

EFFICACY OF METACOGNITIVE REFLECTIVE ASSESSMENT INSTRUCTIONAL STRATEGY ON STUDENTS' ACHIEVEMENT IN SENIOR SECONDARY SCHOOL CHEMISTRY

Anthonia Ebere Onah, David Nwoye Ezeh & Chiegeonu Valentina Agugu

Abstract

The study examined the efficacy of metacognitive reflective assessment instructional strategy on students' achievement in senior secondary school chemistry. The research adopted a pre-test-post-test, control group quasi-experimental research design. The population for the study was 1180 SS1 chemistry students in public schools in Igbo-Eze North Local Government Area of Enugu State. The sample was 100 chemistry students (48 males and 52 females) of two intact classes. This sample was obtained from two co-educational schools with the use of simple random sampling techniques. A 25-item chemistry achievement test (CAT) was employed in generating data. The data generated were analysed with the use of mean, standard deviation and ANCOVA. Result showed that the mean score for the students who received chemistry instructions through metacognitive reflective assessment technique was significantly higher compared to the mean score of those who received chemistry instructions through traditional assessment technique. Also, its effect on gender was not significant and the interaction effect of assessment method and gender on achievement of students in chemistry was not significant. The study recommended that chemistry teachers should adopt metacognitive reflective assessment strategy in classroom instructions.

Keywords: Metacognition, Reflective Assessment, Chemistry, Achievement

Introduction

Chemistry is a subdivision of science which makes people understand how things that occur naturally and things made by man are made, their composition and uses (Omiko, 2014). Chemistry features in almost every aspect of human endeavour. According to Nwaka, Egbo and Okechineke (2016), almost all processes of production involve one aspect of the chemical process or the other. Chemical principles are employed in oil refineries, petrochemical industries, agriculture, textiles, waste management and in the production of drugs, cosmetics, paper, plastics, dyes and pesticides. Chemistry

contributes substantially to sustainable economic development and growth of every nation. At the senior secondary school level, chemistry enables students learn basic science concepts and principles help the students contribute effectively to the development of their immediate environment and the nation.

Although chemistry is vital to the nations' technological growth and the individual well-being, the achievement of students in the subject at secondary school level is not encouraging (Ademola, Olufunke & Amoke, 2013, Gigina & Nweze, 2014). Records of the analysis of students' results conducted by West African Examination Council (WAEC) 2012-2016 indicated poor achievement of students in chemistry as shown in Table 0.1.

Table 0.1: Mean Raw Scores of May/June WASSCE Chemistry from 2012 - 2016

Year	Raw Mean Score	Standard Deviation
May/June 2012	30	13.89
May/June 2013	25	9.75
May/June 2014	25	9.06
May/June 2015	27	8.83
May/June 2016	25	7.81

Table 0.1 shows that the performance of students in chemistry was poor in those years. The low performance has been attributed to several factors. Uchegbu, et al, (2016) reported that the poor performance is as a result difficult topics such as gas laws, redox reaction, and organic chemistry 2. Poor assessment strategy (Edeh & Vikoo, 2013) and inappropriate pedagogical approach (Nworgu, 2016) have been reported as causes of poor performance in chemistry.

Assessment is central to teaching and learning. It is a systematic process of gathering data from a variety of sources to understand, describe and improve learning (Nworgu, 2016). Through assessment, both teachers and students are able to identify students' area of strength and deficiencies. Although assessment can be carried out during or at the end of instructions, many researchers have advocated the adoption of assessment during classroom instructions (Looney, 2011, Lindsey, 2013 & Olangunju, 2015).

There are several ways teachers assess students during classroom instruction like asking oral questions, observing students as they work or observing their facial expressions. According to Lindsey, (2013), one of the assessment strategies most used by teachers is oral questioning. Oral questioning, according to Dandis (2013), is a traditional assessment strategy, through which the teacher poses a question to the students, and the students either volunteer or are appointed by the teacher to answer the question. The students give verbal response to the question which always results from

memorization. Memorized information are often not linked to students' previous knowledge. Oral questioning involves only few students who respond to the questions while others sit passively. Consequently, class participation is reduced to only students who attempt answering questions in the class. Oral questioning stresses recall rather than reasoning processes (Looney, 2011). Traditional assessment strategy does not give students the opportunity to view assessment as a moment of learning. Rather, students view assessment as a moment of just providing answers to questions. To provide every student with the best learning opportunity, there should be a shift from traditional assessment strategy to an alternate assessment strategy that involves metacognition.

Metacognition is being aware of what one is thinking. According to Chick (2014), practicing metacognition helps students to discover their strong and weak areas. Metacognition enables students to participate actively in their learning. One of the metacognitive strategies is reflective assessment. Reflective assessment is a form of metacognitive strategy that uses a formative approach which places students at the centre of assessment practice and encourages students to think about their thinking (Davies, 2012). Reflective assessment employs strategies which elicit written and collaborative responses from students. The responses help students to build their knowledge focus on learning.

