

Improving the Problems of Writing Chemical Symbols, Formulae and Chemical Equations an Action Research



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Abstract

Objective: The researchers interested to assess and improve the general understanding of Generalist Focus Year II students in Nekemte College of Teacher education on chemical symbols, chemical formulae and chemical equations which are the fundamental elements of chemistry for anyone to begin learning this subject.

Methods: The study was both qualitative and quantitative type of research, because both numerical and non-numerical data were collected during the study through questionnaire, classroom observation, pre- and post- attitude tests and written tests. As type and source of data, the study used only primary. We used all the population as samples (totally 98 students in both sections) purposely. For the implementation of the action research, we first prepared action plan, applied the interventions, analyzed the changes and reported the results.

Results: Based on our null hypothesis, from both attitude tests (questionnaire) and written tests (for both pre-and post-) there is progressive change observed after interventions. From the base line data questionnaire of 15 items, almost 79.5 % of the respondents disagreed for items 1-11 (except item 5) which are assessing the students background on chemical symbols, chemical formulae and chemical equations and very high interest was raised from the students on items 12-15 (highest agreement for both item 12 & 13 by 93.88 % response) which were asking students' interest to learn the basic elements of chemistry languages. After interventions, both post-tests showed correlatively progressive figure in addition to the observations conducted during all interventions. For the attitude test analysis almost, the reverse responses were recorded with agreement response (in average 71.93 %) and for the written test result analysis at p (0.05) the t-statistic is greater than t-critical in all the three cases i.e. chemical symbols, chemical formulae and chemical equations.

Keywords: Chemical Formulae; Chemical Equations; Chemical Symbols; Focus; Generalist; Qualitative Analysis and Quantitative Analysis

Introduction

From our experience of teaching in the Nekemte College of Teachers Education (NCTE) since the introduction of linear and stream case in Educational colleges of Ethiopia, we have found that most of our students lack confidence in writing chemical symbols and Formulae. This problem was aggravating especially with the 2nd and 3rd year generalist students. It was what we have been confronted from student with different activities like class work, individual and group activities, and tests on different courses such as BNSc.101, BNSc. 102 and general chemistry (Chem. 201) in recent cases. When such difficulties occur in chemistry courses, it is difficult to measure whether the objectives of courses attained or not. In addition we have assessed that most of our students hesitate to choose Integrated and Generalist streams after completing bridge courses.

Literature Review

Studies of [1,2] argued that success in studying Chemistry depends upon the familiarity of students with a few basic ideas, conventions, and methods upon which later studies are built. When a student has achieved mastery of them, further studies can be pursued with greater confidence. One of the studies

[1] further adds that without mastery of these concepts, it is difficult for students to find higher levels of study in Chemistry. Specially, the use of chemical symbols, Formulae, writing chemical equations, calculations involving moles (solids, gases, and solutions) etc. are areas where students of chemistry beginners face most challenges. Action research, according to [3] defines as "a systematic collection of data in order to answer a research question for the purpose of improvement". For Lo Castro (1995) is "one form of classroom centered research which is seen as being small scale and situational focused on a particular problem, to try to understand and perhaps solve some concrete problem in an individual teacher's classroom" [4].

Thus, action research solves the problem and brings improvement to the student nationwide. It gives the area to the teacher in solving the problem faced by the students. There are three methods of doing action research, quantitative, qualitative and mix method. This paper focuses on a mixed method where results are quantified and analyzed accordingly. Research has become primary elements in education system around the world. With the developmental stages in the country, research would help to face adverse competition. It will moreover help to

understand the need of the society and will help accordingly to bring development. With stage changes must happen. Different disciplines of sciences Biology, Chemistry and Physics are of importance now a day. Coming to chemistry, student across the country finds it a difficult subject to learn. They even go to the extent of losing interest to study. Thus, our action research will motivate and inculcate interest in Chemistry, especially balancing chemical equation where student finds it difficult.

