
The Efficacy Of Formative Assessment On Chemistry Students' Achievement And Knowledge Retention

By

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Abstract

The study was undertaken to determine the efficacy of formative assessment on chemistry students' achievement and knowledge retention. The design adopted was a quasi experimental of non-equivalent, pre-test and post-test design. The study was conducted in Igbo-Eze South Local Government Area of Enugu State in Nigeria. The population of the study was eighty-one (81) senior secondary one (1) chemistry students and the sample size was also eighty-one (81) Senior Secondary School one chemistry students. No randomization was done because the sample size was considered to be small. Four research questions were answered using mean and Std. deviation and two research hypotheses were tested at 0.05 significance level using z-test. The instrument used for data collection was a 20-items objective questions test named Chemistry Achievement Test (CAT). The reliability coefficient of the instrument was 0.85. The study found out that chemistry students exposed to formative assessment teaching performed very well and have a high retention of knowledge in the topic they were taught. It was observed

that female students exposed to formative assessment performed better than the male chemistry students. The study recommended that students should be exposed to formative assessment form of teaching.

Keywords: Formative Assessment, Knowledge Retention, Pre-test and Post-test.

Assessment in education is the product of the 20th century. Assessment in any situation is meant to serve two purposes namely to improve instruction and to measure students' achievement. Assessment has significantly affected students' approach to learning; hence assessment paradigms have shifted from testing learning of students to assessing for students learning (Guskey, 2003).

Assessment of students' academic achievement is a basic step in any educational enterprise, since it provides information about the success in the attainment of specific teaching objectives. It is a well known fact that students cope with learning processes according to the particular type of assessment used, hence, assessment must closely match the learning objectives (Rolfe and Macpherson, 2000).

The word assessment is derived from the Latin word "assidere" meaning to sit with (Wininger,2000) the phrase "to sit with" conjures up the things that teachers do such as observing, discussing and working with students.

Assessment in school system is a process of gathering information. The word connotes all the activities teachers undertake in order to help students learn and measure students' progress. Earl (2003), saw assessment as an activity in which evidence of learning is collected in planned and systematic way and is used to make a judgement about the learning. It helps teachers to determine what their students know and can do. The information gathered helps the teachers to decide what to teach and how to teach it. Assessment can focus on the individual learner, learning community, institution or educational system as a whole. Finally, education assessment can be defined as the process of documenting, usually in measurable terms, knowledge, skills, attitude and beliefs.

Although, teachers and administrators can select assessment forms and tasks, the purpose of assessment varies among various education stake holders such as students, teachers, parents, schools and policy makers. There are different types of assessment, which include the following:

- (i) **Formative Assessment:** Formative assessment is generally carried out throughout a course or project. Formative assessment also known as "educative assessment" is used to aid learning. Formative assessments can take the form of

diagnostic, standardized tests. It is an integral part of teaching and learning. It does not contribute to the final mark given for the module, rather it contributes to learning through providing feedback. It indicates what is good and how the work could be improved. Effective formative feedback affects what next the students and the teachers do.

- (ii) **Summative Assessment:** Summative assessment is generally carried out at the end of a course or project. In an educational setting, summative assessments are typically used to assign grades to students' class work. Summative assessments are evaluative. They measure learning outcomes and report those outcomes to students, parents and administrators. Assessment usually occurs at the conclusion of a class, course, semester or academic year. Summative assessment demonstrates the extent of a learner's success in meeting the assessment criteria used to measure the intended learning outcomes of a module or programme. It is used to qualify achievement, to reward achievement and to provide data for selection. For all these reasons, the validity and reliability of summative assessment are of the greatest importance.
- (iii) **Diagnostic Assessment:** This is an integral part of formative assessment. It improves the learner's experience and their level of achievement. It looks backwards, assesses what the learner already knows and the nature of difficulties that the learner might have. It measures students' current knowledge and skills for the purpose of identifying a suitable programme of learning. For instance, self-assessment is a form of diagnostic assessment which involves students assessing themselves.
- (iv) **Dynamic Assessment:** Dynamic assessment measures what the student achieves when given some teachings in an unfamiliar topic or field. It can be used to assess general learning potential for students who have a particular disadvantaged background.
- (v) **Criterion – Referenced Assessment:** This occurs when students are measured against defined criteria. However, it is not always used to establish a person's competence.
- (vi) **Ipsative Assessment:** This is assessment against the student's own previous standard. It can measure how well a particular task has been undertaken against the students' average attainment, best work or against most recent piece of work.

