Impact of Classroom Assessment Cycle on Performance in Stoichiometry among Senior Secondary Students in Giwa Educational Zone, Kaduna State

[1]David Oluwadamilare ISRAEL
Email: davidisreal20@gmail.com
Tel: 08161832306

[1]Ramatu Ematum UMAHABA
Email: lilianumahaba@yahoo.com
Tel: 07010801327

[2]Abdullahi A. YAKUBU
Email: abdullahiyakub74@yahoo.com
Tel: 07065699399

[1]Department of Science Education, Ahmadu Bello University, Zaria
[2]Department of Science Education, Federal University, Gusau

Abstract
This study investigated the impact of classroom assessment cycle on performance in stoichiometry among senior secondary chemistry students in Giwa Education Zone, Kaduna State. Two research objectives of the study and null hypotheses, respectively guided the study. A total of 817 SS II chemistry students constituted the target population out of which 120 SS II chemistry students formed the sample size of the study. The study adopted pre-test, post-test quasi-experimental control group designs. The students in the experimental group were taught stoichiometry concepts using classroom assessment cycle while the control group students were taught stoichiometry concepts using lecture method. The instruments used for data collection was Stoichiometry Performance Test (SPT). The Reliability coefficient of SPT was 0.81 using test-retest method. The research questions were answered using descriptive statistics while the two null hypotheses were tested at $P \leq 0.05$ level of significance using independent t-test. The findings of the study showed that students in the experimental group were significantly better than those in the control group in performance. And classroom assessment cycle is found to be more effective in improving students' performance regardless of their gender. Based on the findings of this study it was recommended among others that chemistry teachers in senior secondary schools should adopt classroom assessment cycle in teaching difficult concepts like stoichiometry since it is not gender bias as this can serve as a tool for restoring quality teaching and learning of chemistry.

Keywords: Classroom Assessment Cycle, Stoichiometry and Performance.

Introduction

Within the context of science education, Chemistry is a very important school subject and its importance in scientific and technological development of any nation has been widely reported. Chemistry has contributed greatly towards providing our basic needs and improving the quality of our life. Chemistry is chiefly one of the fundamental ingredients of technology and an important requirement for technological development of any nation. It is based on this that the subject is placed as one of the core subjects that each science student must be exposed to at the senior secondary school level as stipulated in the National Policy on Education. According to Upahi and Jimoh (2015) the chemistry curriculum attempts to make the study of chemistry exciting and relevant. It is suggested that the learning of chemistry be situated in real-life contexts. The adoption of a range of such contexts together with a range of learning and teaching strategies and assessment practices is intended to appeal to students of all abilities and aspirations, and to stimulate interest and motivation for learning. Students are expected to be able to apply their knowledge of chemistry, to appreciate the relationship between chemistry and other disciplines, to be aware of the science-technology-society-environment (STSE) connections within contemporary issues, and to become responsible citizens. However, despite the fundamental position of chemistry among other science and related disciplines, several studies like that of Abdullahi (2014) and Yakubu (2016) revealed that academic performance of students in chemistry has been consistently poor and unimpressive.

Performance as observed by Danima (2016) is the exhibition of knowledge attained or skills developed by students in a subject designed by test scores assigned by teachers and the level of such students' growth when compared with the scores of others at the same level. Omorogbe (2013) ascertained that performance is a function of various factors such as method of teaching, teachers' qualification, attitude, motivation, among others. Hence, the problem of poor performance in chemistry have been attributed to poor preparation of teachers, low students' morale, overcrowded classroom, inadequate laboratory equipment, poor attitude of students to work amongst others. However, the use of poor teaching methods has been identified as a major cause of poor performance in science subjects. A shift is therefore advocated by researchers to methods that will enable the learners construct his/her own understanding. Therefore, efforts to find solutions to the recurring failure rate among science students will continue among science educators.