According to Johnstone [5] "Chemistry is a difficult subject for students. The difficulties may lie in the capabilities of human learning as well as in the intrinsic nature of the subject." Chiu [6] believes that "Chemistry is a world filled with interesting phenomena, appealing experimental activities, and fruitful knowledge for understanding the natural and manufactured world. However, it is complex." As a result of the difficult and complex nature of chemistry and also the fact that it is one of the most conceptually difficult subjects on the school and higher institution curricula, it is of major importance that anyone teaching chemistry is aware of the areas of difficulty in the subject. The concepts and principles in chemistry range from concrete to abstract. Many students of chemistry find certain concepts difficult to comprehend. The root of many of these difficulties that students have in learning chemistry is traceable to inadequate understanding of the underlying concepts of the atomic model, and how these are used to explain macroscopic properties and laws of chemistry [7].

Difficulties Faced in Writing Chemical Symbols and Formulae

Difficulties in the learning of chemistry can be precipitated by a lack of chemistry language skills. [8] found that students experienced greater problem in interpreting symbols than words correctly (as cited in research of [9]. Danili & Reid [10] studied the effects of working memory space and field-dependency on the learning of chemistry by Greek students. Learning not only of chemistry, but of all new information will fail if the working memory space is overloaded. This could occur if students are given too much information at once. Moreover, if students study chemistry in a language other than their mother tongue, difficulties experienced in chemical language could be linguistic, contextual or cultural in nature.

The understanding of valency, appreciation of concepts of polyatomic ions and molecules and ultimately the production of correct chemical formulae will depend on student's knowledge of bonding. Unfortunately, concepts in chemical bonding are highly abstract and it appears that only the most able students will be in a position to apply their knowledge of bonding effectively to scaffold the writing of chemical formulae [11].

Difficulties Faced in Writing Chemical Equations

Chemical equations can be defined as symbolic and quantitative representations of the changes that occur in the process of chemical reactions, based on the principle that matter

is neither created nor destroyed during chemical reactions. For example, the chemical equation: shows that A and B are the reactants while C and D are the products. The subscripts x, y, p and q are the stoichiometric coefficients which represent the relative amount of substance of the reactants and products. The single-headed arrow indicates the direction of the reaction and shows that the reaction is an irreversible one. The arrow means "gives", "yields" or "forms" and the plus (+) sign means "and".

However, studies have shown that the ability to write chemical equations correctly is not a simple one [11,13]. It is one that requires a functional understanding of the requisite subordinate concepts of atoms and atomicity, molecules and molecular formula, atomic structure and bonding, valency, use of brackets, radicals, subscripts and coefficient and molar ratio [11]. Studies conducted by Savoy [11] & Hines [14] have reported that chemistry students often have great difficulties in both acquiring and using the skills required to balance chemical equations. A similar study conducted by Johnstone, et al. [15] in Scotland revealed that students in senior high schools are rarely confident about writing chemical equations and then carrying out calculations based on them. A study by Anamuah-Mensah & Apafo [16] likewise revealed that students in Ghanaian senior high schools have difficulties in learning certain chemical concepts, including chemical combination. Approximately two-thirds of the students who took part in the study indicated that the topic chemical combination was either difficult to grasp or never grasped. Findings from research conducted by Lazonby, et al. [17]; Bello [18] have shown that students' persistent difficulties in solving stoichiometric problems are partly associated with their inability to represent chemical equations correctly.

Chief Examiners' (CE) reports available through the West African Examinations Council (WAEC) confirm that senior high school students experience difficulty when writing chemical equations. The 1994 CE report showed that most candidates were unable to write balanced chemical equations for the Senior Secondary School Certificate Examination (SSSCE) chemistry paper. The 1995 CE report followed suit and reiterated that many candidates demonstrated problems when writing chemical equations. In 1999, the CE report indicated that students were unable to write equations for reactions between Bronsted-Lowry bases and concentrated HCl. In 2001, the CE reported that the writing of ionic equations was poorly handled by candidates [19]. The 2004 chemistry theory paper required candidates to write a balanced chemical equation for the production of oxygen when KClO₃ is heated and then calculate the volume of the dry oxygen gas evolved [20]. The examiners' CE report for the above question noted that candidates had problems writing the equation correctly and hence could not get the correct mole ratio [21].

Based on the above, it is clear that over the years, students have experienced serious problems when writing chemical equations even though this is a basic requirement in chemistry. Without the proper writing of the chemical equation, students cannot subsequently solve or analyze equations.