To achieve optimal students' achievement in chemistry, formative assessment must be used while teaching chemistry. Chemistry teaching can only be result-

oriented when students are willing and teachers are in a position to use the appropriate methods and resources in teaching chemistry. Chemistry is an experimental subject that has to do with observation, recording and making intelligent inferences. It is concerned with the study of non-living components and the way matter reacts. Hence, secondary school chemistry teachers must ensure that the chemical principles and concepts in the contents of the subject are well explained to the students.

Stinggins (2002), argued that well articulated formative assessment models have ability to impact students' achievement. Black and William (2000), reviewed over 250 articles that related to formative assessment. From the articles reviewed, they observed that formative assessment helps in improving students' learning and the students' achievement was high. Foster and Poppers (2009), carried out a work on "Implementation of formative assessment project in Mathematics". They noted that students' instruction must include formative assessment tasks, examining students' work, informing teacher knowledge and informing instruction.

William, Lee, Harrison and Black (2004), explored the impact of 24 teachers' use of formative assessment after a six months training period. The result showed a promotion of students' achievement. However, the authors noted that care must be taken in drawing any general conclusion about the effect of the adoption of formative assessment in teaching. Moreso, Sly (2002) investigated the influence of practice tests as formative assessment to improve students' achievement on computer managed learning assessment. He noted that students who were selected to take practice tests performed better than those who did not take part in practice tests on the two units.

Seeing the importance of formative assessment in teaching, it is pertinent therefore to investigate the efficacy of formative assessment in enhancing students' achievement and knowledge retention in chemistry. The question then is will formative assessment help to improve students' achievement and knowledge retention in chemistry? Again, will gap in gender differences in achievement and knowledge retention in chemistry be narrowed if formative assessment is adopted by chemistry teachers?

Purpose of the Study

Purposefully, the study was intended to determine the efficacy of formative assessment technique on students' achievement and knowledge retention in chemistry. Secondly, to ascertain the efficacy of this strategy in helping students to retain the knowledge gained in chemistry. Finally, to determine the influence of gender on the achievement of students' who were taught chemistry using formative assessment technique.

Research Questions

The following questions guided the study.

- i. What is the effect of formative assessment technique on the mean achievement scores of students in chemistry?
- ii. What is the effect of formative assessment technique on the mean retention scores of students in Chemistry?
- iii. What is the effect of formative assessment technique on the mean achievement scores of male and female students in Chemistry?
- iv. What is the effect of formative assessment technique on the mean retention scores of male & female chemistry students?

Research Hypotheses

The following hypotheses were tested at 0.05 significance level in this study.

- i. There is no significant difference in the post mean achievement scores of male and female students who were taught Chemistry using formative assessment technique.
- ii. There is no significant difference in the post mean retention scores of male and female students who were taught Chemistry using formative assessment technique.

Methods

The design of the study was quasi experimental constituting a pre-test, post-test design. The sample comprised eight-one senior secondary one chemistry students drawn from two intact classes purposively sampled from the only two co-educational secondary schools in the Local Government Area. Forty-two students were in experimental group, while thirty-nine students were in the control group. Purposive sampling technique was employed in drawing the two participating schools because only the co-educational schools were sampled, while simple random sampling technique was used in assigning the schools to experimental and control groups. Hence, two schools were assigned the experimental group, while the other school was assigned to control group. The experimental school was assessed using formative assessment technique after teaching the chemistry concepts, while the control group was not assessed using formative assessment technique. The treatment lasted for four weeks, before the treatment started both groups were pre-tested and also post tested after the treatment. Then after three weeks of the post-test, the same test was given to both groups as a retention test. The instrument used was structured multiple choice tests known as chemistry achievement test (CAT) which was also used as a retention test (CRT). The test was prepared based on senior secondary one topic on separation techniques. The CAT was validated using two experts from science education and two from education measurement and evaluation from Nnamdi Azikiwe University, Awka and Nwafor Orizu College of Education, Nsugbe. The reliability of the instrument was established using coefficient (Cronbach) alpha and the calculated value was 0.85.

Mean and standard deviation were used to answer the research questions while the hypotheses were tested using z-test.

Results

The results of the study are presented in Tables (i – vi).

Table (i): Mean and Standard deviations of the Pre and Post Achievement Scores of the Experimental and Control Groups.