Stoichiometry, an aspect of SSCE chemistry curriculum is a concept that involves the use of quantitative relationships between reactants and/or products in a chemical reaction in order to determine desired quantitative data. According to Ajayi and Ogbeba (2017), despite the importance of Stoichiometry in understanding chemistry, and its industrial applications, research studies such as that of Olorundare and Oyelekan (2009) have shown that teaching Stoichiometry calculations is viewed by Chemistry instructors as a difficult task and invariably, Stoichiometry calculations have always been difficult for students. The factors responsible for these difficulties ranges from inadequate knowledge of the subject matter on the part of the teachers, use of lecture method and rote learning among others. Based on current reforms hinged on constructivism, several instructional strategies that ensure students' active participation have been advocated by various researchers. Nonetheless, Alkharusi (2008) and William (2011) are of the opinion that assessment is intrinsic to effective instruction and the use to which it is put by teachers has an impact on students' performance regardless of the approach to teaching and learning. Alkharusi

(2008) stated that classroom assessment practices which is an interplay of class contextual features, teachers' teaching experiences and assessment practices interacted significantly with students' characteristics in influencing students' achievement goals thus determining the level of their performance.

Assessment as an integral aspect of the teaching and learning system, according to Carless (2017), is a crucial driver of student learning and that well-implemented assessment processes can provide positive prospects for meaningful learning. Recent educational efforts have been geared towards the use of assessment to inform learners of their progress and empower them to take the necessary action to improve their performance. This approach to assessment is termed assessment for learning. According to William (2011), the evidence generated from any assessment that will support learning must be instructionally tractable. In other words, the evidence is more than information about the presence of a gap between current and desired performance. The evidence must also provide information about what kinds of instructional activities are likely to result in improving performance. The second requirement is that the learner engages in actions to improve learning; this may be undertaking the remedial activities provided by the teacher, asking a peer for specific help, or reflecting on different ways to move her own learning forward-after all, the best designed feedback is useless if not acted upon. Assessment for learning is focused on assessments that occur on a day-to-day basis within the science classroom. Such classroom assessment constitutes an on-going process in which teachers and students interact to promote enhanced student learning.

Chappuis, Stiggins, Arter, & Chappuis (2004) characterize this enhancing of student performance assessment process as assessment for learning and state that when they assess for learning, teachers use classroom assessment and continuous flow of information that it provides to advance and not merely check on student learning. Such assessment for learning helps students identify the strengths and weaknesses of their performance so that they can improve their achievement. It is differentiated from assessment of learning, which simply provides a means of rating students, or comparing them to one another. In order to meet up with the goals stated above and to promote assessment for learning, an outline of the classroom assessment practice is essential. This framework of classroom assessment is provided by Butler and McMunn (2005).

Classroom Assessment Cycle according to Butler and McMunn (2005) is an instructional tool involving an outline of assessment process that focuses on improving students' performance. Classroom Assessment Cycle constitute an ongoing instructional process in which teachers and students interact to promote and enhance student learning. This cycle involves using a variety of assessment strategies and tools such as rubrics, score cards, selected and constructed response tests, verbal questioning, informal and formal observations, teacher/student dialogue among others to collect information about student learning and then using the data collected to diagnose learning problems, monitor student progress, or provide meaningful and timely feedback to students. Classroom assessment cycle involves formative assessments conducted with the aim of enhancing both teaching and learning. It encompasses a range of activities from construction of assessment tasks, administration, marking and grading tasks, interpreting the results and using feedback to make decisions about teaching and learning so as to ensure that meaningful learning takes place. Classroom assessment cycle can be integrated into an instructor's teaching in a graduated way to elicit constructive feedbacks from students on teaching and learning. The four main steps of the

cycle according to Butler and McMunn (2005) are: clarifying learning targets; gathering evidence in a variety of ways; analyzing assessment data; and modifying instruction.