Methods to Practice Writing Chemical Symbols and Formulae

Marais & Jordaan [8] recommended that students' understanding of symbols should be tested by including meaning items in content related tests and students should be discouraged from regarding chemical symbols as merely short-hand notations. Providing with a glossary of symbols and assigning group or individual exercises to supply correct symbolic notation is another technique [9]. Chunking or grouping pieces of information is important to reduce the demands on the amount of information to be held in the working memory. It will be affected by students' prior knowledge, experience and skills in a particular subject. Since chunking is highly individualized, students should be given the opportunity to develop their own chunking techniques [10]. The second language science students require the opportunity to practice science in the presence of more capable peers and they need to be introduced overtly to the language requirements of the particular discipline [22].

According to Bradley & Steenberg [9] the difficulty of lack of chemistry language skill can be solved by maximizing exposure to chemical language. Teachers should not assume that students are familiar with chemical terms; rather they should introduce the terms carefully. The symbols of common elements should be memorized thoroughly, and as well the less common ones might also need to be memorizing as they come to attention (Clark, 1982). Chemical formula writing worksheet solutions is another. It is a tabulate form consisting of boxes. We have to write chemical Formulae for the compounds in each box. The names are found by finding the intersection between the cations and anions written in the boxes. We can also write formulae using valencies. To write chemical formula using valencies, we need to know how to use the zero-sum rule; "for neutral chemical formulae containing ions, the sum of positive valencies plus negative valencies of the atoms in a compound must equal to zero".

Methods to Practice Writing and Balancing Chemical Equations Understanding the Language of Chemistry

Student should be familiar with the language of chemistry so that they can easily balance chemical equation. Knowing symbols, knowing the difference between ions, atoms, molecules and compound will invariably play important role. And not only knowing formula of compound but also the teacher should help students to think why chemical equation is balanced; will also help to easily balance the chemical equation. According to Beek & Louters [23], Marais & Jordaan [8] and Danili & Reid [10] also states "Difficulties in the learning of chemistry can be precipitated by a lack of chemistry language skills". They provide following recommendation to maximize students learning:

- Students exposure to chemical language should be maximized.
- Teachers should not assume that students are familiar with chemical terms and terms should be introduced carefully.

Marais & Jordaan [8] found that students experienced greater problems in interpreting symbols than words correctly. Based on their findings, they recommended that:

- Students understanding of symbols should be tested by including meaning items in content related tests,
- Students should be discouraged from regarding chemical symbols as merely short-hand notations which could be adapted to suit the individual user,
- Students should be provided with a glossary of symbols, and
- Students should be given group or individual exercises to supply correct symbolic notation [9].

Motivation

According to Johnstone and Kellett there is no doubt that motivation to learn is an important factor controlling the success of learning and teachers face problems when their students do not all have the motivation to seek to understand [24]. Motivating students in learning chemistry play key role when teaching students balancing chemical equation. Whenever they get their equation correctly balanced one should reinforce them and they overtly motivated for future learning. Through motivation students participate more and more and this makes the teacher to be highly interested to work hard at the same time to help students furthermore.

Methods

The Subjects of the Study

The target population of the study as aforementioned, are all Generalist Focus of Year-II regular and evening students of Nekemte CTE in semester two and 2017 academic year. There are two sections (one Regular-IIA and one Evening-IIA) in which totally 98 students were enrolled and attending their education.

The Sample and Sampling Techniques of the Study

All of the populations are included in the study purposely.

Research Approach and types & Sources of Data

The study was both qualitative and quantitative type of research, because both numerical and non-numerical data were collected during the study. As type and source of data, the study used only primary.

Instruments for Gathering Data

Questionnaire

The researchers employed questionnaire as a primary tool for gathering data. The questionnaire contains both open-ended and close-ended questions. This is because it is the most appropriate tool to obtain qualitative as well as quantitative information relative to the other methods. Besides, questionnaire is easy for the researcher to manage the construction of the questions and analysis of the responses. Moreover, it

Minimizes respondents' difficulties of anonymity and reduces effect of biased conclusion and misinterpretation of the data.

Classroom Observation

The other instrument used was classroom observation. The researchers decided to use this instrument to obtain data about the actual classroom situation during instructions. This was expected to enable the researchers collect information regarding the participation of students, the way the teacher implements the active learning methods and other related classroom conditions.