Laurynn (2016) identified two techniques which can be used in reflective assessment. These techniques are “I learned statement” and “think aloud or talk about it”. I learned statement is a technique in which the student writes down statement of personal learning. It involves the student writing reflection upon the key concepts or understandings that has been learned in a lesson. “Think Aloud” is a technique in which students verbalize their thinking as they solve problems. Here, the students share their written “I learned statement” with a partner. In reflective assessment, when the teacher asks question, every student in the class first write whatever he/she thinks is the answer, then practice the think aloud technique by discussing their written statement with a classmate, and finally edit their first “I learned statement” and write the second one. Reflective assessment gives every student opportunity to participate in classroom assessment and through it students can experience assessment as a part of learning and could learn meaningfully.

Youcef, (2017) showed that male and female learners have different styles of learning. According to the researcher, male learners tend to be extroverts and prefer to work in groups while females tend to be introverts and prefer to work individually. This may be one of the reasons why there are different views concerning gender and achievement in chemistry. Fatokun, Egya &Uzoечи (2016) report that chemistry students' achievement is not influenced by gender. Contrarily, Aniodoh (2014) assert that female students perform better than male students while Arsaythamby, Lee and Lee (2015) contend that male students achieve significantly higher than the females in

chemistry. It is, therefore, necessary for chemistry teachers to employ the strategies that will be effective for both male and female students. Reflective assessment which gives students the opportunity to work as individuals (I learnt statement) and as a group (talk it aloud) could be an effective strategy for all students. This paper therefore explores the efficacy of metacognitive reflective assessment on secondary school students' achievements in Chemistry.

The purpose of this study was therefore to ascertain the efficacy of metacognitive reflective assessment instructional strategy on senior secondary school students' achievement in Chemistry. The study will determine: the efficacy of metacognitive reflective assessment instructional strategy on the mean achievement scores in chemistry; gender influence on chemistry mean achievement scores of students; and the interaction effect of assessment instructional strategy and gender on chemistry students' achievement.

Research Questions

To guide the study, two research questions were posed:

1. What are the mean achievement scores of students that received chemistry instructions through metacognitive reflective assessment instructional strategy and those that received through traditional assessment instructional strategy?
2. What are the mean chemistry achievement scores according to gender?

Research Hypotheses

Three null hypotheses that were tested at 0.05 level of significance guided the study.

H₀1: The mean achievement scores will not differ significantly between students that received chemistry instructions through metacognitive reflective assessment instructional strategy and those that received through traditional assessment instructional strategy.

H₀2: The mean chemistry achievement scores will not differ significantly between genders.

H₀3: Assessment instructional strategy and gender will not have significant interaction effect on students' achievement mean score in chemistry.

Methods

The study adopted the non-equivalent pre-test, post-test, control group experimental design. It was carried out in Igbo-Eze North Local Government Area of Enugu State, Nigeria. The local government has 21 government owned secondary schools. The

population comprised 1180 SS1 students offering chemistry in the co-educational government owned secondary schools. Through the use of a simple random sampling procedure, two secondary schools were randomly selected from which two SS1 intact classes (one from each school) were sampled using random sampling procedure. The two classes were randomly assigned to experimental and control groups. The 100 students (48 males and 52 females) formed the two intact classes of chemistry students used for the study. A 25- item chemistry achievement test (CAT) was employed in gathering data. The items in the instrument were developed by the researchers and validated by three experts from chemistry and measurement and evaluation departments. The instrument was administered to 25 students who were not part of the study to obtain a reliability of 0.79 with Kuder-Richardson Formula 20.

The regular teachers of chemistry in the sampled schools assisted in conducting the research. Prior to the experiment, the instrument was given to both groups to respond as pre-test. After that, the students were subjected to treatments which lasted four weeks. Students in the experimental group were subjected to metacognitive reflective assessment during lesson activities and those that served as control were subjected to traditional assessment during lesson activities. After the teaching exercise, the instrument was given to both groups to respond as post-test. The scores from pre-test and post-test were collated and analysed to answer the research questions with the use of mean and standard deviation. The hypotheses were tested with the use of analysis of covariance (ANCOVA) statistics.

Results

- 1. Research Question One:** What are the mean achievement scores of students that received chemistry instructions through metacognitive reflective assessment instructional strategy (MRAIS) and those that received through traditional assessment instructional strategy (TAIS)?

Table 1: Groups' Mean Scores in Achievement Test in Chemistry

Group	N	Pre-test		Post-test		Gain Score
		Mean	SD	Mean	SD	
MRAIS (Experimental)	48	35.83	6.66	75.12	10.11	39.29
TAIS (Control)	52	35.50	6.77	53.69	10.81	18.19

Table 1 shows that the post-test mean score (75.12) of the students who received chemistry instructions through metacognitive reflective assessment instructional strategy were higher than the post-test mean score (53.69) of those who received through traditional assessments strategy.