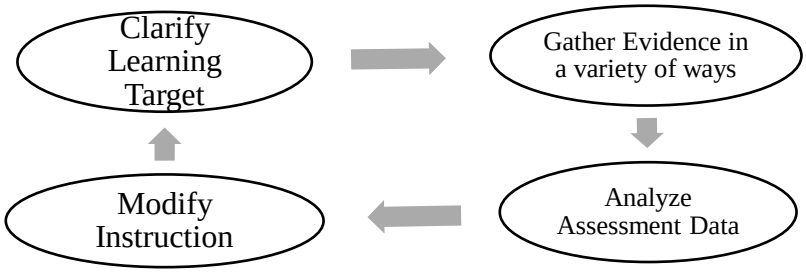

Figure 1: Classroom Assessment Cycle

Clarify Learning Targets: Learning targets helps to understand exactly what students should know and be able to do. Therefore, learning targets should be shared with students prior to the actual instruction or assessment of that learning target. Knowing the target is necessary for learning to occur and when shared with students upfront, we are making it possible for them to hit the target.

Gathering Evidence in a Variety of Ways: assessments are valid when they actually provide information about student achievement of the intended learning target. Getting evidence of learning target achievement have to be done in a variety of ways. Methods of assessment could be through the use of selected response or constructed response, questioning, observations and teacher/student dialogues. To foster validity, it is important to tie assessments to particular learning targets. More so, meaningful feedback during practice must be given to students to make them learn about their strengths and weaknesses before it counts, that is, before a grade is taken or recorded. In addition to using variety of assessments which is suitable for learning targets, it is important for the teacher to convey his/her expectations to the students, provide evidence of their present level of performance, and then suggest strategies to improve that performance.

Analyzing Assessment Data: It is not enough to collect the assessment data, assessment data must be reviewed immediately after collection; the data must be interpreted to formulate inferences and/or conclusions; feedback (verbal, written comments, rubric scores etc.) must be provided to students relative to their performances; and ultimately, the findings of the analysis must be used to adjust instruction.

Making Instructional Modifications: In analyzing assessment data after reviewing assessment data, the teacher is expected to look for patterns, formulate inferences, test or verify inferences, and draw conclusions. Once learners' problem has been identified through these processes, an instructional modification is necessary.

This study is hinged on socio-cognitive theory as advocated by Vygotsky (1978). Vygotsky's socio-cognitive theory perceives learning as a social process that takes place in a context that allows for social interactions and communication which eventually leads to the construction of knowledge and cognitive development. According to this theory, learning first occurs through human interaction, after that, with help of tools (including language) and human mediation, it is eventually internalized. The social cognitive learning theory of Vygotsky is related

to the present study in that classroom assessment cycle, which is an instructional tool involving an outline of assessment process that focuses on improving students' performance, provides the context that allows for social interactions and communications between student-student and teacher-students.

A number of factors have been identified as militating against students' attainment of the objectives of science instruction. Common isolated factor among researchers is the inappropriate and uninspiring pedagogical approach of imparting knowledge to learners. Hence, majority of the researches have seek to establish plausible and innovative approach to teaching. These researches hinge on the theory of constructivism. This theory emphasizes students' active participation in the construction of their knowledge and the teaching strategies associated with this theory provides a continuum along which teacher participation decreases and students' participation increases.

Reports of several researches such as Nbina (2010), Yakubu (2016) and Ahmad (2017) based on constructivism conducted over the years revealed a positive relationship between academic performance, retention, interest, motivation etc. and the teaching-learning strategies accentuated by the constructivists. For example, Yakubu (2016) submitted that when students are taught mole concepts using concept-mapping and analogy strategy, there was a significant difference in their performance when compared to those taught using the conventional method. While the findings of these researches are worthwhile, it is evident in literature that most teachers still depend on lecture method. One aspect that is being left out is the place of students centered assessment which may be another factor affecting students' performance. Students' decisions about their academic capabilities are formulated on the basis of classroom assessment evidence. In contexts where wide gaps appear in performance between and among different subgroups of the student population, the chances are high that low performers have judged themselves to be incapable of succeeding.