Written Test

Pre- and post-tests were carefully prepared by the team and conducted to assess performance of students in all the targeted items in the research i.e. chemical symbols, chemical formulae and chemical equations.

a. Baseline Data collection

1. Checking accuracy in writing chemical symbols and formulae,
2. Common mistakes everybody makes,
3. Barrier in writing chemical symbols and formulae,
4. Pre-test (including attitude test).

b. Methods of Data Analysis

The findings of the study were put into three categories in relation to our specific research questions that we found from the data collected (i.e. checking accuracy of students in writing chemical symbols, formulas and equations; barriers in writing

these basic elements and the ways of teaching that enhance students' learning of chemistry). Therefore, the data collection tools used were to answer the specific research questions as much as possible.

The data gathered from the respondents were organized and analyzed by the use of tables and percentages. This was conducted in such a way that the data were tabulated in tables and graphically indicated to illustrate more quantitatively described for the test results which were interpreted by using T-test method for the pre-test and post-test data. Responses gathered from targeted students in the Attitude tests were tabulated one by one for each item where necessary and converted in to percentages which enabled the researcher to describe in relation to the data collected through observation. Moreover, the responses that are collected by the open-ended questions collected from students specially, Attitude test questions, were organized and analyzed in accordance with the responses gathered through close-ended questions and classroom observations.

c. Implementation of the Action Plan

The researchers were implemented the proposed action strategies by interventions to improve student's performance through designing student-centered approach that help easily to avoid errors in writing the basic elements of Chemistry Language thereby developing confidence in how easily learn chemistry concepts. The interventions were implemented after the pre-test result analysis including other data results. Generally, the interventions implemented step-by-step are indicated in the table below (Table 1).

Table 1: Description of Interventions Implemented.

Interventions	Description of Tasks Accomplished
1	Teaching chemical names and terms
2	Teaching how chemical symbols are written, Giving the group activity and glossary of symbols
3	Teaching the concepts of atoms, atomic mass, ions, radicals, valency and molecules
4	Teaching the steps to write the chemical formulae
5	Teaching the significance of symbols and formulae in writing chemical equations and teaching the complete meaning of chemical equations including balancing chemical equations.

Note: Methods implemented to practice writing chemical symbols and chemical formulae were in accordance with Jordaan (2000); Bradley and Steenberg (2006); Danieli and Reid (2004); Rollnick (2000); Clark (1982); Johnstone & Kellett (1980). * Methods implemented to practice writing chemical equations were additionally used as Beek and Louters (1991).

Findings and Discussions

Attitude Test Results (Questionnaire)

Baseline data results and analysis

Students were made to tick against their degree of acceptance against each item. After collecting the baseline data we counted the total number of students in each item against [SD-strongly agree (4), A-Agree (3), DA- Disagree (2) and SD-Strongly disagree (1)]. Then we have taken the percentage of each item and analyzed it (Table 2 & Figure 1). From both Table 2 and graph 1 above more than 79.5 % of the respondents (on average) disagreed indicating lack of knowledge and understanding of the basic elements

of chemistry languages i.e. chemical symbols, formulae and chemical equations except in item 5 (which is relatively odd when compared to others, only 27.56 % of respondents showed their disagreement). The disagreement responses were figuratively high (more than 79 %) out of 10 (1-11) items asking their level of knowledge assessment, the highest response of disagreement were observed in item 11 (91.84 %) and items 9, 7, 3 and 1 (83.67 %, 82.65 %, 79.59 % and 79.59 % respectively) showing that the students were very poor background in having knowledge and skill in concepts of radicals, writing chemical formulae and about balancing chemical equations which is the worst of all. The reason that about 70 students showed agreement in item 5 is that they

seem to know and have better understanding of the symbols of the common most 20 elements of the periodic table. This is also

supported by chemistry that of all the items forwarded to the respondents, item 5 seems the common and easiest one.

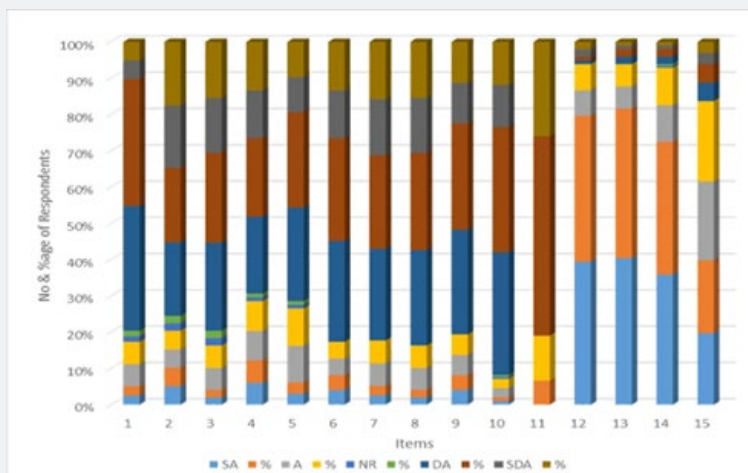


Figure 1: Table showing base line data of number of respondents and in percentage for each items (Questionnaire).