HO₁: The mean achievement scores will not differ significantly between students that received chemistry instructions through metacognitive reflective assessment instructional strategy and those that received instructions through traditional assessment instructional strategy.

In order to test this hypothesis, the data collected from the Chemistry Achievement Test (CAT) were subjected to analysis of covariance. The result obtained is presented in Table 2.

Table 2 : Analysis of Covariance of the Effects of Metacognitive Reflective Assessment Technique and Traditional Assessment Approach on the Achievement of Chemistry Students.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	11485.030 ^a	4	2871.258	25.372	.000	.517
Intercept	14544.273	1	14544.273	128.520	.000	.575
Pre-test	9.511	1	9.511	.084	.773	.001
Method	11200.574	1	11200.574	98.973	.000	.510
Gender	8.338	1	8.338	.074	.787	.001
Method * Gender	3.773	1	3.773	.033	.856	.000
Error	10750.930	95	113.168			
Total	431580.000	100				
Corrected Total	22235.960	99				

Table 2 revealed an F- value of 98.973 for the method which is significant at 0.000. This is below 0.05 level of significance. The null hypothesis was rejected. This implies that the mean achievement scores differ significantly between the students that received chemistry instructions through metacognitive reflective assessment technique and those that were taught using traditional assessment strategy. Those that received instructions through metacognitive reflective assessment technique performed better than those that received instructions using the traditional assessment strategy.

Research Question Two: What Are the Mean Chemistry Achievement Scores According to Gender?

Table 3: Mean Chemistry Achievement Scores According to Gender

Group	Pre-test			Post-test		Mean Gain
	N	Mean	SD	Mean	SD	
Male	48	34.74	6.59	64.37	15.24	29.63
Female	52	36.35	6.74	63.68	14.91	27.33

Table 3 shows that the post-test mean achievement score of male students (64.37) is a little higher than that of the female students (63.68).

HO₂: The mean achievement scores will not differ significantly between male and female students.

In order to test this hypothesis, the data collected from the Chemistry Achievement Test (CAT) was subjected to analysis of covariance. The result obtained is presented in Table 2.

Table 2 reveals that F-value for gender is 0.074 and is significant at 0.787 which is higher than 0.05 level of significance. The null hypothesis was not rejected. This implies that the mean chemistry achievement did not differ significantly according to gender.

HO₃: Assessment instructional strategy and gender will not have significant interaction effects on chemistry achievement mean scores of students.

To test this hypothesis, the data collected from the Chemistry Achievement Test (CAT) was subjected to analysis of covariance. The result obtained is presented in Table 2.

Table 2 shows that assessment instructional strategy and gender did not interact significantly on students' achievement mean score in chemistry. This is because the F-value for assessment techniques and gender is 0.033 and it is significant at 0.856, which is above 0.05 level of significance.

Discussions

The result of the research showed that the students who were exposed to metacognitive reflective assessment classroom instructions improved in their achievement more than the students who received class instructions through traditional assessment strategy. Metacognitive reflective assessment strategy could have accounted for the students' high achievement in chemistry. It is a learner-centered approach which makes the students view assessment as a time of learning and in which all the students participated in classroom assessment. This makes it different from the traditional assessment strategy which makes students view assessment as a period of simply answering questions and obtaining grades. The findings agree with the earlier reports of Bond (2013), Yang, Aalst, Chan and Tain (2016) and Laurynn (2009) which revealed that reflective assessment strategy attract higher student's achievement. Also, YuekMing and Latifah (2014) observed that students' reflective writing improves students' achievement. Metacognitive reflective assessment strategy makes learners to see assessment from a different perspective and become more strategic in pursuing learning (Laurynn, 2016).

The result of the study revealed that the achievement of male students is a little higher than that of the female students in chemistry. The finding is in line with the report of Nantongo (2011) and Fatokun, Egya & Uzoечи (2016) who found that in chemistry, male and female students' achievement do not differ significantly.

The outcome of the study also revealed that assessment instructional approach and gender do not have significant interaction effect on students' achievement in chemistry. From the result, it does appear that the assessment strategy is not gender dependent. This result lends support to Okonkwo (2016) who found that in basic Science, metacognitive learning cycle and gender do not interact significantly on students' achievement.

Conclusion

The study concludes that metacognitive reflective assessment strategy enhances students' achievement in chemistry. Gender is not a factor to students' achievement in chemistry and both assessment approach and gender do not interact significantly on the achievement of chemistry students.

Recommendation

The researchers recommend that chemistry teachers should be trained on how to use metacognitive reflective assessment instructional strategy in the assessment of students. Chemistry teachers should also endeavour to employ metacognitive reflective assessment instructional strategy for better achievement of students in chemistry.

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