In most of the researches and teaching process, assessment and instruction are often conceived as distinct entities in both time and purpose. More so, students are not allowed to get involved in their own assessment. Since one of the unique peculiarities of constructivism is students' active participation, there is need to also involve them in the classroom assessment which is also an integral part of the curriculum and instructional process. It has been advocated that students' involvement in assessment could add more value to the learning process. This is the posit of the classroom assessment cycle. In this study it was proposed that the use of classroom assessment cycle may change students' thinking about their capability and possibly enhance their performance in stoichiometry.

Recently, studies have been conducted to stress the importance of varying assessment strategies to advance students' learning such as Hager, Eremina and Reginald (2016); Olagunju (2015); Baylon (2014) and Balan (2012). Hager, Eremina and Reginald (2016) observed that in most developing countries, such as Nigeria, assessment practices focus primarily on examinations (summative assessment) in which little or no emphasis on classroom assessment methods are made. Most teachers appear to focus more on the activities, laid- out for teaching in order to end scheme of work than on outcome/mastery. Most teachers administer classroom assessment specifically to generate mandatory terminal continuous assessment scores. The evaluation functions are high-lighted, whereas the guidance and learning processes are not high-lighted. A high priority is accorded the collection of marks for records, rather than enquire into learners'

activities to detect learning requirements and assessment strategies that would improve and enhance learning.

Balan (2012) conducted a study on Assessment for Learning: A case study in Mathematics Education. The study was conducted in an upper-secondary school mathematics classroom situated in the south of Sweden. The aim of this study was to introduce a formative-assessment practice in a mathematics classroom. The findings indicate an improvement in problem-solving performance for the students in the experimental group. The students also show improvements in how to reason about mathematical solution. Baylon (2014) investigated the effects of classroom assessment on the critical thinking and academic performance of students. The study was undertaken to evaluate the classroom assessment employed by the teachers, the critical-thinking and academic performance of the students in the laboratory high schools (LHS) of Central Bicol State University of Agriculture Philippines, school year 2012-2013 in Mathematics, Science and English. The findings reveal there were significant differences in the levels of critical thinking and their academic performance in the three subjects. In general, the findings indicated that there were significant association between the student-related factors and the different levels of critical thinking.

Olagunju (2015) investigated the effect of formative Assessment on students' achievement in secondary school Mathematics. This study was carried out in Iseyin Local Government of Oyo State, Nigeria selected through purposive technique made up the study sample. Findings from analysis revealed that formative assessment has a strong significant difference in the mean achievement score of Mathematics students that are exposed to it while there is no significant difference in the mean achievement scores of student who were not exposed to formative assessment. Also, there was no gender difference in the achievement scores of Mathematics students that were exposed to formative assessment.

Difference in the performance of both male and female students in science subjects when exposed to various instructional strategies are reported by Nbina (2010), Wachanga, Mugiira and Mbugua (2013); Ajayi and Ogbeba (2017) to be insignificant. However, some research findings such as Nalado (2017) and Oluwatelure (2015) revealed consistent differences between the performance of male and female learners in achievement tasks in science. The reasons for gender-related differences in performance between male and female learners may include the innovative nature of the instructional approach used, students' varying ability levels, psychological and socio-cultural factors.

Objectives of the study

Specifically, the objectives of the study is to examine the impact of;

1. Classroom assessment cycle on performance in stoichiometry among senior secondary chemistry students in Giwa educational zone.
2. Classroom assessment cycle on performance in stoichiometry among male and female chemistry students in Giwa educational zone.

Research Questions

The study was guided by the following research questions:

1. What is the impact of using classroom assessment cycle on performance in stoichiometry among secondary school chemistry students in Giwa educational zone?

2. What is the impact of Classroom assessment cycle on performance in stoichiometry among male and female chemistry students in Giwa educational zone?