Table 2: Table showing base line data of respondents & in percentage for each items (questionnaire).

Item	SA	%	A	%	NR	%	DA	%	SDA	%	TNR
1	5	5.1	12	12.24	3	3.06	68	69.39	10	10.2	95
2	10	10.2	10	10.2	4	4.08	40	40.82	34	34.69	94
3	4	4.08	12	12.24	4	4.08	48	48.98	30	30.61	94
4	12	12.24	16	16.33	2	2.04	42	42.86	26	26.53	96
5	20	20.41	50	51.02	1	1.02	14	14.29	13	13.27	97
6	6	6.12	20	20.41	2	2.04	51	52.04	19	19.39	96
7	8	8.16	9	9.18	0	0	55	56.12	26	26.53	98
8	5	5.1	12	12.24	0	0	49	50	30	30.61	98
9	4	4.08	12	12.24	0	0	52	53.06	30	30.61	98
10	8	8.16	11	11.22	0	0	57	58.16	22	22.45	98
11	2	2.04	5	5.1	1	1.02	67	68.37	23	23.47	97
12	78	79.59	14	14.29	0	0	2	2.04	4	4.08	98
13	80	81.63	12	12.24	0	0	4	4.08	2	2.04	98
14	71	72.45	20	20.41	1	1.02	4	4.08	2	2.04	97
15	39	39.8	43	43.88	0	0	10	10.2	6	6.12	98

Key: - SA-Strongly Agree; A-Agree; NR-No Response; DA-Disagree; SDA-Strongly Disagree; TNR-Total Number of Respondents for each items.

When we come to their interest pre-test assessment to learn about the basic elements of chemistry languages, responses were recorded in items 12 and 13 (almost 93.88 % for both) with highest agreement but least interest in item 15 (83.68 %) when compared to the rest three items. This might indicate that in one case the difficulty level of balancing chemical equations and on the other hand, it needs various methods and investment of time to get students' understanding at all levels (Table 2) (Figure 1).

Post data results and analysis

After intervention the researchers started collecting post data's. We used the same tools to collect data for the Questionnaire. Different strategies were used considering the learning difficulties of the students when implementing the interventions according to

the designed strategies of interventions. After our interventions we analyzed the following data's based on questionnaire. The responses made by the students in each items (questionnaire) were compared in (Table 3) (Figure 2). During pre-data collection only less respondents have accepted (agreed) that they know the concepts stated in each the items 1 through 11 (except item 5) of the questionnaire. In post data collection almost the reverse responses were recorded (in average 71.93 %). respondents for items 1 through 7 have accepted that they can explain and apply the knowledge they acquired by interventions as stated in each items). Highest respondents in item 5 (85 respondents or 86.73 %) and lowest respondents in item 9 (52 respondents or 53.06 %) indicating that the difficulty level and investment time for different level of students' learning which is similarly interpreted

for the low in number of respondents on agreement in items 11 through 8 (57 and 59 respondents or 58.17 % and 60.21 % respectively). After implementation of intervention strategies, we

could see commendable improvement about understanding the concept stated in each item of questionnaire which were clearly indicated in (Figure 2).

