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Impact of Peer Assessment on Performance in Mathematics among Senior Secondary School Students in Delta State, Nigeria

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Abstract
Peer Assessment is the systematic process of peers assessing each others' work using instructional rubrics for grading. The purpose of this study was to examine the impact of peer assessment on performance in mathematics among Senior Secondary School Students in Delta State. It is envisage that this study would benefit students to promote creativity in solving problems, evaluate new ideas, select the best ones and or modify them. Policy makers and curriculum developer in the education sector would also benefit by helping them to review the present educational policy and curriculum with the aim of introducing Peer Assessment as an assessment tool to improve students' learning abilities in Mathematics. The information gathered in this study would also help teachers, institutions and researchers in education to have a better understanding of Peer Assessment which would enable them evaluate students' academic performance in secondary schools more appropriately. Multi-stage sampling techniques were applied to select sample of 212 senior secondary school students. Mathematics Performance Tests and Peer Assessment Mathematics Scale were the instruments used to collect data for the study. Three research hypotheses were generated to guide the study while Analysis of Covariance was used to test the hypotheses. Results of the data analysis revealed that there is significant difference in Mathematics test among experimental conditions. The study also found out that there is significant difference in peer assessment test among participants exposed to the training conditions. However, the study also revealed that there is no significant gender difference in peer assessment among experimental conditions. It is therefore recommended that in teaching Mathematics, Peer Assessment should be introduced in teaching students in schools and should be part of the curriculum of teaching Mathematics.

Keywords: feedback, gender, instructional rubrics mathematics, and peer assessment.

INTRODUCTION

The act of assessment seems to be as old as mankind because it is a tool used to evaluate performance, maintain standard using sets of criteria as a bench mark to judge the work of people in and out of class room. Therefore, the role of assessment in promoting effective teaching and learning process cannot be over-emphasized. Anikweze (2005) posited that learner's assessment is the means of knowing what kind of learning that has taken place during schooling and as such can be rightly regarded as a basic demand in school accountability.

Traditionally, students were seen as passive receivers of information in the classroom who were expected to provide samples of their knowledge in teacher-made tests. Teachers act as personnel who give out instructions and also as the judge who evaluated students' success. This process would make the students passive and not active because they only listen to instructions given to them. More recently however, alternative ways of assessment are being tried and one of such is Peer Assessment which is defined as a student's evaluation of his own success (Khadijeh, 2010). Peer Assessment is used to describe the process undertaken by students to assess the performance/contribution of themselves and their peer group, in relation to a group task (Loddington, 2008). It could also be described as peer moderated marking of students work based on sets of success criteria from the teacher.

In assessing students work, there is need to involve both the teachers and students so that the students will be aware of the success criteria and the process of grading. One of the ways in which students internalize the characteristics of quality work is by evaluating the work of their peers. However, if they are to offer meaningful feedback, students must have a clear understanding of what they are to look for in their peers' work. The teacher must explain the expectations clearly to the students before they start assessing one another. For effective understanding of the Peer Assessment, the teacher will provide a sample of work done or an assignment with instructional rubrics for practice to enable them grade each other. This will give both the teacher and the students confidence in marking their scripts without being bias. For Peer Assessment to be effective, the learning environment in the classroom must be supportive. Students must feel comfortable and trust one another in order to provide honest and

constructive feedback because they were selected to different group (the weak students mixed with the strong students).This allows them to become more comfortable with each other and this may lead to better peer feedback.

In introducing Peer Assessment, the teacher would ensure that students become aware of the benefits for them because they need to see the value for themselves rather than the gains for their teachers. So it is important to introduce peer assessment to improve learning in Mathematics and to develop new skills to solve mathematical problems. The process also allow students to comment on and judge their colleagues work, has formative and summative assessment. One of the desirable outcomes of education is to improve the ability of the learner and to make the learner independent judge of their own and other people's work. Peer Assessment exercises are seen as means by which these general skills can be developed and practiced. A peer rating format can encourage a greater sense of involvement and responsibility, establish a clearer framework and promote excellence, direct attention to skills and learning and provide increased feedback (Weaver and Cotrell, 1986).