Hypotheses

1. There is no significant difference between the performance of students taught stoichiometry using classroom assessment cycle and those exposed to lecture method.
2. There is no significant difference between performance of male and female students taught stoichiometry using classroom assessment cycle and those exposed to lecture method.

Methodology

Quasi-experimental research design involving pretest-posttest non-equivalent control group design was used for the study. The population of the study comprised of eight hundred and eleven (817) SSII students involving four hundred and sixty-three (463) male and three hundred and fifty-four (354) female SSII students. Simple random sampling technique using balloting method was used to select a sample size of 120 (67 experimental:53 control group) SSII Chemistry students. Hence, for experimental group a sample of 67 students consisting of 49 Males and 18 female SSII chemistry students. The experimental group students were taught Stoichiometry concept using classroom assessment cycle while the control group students were taught the same concept using lecture method. The instruments used for data collection was Stoichiometry Performance Test (SPT). The instrument was validated by two qualified experts in Science Education Department, Ahmadu Bello University, Zaria. Pearson Product Moment Correlation was used to determine the reliability coefficient of SPT. The Reliability index of SPT was found to be 0.81. The research questions were answered using descriptive statistics while the null hypotheses stated were tested at $P \leq 0.05$ level of significance using independent t-test.

Results

Research Question 1

What is the impact of using classroom assessment cycle on performance in stoichiometry among secondary school chemistry students in Giwa educational zone?

Table 1: Mean and Standard Deviation of Posttest Performance Mean Scores of the Experimental and Control Groups

Groups	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference
Experimental	67	53.32	10.95	1.34	
					21.35
Control	53	31.97	5.49	0.75	

Table 1 clearly showed that the experimental group recorded a post-test mean score of 53.32 while the control group recorded a post-test mean score of 31.97. The mean difference between the two groups was 21.35. The large mean difference between the two groups implies that the mean score of students taught stoichiometry using classroom assessment cycle (experimental group) is higher than the mean score of students taught stoichiometry using lecture method (control

group). This means that classroom assessment cycle enhanced students' performance in stoichiometry.

Research Question 2

What is the impact of Classroom assessment cycle on performance in stoichiometry among male and female chemistry students in Giwa educational zone?

Table 2: Mean and Standard Deviation of Posttest Scores of Male and Female Students in the Experimental Group

	N	Mean	Std. Deviation	Std. Error Mean	Mean Difference
Male	49	53.37	9.51	1.36	
					0.18
Female	18	53.19	14.49	3.42	

Table 2 clearly showed that the male recorded a post-test mean score of 53.37 while the female recorded a post-test mean score of 53.19. The mean difference in their performance was 0.18. The small mean difference between the two groups shows that the performance mean scores of male and female students exposed to classroom assessment cycle are similar.

Hypothesis 1

There is no significant difference between the performance of students taught stoichiometry using classroom assessment cycle and those exposed to lecture method.

Table 3: t-test Analysis of Performance Mean Scores of Experimental and Control Groups

Group	N	Mean	Std. Deviation	Df	t-Cal	p-value	Remark
Experimental	67	53.32	10.95				
				118	12.9	0.01	Significant
Control	53	31.97	5.49				

Significant at P≤0.05 level

Table 3 reveals that there is significant difference in the performance mean scores between the experimental and control groups. The experimental and control group recorded a mean of 53.32 and 31.97 respectively. The P-value is 0.01 which is less than 0.05 level of significance at 118 degree of freedom. Therefore, the null hypothesis which stated that there is no significant difference between the performance of students taught stoichiometry using classroom assessment cycle and those exposed to lecture method is rejected. This implies that there is significant difference between the performance in stoichiometry of students exposed to assessment for learning and those exposed to lecture method. Thus, classroom assessment cycle is found to be more effective in improving students' performance in stoichiometry than the lecture method.

Hypothesis 2

There is no significant difference between performance of male and female students taught stoichiometry using classroom assessment cycle.