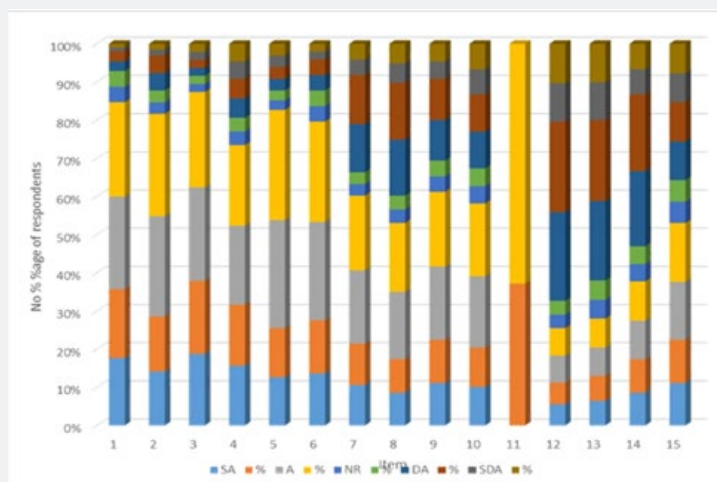


Figure 2: Figure showing students response against each items after interventions, questionnaire (post data).

Table 3: Table showing students' response against each items after intervention, Questionnaire (post data).

Item	SA	%		%	NR	%	DA	%	SDA	%	TNR
1	35	35.71	48	48.98	8	8.16	5	5.1	2	2.04	90
2	28	28.57	52	53.06	6	6.12	9	9.18	3	3.06	92
3	36	36.73	47	47.96	4	4.08	4	4.08	4	4.08	94
4	31	31.63	41	41.84	7	7.14	10	10.2	9	9.18	91
5	27	27.55	58	59.18	5	5.1	5	5.1	3	3.06	93
6	25	25.51	56	57.14	5	5.1	6	6.12	6	6.12	93
7	27	27.55	51	52.04	8	8.16	8	8.16	4	4.08	90
8	21	21.43	38	38.78	6	6.12	25	25.51	8	8.16	92
9	17	17.35	35	35.71	7	7.14	29	29.59	10	10.2	91
10	22	22.45	38	38.78	8	8.16	21	21.43	9	9.18	90
11	20	20.41	37	37.76	9	9.18	19	19.39	13	13.27	89
12	11	11.22	14	14.29	7	7.14	46	46.94	20	20.41	91
13	13	13.27	15	15.31	10	10.2	42	42.86	20	20.41	88
14	17	17.35	20	20.41	9	9.18	39	39.8	13	13.27	89
15	22	22.45	30	30.61	11	11.22	20	20.41	15	15.31	87

Student's exposure to the language of chemistry was maximized through concept teaching. The chemical terms used were explained in detail by applying various methodologies. Differences between atoms, molecules and compound were made clear. The only way student could learn Symbol and formula of different compound was through rote learning, memorization but background based concept analysis. Thus the above strategies have given area to learn and improvement was seen at the same time in our students after our interventions.

Results and Data Analysis on Pre- and Post-tests

Significance test of pre-test and post-test results

The researchers' analysis is that the significance difference between the mean scores in case of chemical symbol, chemical

formulae and chemical equations based on our null hypothesis in all three cases is $\mu_1 = \mu_2$ and the alternative hypothesis is $\mu_1 < \mu_2$. At $p(0.05)$ the t-statistic (3.35) is greater than t-critical (1.99); as a result, the null hypothesis is rejected for the chemical symbols i.e. there is significance difference between the post and pre-test result. Students who participated in the tutoring program, scored statistically significantly higher ($p < 0.05$) on the post-test than on the pre-test in chemical symbols questions. Similarly, at $p(0.05)$ the t-statistic (3.6) is greater than t-critical (1.99); as a result, the null hypothesis is rejected for the chemical formulae i.e. there is significance difference between the post and pre-test result. Students who participated in the tutoring program, scored statistically significantly higher ($p < 0.05$) on the post-test than on the pre-test in chemical formulae questions (Table 4).

And also at $p(0.05)$ the t-statistic (4.99) is greater than t-critical (1.99); as a result, the null hypothesis is rejected for the chemical equation as well i.e. there is significance difference between the

post and pre-test result. Students who participated in the tutoring program, scored statistically significantly higher ($p < 0.05$) on the post-test than on the pre-test in chemical equations questions.

Table 4: Statistical Excel T-Test Out Puts and Significance Test is to indicate that t-Test: Two-Sample Assuming Equal Variances for two variables (pre and post).