Teaching Groups	Types of test	\bar{X}	S.D	N
Experimental	Pre-test	14.10	3.90	42
	Post-test	17.60	8.30	-
Control	Pre-test	13.00	3.70	39
	Post-test	16.50	8.25	-

The mean achievement scores in table (i) shows that students who were taught chemistry using formative assessment had a post mean achievement score of 17.60 with SD of 8.30, while students who were taught chemistry without formative assessment had a post mean achievement score of 16.50 with S.D of 8.25. There was a significant difference between the post achievement scores of the two groups in favour of the experimental group.

Table (ii): Mean and Standard Deviations of Pre and Post Retention Scores of the Experimental and Control Groups

Teaching Groups	Types of test	\bar{X}	S.D	N
Experimental	Pre-test	14.10	3.90	42
	Post-test	19.10	7.23	-
Control	Pre-test	13.00	3.70	39
	Post-test	-	18.80	5.16

Table (ii) answered research question 2, it shows that students who were taught chemistry using formative assessment had a post mean knowledge retention score of 19.10 with SD of 7.23, while students who were taught without the use of formative assessment had a post mean knowledge retention score of 18.80 with SD of 5.16. There was a significant difference between the post mean knowledge retention scores of the two groups in favour of the experimental group.

Table (iii): Mean and Standard deviations on Pre and Post Achievement Scores of Males and Females Taught Using Formative Assessment.

Gender	Types of test	\bar{X}	S.D	N
Males	Pre-test	15.50	5.60	20

Females	Post-test	19.10	7.23	22
	Pre-test	17.00	4.84	
	Post-test	21.50	5.40	

Table (iii) answered research question 3, it shows that male students who were taught using formative assessment had a post mean achievement score of 19.10 with SD of 7.23 while the female students who were taught using the same type of assessment had a post mean achievement score of 21.50 with SD of 6.40. Hence, the female students performed better than the male students.

Table (iv): Mean and Standard deviations on Pre and Post knowledge Retention Scores of Males and Females Taught Using Formative Assessment

Gender	Types of test	\bar{X}	S.D	N
Males	Pre-test	16.83	4.10	20
	Post-test	22.91	4.78	
Females	Pre-test	18.01	4.24	22
	Post-test	22.10	4.70	

Table (iv) answered research question 4, it shows that male students who were taught using formative assessment technique had a post mean knowledge retention score of 22.91 with SD of 4.78, while the female students had a mean of 22.10 with SD of 4.70. Hence, the male students had more knowledge retention than the females. The difference is slightly significant.

Table (v): Summary of z-test on Post Achievement Scores in Chemistry on Male and Female Students Taught Using Formative Assessment.

Gender	N	\bar{X}	SD	df	z-cal	z-crit
Females	22	21.50	6.44	40	1.60	2.00
Males	20	19.00	7.23			

The null hypothesis H_0 was accepted. This is shown in table (v), it was observed that the z-calculated value (1.60) is less than the z-critical value (2.00). Hence, no significant effect was observed with respect to males and females who were taught chemistry using formative assessment on chemistry achievement.

Table (vi): Summary of z-test on Post knowledge Retention Scores of Male and Female Chemistry Students taught using Formative Assessment.

Gender	N	\bar{X}	SD	df	z-cal	z-crit
Females	22	22.10	4.70	40	0.54	2.00
Males	20	22.91	4.78			

From table (vi), it was also observed that the z-calculated value (0.54) is less than the z-critical value (2.00). Hence, the null hypothesis was accepted, no significant difference was observed with respect to male and female chemistry students taught chemistry using formative assessment technique on knowledge retention.

Discussions and Conclusion

From the findings of this study, it revealed that the use of formative assessment in teaching chemistry has a significant effect on students' achievement and knowledge retention. The students taught separation technique in chemistry using formative assessment performed significantly better than those taught the same concept without the use of formative assessment. This therefore, implies that teaching using formative assessment enhanced students' achievement as well as knowledge retention in chemistry.

Gender had no significant effect on both achievement and knowledge retention with students taught using formative assessment. The result of this study on gender is not in agreement with the findings of Ishiola (2005) who supports that female students were better problem solvers than male students. It is, therefore, necessary for teachers to use formative assessment in teaching, for this enhances effective learning especially in chemistry. Teachers should also encourage such type of assessment in chemistry classroom as this helps to improve students achievement and knowledge retention.

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