Table 4: t-test Analysis of Performance Mean Scores of Male and Female Students in the Experimental Group

Group	N	Mean	Std. Deviation	Df	t-Cal	p-value	Remark
Male	49	53.37	9.51				
				65	0.57	0.95	NS
Female	18	53.19	14.49				

Significant at P≥0.05 level

Table 4 reveals that there is no significant difference in the mean performance scores of male and female students in the experimental group. The male and female students recorded a mean score of 53.37 and 53.19 respectively. The P-value is 0.95 which is higher than 0.05 level of significance at 65 degree of freedom. Therefore, the null hypothesis which stated that there is no significant difference between performance of male and female students taught stoichiometry using classroom assessment cycle was retained. This implies that there is no significant difference between the performance in stoichiometry of male and female students exposed to classroom assessment cycle. Thus, classroom assessment cycle is found to be more effective in improving students' performance regardless of their gender.

Discussion of Findings

This study was designed to examine the impact of classroom assessment cycle on Performance in Stoichiometry among Senior Secondary Chemistry Students in Giwa Educational Zone, Kaduna State. To achieve this purpose, students in the experimental group were taught stoichiometry concepts using classroom assessment cycle while students in the control group were taught stoichiometry concepts using lecture method. Two research questions and null hypotheses guided the study. It was established through a pretest that the subjects in both groups had equivalent knowledge of stoichiometry. Therefore, the observed differences in the result were due to the treatment. The results of the data analysis on the research questions and null hypotheses are hereby discussed.

The result from the research question and testing of hypothesis two as shown in Table 1and 2 showed that students taught stoichiometry concepts using classroom assessment cycle performed significantly better in stoichiometry than students taught using lecture method. This finding agreed with that of Hager, Eremina and Reginald (2016) whose work showed that assessment for learning (which is the major focus of the present study) have positive impact on students' conceptual understanding. Butler and McMunn (2005) suggested that the use of classroom assessment cycle can enhance students' performance by helping them identify the strengths and weaknesses of their performance so that they can improve their achievement. The finding also agrees with that of Ibrahim and Omar (2006) who also discovered that students' active participation and collaboration result to significantly better performance than those taught using lecture method. The performance of the students exposed to classroom assessment cycle might have been engendered by the opportunity the students had to interact together, share ideas, assess themselves, had their misconceptions immediately corrected by their colleagues and have better grasp of concept which intrinsically motivated their interest in achieving their own intellectual goals.

The result of data analysis presented in Tables 3 and 4 showed that there was no significant difference in the performance of male and female students taught stoichiometry concepts using classroom assessment cycle. This finding indicates that gender has no effect on learning

stoichiometry concepts with classroom assessment cycle as a result of similar mean scores of the male and female students. This result is in line with the findings of Wachanga, Mugiira and Mbugua (2013) and Ajayi and Ogbeba (2017) who observed that gender has no significant effect on chemistry performance test. However, this finding is not in line with that of Oluwatelure (2015) and Nalado (2017) who found out that male student performed better than their female counterparts. The analyses revealed significant differences in student achievement favoring the experimental conditions that relied on classroom assessment to support learning. In other words, the use of classroom assessment cycle helped all students, especially the females, come to believe that they can control their own success in learning.

Conclusion

Based on the findings of this study, it was concluded that performance of senior secondary chemistry students in stoichiometry can be enhanced through the use of classroom assessment cycle. Also, classroom assessment cycle is more effective in increasing the performance of senior secondary school students in chemistry than Lecture Method. Finally, classroom assessment cycle is gender friendly since both gender showed improved performance in stoichiometry.

Recommendations

On the basis of the findings and conclusions emanating from this study, the following recommendations are made:

1. Chemistry teachers in senior secondary schools should adopt classroom assessment cycle in teaching difficult concepts like stoichiometry.
2. Since classroom assessment cycle is not gender bias, it could appropriately be useful in co-educational setting where both males and females come together to learn.

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