Variables	Statistical values	Symbol	Chemical Formula	Chemical Equation
pre-test	Mean (μ_1)	3.69	1	0.082
	Variance	3.26	1.42	0.076
	Observation	49	49	49
	t-statistic*	3.35	3.6	4.99
	t-critical*	1.99	1.99	1.99
Post-test	Mean(μ_2)	5.26	2.06	0.52
	Variance	7.26	2.77	0.29
	Observation	46	46	46
	t-statistic			
	t-critical			

Observation Assessment Discussions

Both the base data and pre-data (observation) was collected only after our interventions. First class work questions were forwarded in the class during interventions and checking and correcting their errors were conducted. Most of the students were successful on matching the chemical symbols and their word written on flip chart. However, there was still difficulties on balancing chemical equations for most students. But convincing improvements were observed through repeated practice and correcting for few students. In case of writing chemical formulae, average students shown interesting improvements after interventions specially, for monoatomic ions. Then through another intervention, the concepts were clear for most students on how to write chemical formulae including for polyatomic ions. After our overall interventions and student's continuous practices, there were admirable improvements in maintaining the retention of the concepts of basic elements of chemistry languages. These improvements were brought about by the researcher's most strategic interventions. When students do their work correctly on time they were reinforced and motivated at the same time. Sirhan [24] in his article pronounce the key to successful learning of the students are through motivations. When reinforced and motivated, students do their work on time and do it correctly [25-27].

Conclusion

Assessment through all of our tools (questionnaire, tests and observation) indicated us that almost all of the students lack good background on basic concepts of chemistry, especially, in case of our target (the basic elements of chemistry languages). As evidences shown us, our action research was successful. There were improvements in terms of writing chemical symbols (high achievement), writing chemical formulae (more than average) and balancing chemical equation (average to low). The success was due to the quality of intervention strategies implemented that were put forward by different authors. Following were the strategies;

understanding the language of chemistry, motivation, steps and different method in doing so Getting student exposed to language of chemistry was the best way to enhance student understanding. When student were taught with different chemical languages, like differences between ions, atoms, molecules, symbol and formula of the compound, student learn with ease. Motivation on other hand brings students interest and participation into teaching and learning process. Steps and methods helped student accurately to write chemical formulae and balance chemical equations. Additionally, action research helped us boom our professional qualities. Moreover this gives us area to learn ourselves and bring forth best improvement in our teaching. Research participants are benefitted as researchers put forward best learnt strategies in process of answering research issues. Thus, action research is very helpful especially to benefit oneself and community at large.

Recommendation

This study suggests that students should be made aware of chemistry learning tips of the following nature [23]:

To the Teacher

- Ensure that students' exposure to chemical language should be maximized.
- Teachers should not assume that students are familiar with chemical terms and terms should be introduced carefully [9].
- In the similar way of our case i.e. recommendation has helped to the maximum and is necessary when teaching student the skill of balancing.
- Moreover, when teaching, students must be provided with a glossary of symbols of different elements and formulas of different compounds and make them to rote learn with normal pacing to help students at all levels.
- Teaching students clear rules and steps and making them follow strictly is another way to enhance learning.

f. Using video clips on how to write chemical formulae (the rules) and balancing will also enhance student's understanding as we take them to different mode of teaching [28-30].

To the Students

a. Read the text before class

At least, the students should skim it. If they know what is going to be covered in class, they will be in a better position to identify their troubles and ask questions that will help them to understand the material. It is possible to learn chemistry on their own, but if they attempt this, they are going to need some sort of written material as a reference.

b. Work Problems

Studying problems until you understand them is not the same as being able to work them. If you can't work problems, you don't understand chemistry. It's that simple! Start with example problems. When you think you understand an example, cover it up and work it on paper yourself. Once you have mastered the examples, try other problems. This is potentially the hardest part of chemistry, because it requires time and effort. However, this is the best way to truly learn chemistry.

c. Do Chemistry Daily

If you want to be good at something, you have to practice it. This is true of music, sports, video games, science, everything! If you review chemistry every day and work problems every day, you'll find a rhythm that will make it easier to retain the material and learn new concepts. Don't wait until the weekend to review chemistry or allow several days to pass between study sessions. Don't assume class time is sufficient, because it isn't. Make time to practice chemistry outside of class.

Finally, it is obvious that students are introduced to formal science and science concepts after they joined Colleges. Hence, it would be easy for them to learn things starting from what they know previously. This is preferred especially in the case where names of elements and compounds with vast properties are chunked to one or more symbols of letters which remain mystery knowing properties underlying. In this case students associating the concepts to ideas in their own language could be helpful [31,32].

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