_{3\,(g)}$, respectively. The reaction can therefore be represented as

$$H_{2\,(g)} + N_{2\,(g)} \rightarrow NH_{3\,(g)}$$

- Balance the nitrogen first. To do this, place a coefficient of 2 before NH_3. In doing so, we have temporarily balanced nitrogen.

$$H_{2\,(g)} + N_{2\,(g)} \rightarrow 2NH_{3\,(g)}$$

- Next, balance the hydrogen. This can be done by placing the coefficient 3 before H_2.

$$3H_{2\,(g)} + N_{2\,(g)} \rightarrow 2NH_{3\,(g)}$$

- We now get a balanced chemical equation. We can confirm this by first counting the number of H and N atoms on both sides of the equation:

Left Side	Right Side
H = 3x2 = 6	H = 2x3 6
N=1x2 = 6	N = 2x1 = 6

- As can be seen on the table, there is already an equal number of atoms of H and N on both sides of the equation. Further examination of the coefficients also shows that they are the smallest whole-number coefficients possible. Based on these, we can say that the equation is already the been correctly balanced.

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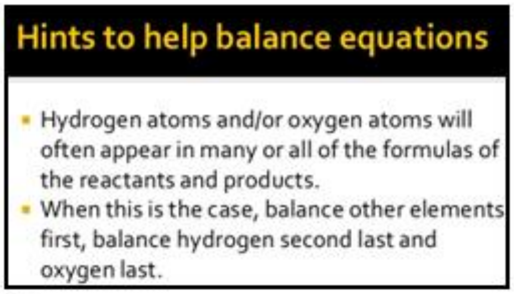
Appendix B

Slide Presentation

Trial and Error Method



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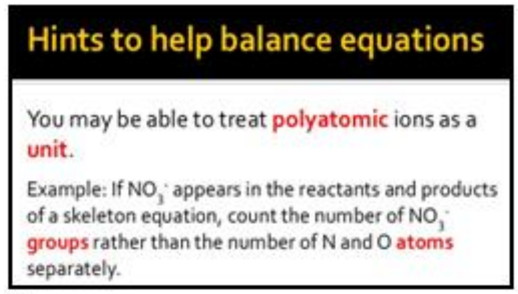

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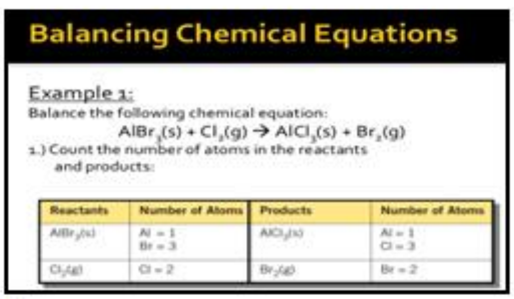

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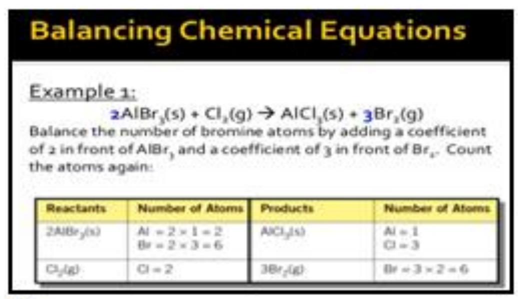

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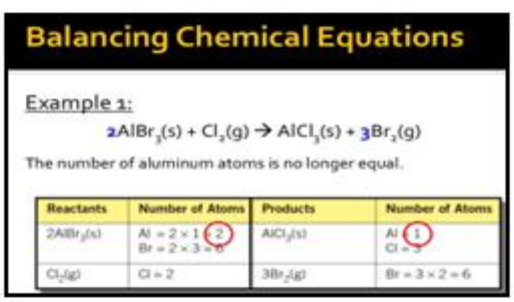

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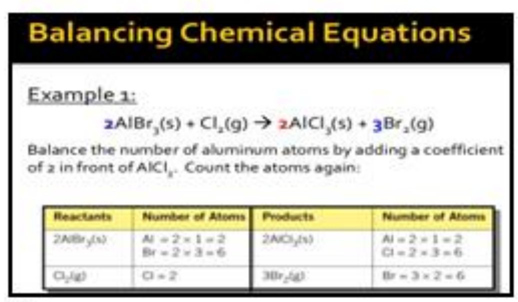

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GSJ: Volume 12, Issue 10, October 2024
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Appendix C

Balancing Chemical Equations Worksheet

Algebraic Equation Method

ALGEBRAIC METHOD

Balancing a chemical equation using algebraic methods involves assigning variables to the coefficients of the reactants and products and then solving the resulting system of equations.

Let's try using the method through the sample chemical reaction between hydrogen and nitrogen to form ammonia:

$$N_2 + H_2 \rightarrow NH_3$$

1. Assign variables to the coefficients of each compound:
   - a for N_2
   - b for H_2
   - c for NH_3

So, the equation becomes: $aN_2 + bH_2 \rightarrow cNH_3$

2. Balance the number of atoms of each element on both sides of the equation.
   - **Nitrogen (N) atoms:** $2a=c$
   - **Hydrogen (H) atoms:** $2b=3c$
3. Have a system of linear equations:
   - $2a = c$
   - $2b = 3c$

We can express **c** in terms of **a** as $c = 2a$
Substitute **c** into the second equation:

- $2b = 3(2a)$
- $2b = 6a$
- $b = 3a$

4. Let's assign smallest integer values for a, b and c. To find the smallest integer values, we can set ***a=1***.

   $a = 1$

   $b= 3a = 3(1) = 3$

   $c= 2a = 2(1) = 2$

Therefore, **a= 1**, **b=3**, and **c=2**

5. Now, we are ready to write the balanced equation by substituting the computed values as the coefficients of the chemical equation.

$$1N_2+3H_2 \rightarrow 2NH_3$$

So, the balanced equation is: $N_2+3H_2 \rightarrow 2NH_3$

NOTE:

If the computed value is a fraction, get the reciprocal and multiply it to all assigned values for each variable.

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UNIVERSITY OF SAINT LOUIS
Tuguegarao City, Cagayan

Appendix D

Pre-Test and Post-Test

Name: ______________________________________ Week: _______ Score: ________

Grade/Section: _________________________ Parent's Signature: _________________

NAME:

Directions: Balance following chemical equations. Show your complete solution and guided with the scoring guide below.

1. $Al + O_2 \rightarrow Al_2O_3$

2. $Fe + NaBr \rightarrow FeBr_3 + Na$

3. $P_4 + O_2 \rightarrow P_2O_5$

4. $NaNO_2 \rightarrow NaNO_2 + O_2$

5. $Mg + HCl \rightarrow H_2 + MgCl_2$

SCORING GUIDE	
COMPLETE SOLUTION (2 points)	
A. Correct balancing of atoms	1 point
B. Simplest whole number coefficient	1 point
FINAL ANSWER (2 points)	
Balanced equation	2 points
Total	4 points

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Appendix F

Test Scores of Students in the Pretest and Post-test

EXPERIMENTAL GROUP				
Student No.	**Pretest Score**	**SCALE**	**Post Test Score**	**SCALE**
1	14	3	16	3
2	14	3	19	4
3	5	1	20	5
4	10	1	20	5
5	7	1	19	4
6	11	2	19	4
7	11	2	17	4
8	3	1	16	3
9	12	2	19	4
10	7	1	19	4
11	13	2	20	5
12	13	2	20	5
13	11	2	15	3
14	6	1	17	4
15	9	1	20	5
16	11	2	19	4
17	11	2	19	4
18	11	2	20	5
19	13	2	20	5
20	13	2	18	4
21	14	3	18	4
22	11	2	18	4
23	11	2	15	3
24	11	2	18	4
25	13	2	17	4
26	13	2	20	5
27	14	3	19	4
28	13	2	19	4
29	11	2	20	5
30	11	2	18	4
31	11	2	18	4
32	12	2	15	3
33	11	2	19	4
34	13	2	17	4
35	14	3	16	3
36	14	3	19	4
37	11	2	20	5
38	12	2	19	4
39	12	2	20	5
40	11	2	20	5
41	12	2	19	4

42	8	1	13	2
43	13	2	16	3
44	13	2	20	5
45	13	2	19	4
46	11	2	17	4
47	15	3	17	4
48	9	1	16	3
49	10	1	19	4
50	8	1	15	3
51	9	1	17	4
52	11	2	20	5
53	11	2	16	3
54	14	3	19	4
55	12	2	20	5
56	7	1	20	5
57	5	1	15	3
58	10	1	18	4
59	11	2	17	4
60	12	2	20	5
61	14	3	20	5
62	12	2	19	4
63	10	1	18	4
64	11	2	19	4
65	10	1	19	4
66	13	2	20	5
67	13	2	17	4
68	12	2	20	5
69	11	2	19	4
70	11	2	14	3
71	13	2	18	4
72	14	3	20	5
73	15	3	20	5
74	13	2	19	4
75	9	1	16	3
76	12	2	20	5
77	12	2	18	4
78	10	1	19	4
79	7	1	15	3
80	12	2	20	5
81	16	3	19	4
82	13	2	20	5
CONTROL GROUP				
Student No.	**Pretest Score**	**SCALE**	**Post Test Score**	**SCALE**
1	12	2	10	1

2	12	2	13	2
3	10	1	12	2
4	7	1	10	1
5	9	1	9	1
6	13	2	10	1
7	10	1	12	2
8	11	2	9	1
9	14	3	10	1
10	13	2	10	1
11	10	1	11	2
12	6	1	10	1
13	13	2	13	2
14	8	1	11	2
15	11	2	10	1
16	12	2	10	1
17	11	2	8	1
18	14	3	11	2
19	12	2	11	2
20	10	1	9	1
21	10	1	11	2
22	11	2	12	2
23	11	2	11	2
24	14	3	13	2
25	8	1	12	2
26	7	1	10	1
27	10	1	13	2
28	9	1	10	1
29	7	1	10	1
30	12	2	10	1
31	10	1	11	2
32	17	4	17	4
33	11	2	11	2
34	10	1	13	2
35	14	3	15	3
36	13	2	12	2
37	12	2	12	2
38	10	1	11	2
39	12	2	13	2
40	10	1	11	2
41	11	2	10	1
42	6	1	9	1
43	8	1	9	1
44	10	1	11	2
45	11	2	12	2
46	9	1	10	1
47	12	2	11	2
48	10	1	9	1
49	9	1	12	2
50	9	1	11	2

UNIVERSITY OF SAINT LOUIS
Tuguegarao City, Cagayan

51	11	2	12	2
52	11	2	13	2
53	14	3	15	3
54	13	2	12	2
55	10	1	11	2
56	10	1	11	2
57	10	1	12	2
58	11	2	13	2
59	17	4	15	3
60	13	2	13	2
61	9	1	10	1
62	12	2	10	1
63	11	2	12	2
64	11	2	14	3
65	10	1	11	2
66	11	2	13	2
67	12	2	11	2
68	16	3	12	2
69	5	1	10	1
70	14	3	15	3
71	11	2	13	2
72	13	2	13	2
73	6	1	9	1
74	9	1	10	1
75	9	1	12	2
76	13	2	14	3
77	10	1	11	2
78	11	2	10	1
79	14	3	12	2
80	13	2	15	3
81	9	1	11	2
82	12	2	11	2