Peer Assessment therefore is a process whereby students assess assignments or tests of their *peers* based on teacher's benchmark or Instructional Rubrics (Sadler and Eddie, 2006). The practice is employed to save teacher's time and improve students' understanding of course materials as well as improve their thinking skills as students would be exposed to each other's work, learn different steps in presenting, analyzing, evaluating, and solving Mathematical problems. Peer Assessment is much more than students' marking their own or each other's work because it also help students to learn from their peers solved work. To improve learning, it must be an activity that engages students with the quality of their work and helps them reflect on how to improve on it. Peer Assessment enables students to give each other valuable feedback so that they can learn from and support each other (Ryan, Marshall, Porter, and Jia 2007).

In assessing students' work based on sets of criteria, Instructional rubrics are information feedback or scoring guides that are used by teachers and participants in assessing and evaluating students work based on sets of criteria ranges from poor to excellent performance. These activities also encourage cooperative learning by making weaker students learn from stronger students thereby removing their phobia in Mathematics. Onuka (2007) carried out a study on teacher-Initiated and guided students- Peer Assessment programme to improving learning assessment in Mathematics and English Language in large classes using 280 participants. The findings shows that those that received training on peer assessment did better in Mathematics test than the control group. Onuka and Oludipo, (2006) also carried out a study on Systematic school based assessment for an improved cognitive performance. The results of their findings show that the performance of students in the experimental group outweighed those from the control group. This shows that peers feedback, which is an outcome of evaluation, and systematic school based assessment may assist in improving students performance and in cognitive learning objectives respectively.

Bassey, Joshua and Asim (2008) carried out a study on gender and Mathematics Achievement in secondary schools in Calabar, Cross Rivers State. The study revealed that there is a significant difference between the Mathematics achievement of the rural male and female students. However, Sprigler and Alsup (2003) carried out a study on gender achievement and found out that there was no gender difference on Mathematical reasoning ability at elementary level. Ding, Song and Richardson, (2007) were also in support of the view that there was no significant difference between male and female students in Mathematics.

Mathematics as an important subject in modern society is useful in schools, workplaces, businesses and for personal decision-making. Mathematics is seen to be the language of everyday use whether in the market place, schools or even at home. The usefulness of Mathematics can even be observed in the application of numbers to measure length, volume, weight, density, temperature, speed and acceleration. The importance of this subject may have led the Nigerian Government to make it a compulsory subject in basic education and senior secondary schools as well as a prerequisite for admission to tertiary institutions. In Nigeria, Mathematics is one of the core subjects taught at all levels but students seem to shy away from the subject for many reasons, some of which include phobia, teachers' attitude towards the teaching of Mathematics and students' negative attitude from the assumption that Mathematics is generally a difficult subject to study (Okereke, 2006).

Peer Assessment Processes

According to Black and Williams (1998), Peer Assessment processes involve:

- Establish rapport and creating awareness of the key processes
- Give out samples of students work from another class.
- Distributes instructional rubrics (success criteria) and explain how to grade students work to all participants.
- Allow students to assess sample work using instructional rubrics as training.

- Plenary discussion of the sample work on approaches and changes

In a school setting, if teachers adopt this process as a strategy the performance of students' may improve.

STATEMENT OF THE PROBLEM

The assessment and mode of teaching in some of the secondary schools in Nigeria seem to be teacher centered approaches which might not give the students the opportunity to be creative and independent in solving mathematical problems and assess one another in terms of their strengths and weaknesses. Teacher-centered approach may appear to have contributed to poor results in public examinations such as WAEC and NECO because some of the students hardly see each other's marked work which would have helped them to learn from and support each other in Mathematics. Peer Assessment using Instructional Rubrics in teaching Mathematics have been used as one of the major assessment tools that have contributed to excellent performance in Mathematics among secondary school students(Schafer, Ben & Newbery, 2001; Sadler & Eddie, 2006; Andrade & Du, 2005) .

THEORETICAL FRAMEWORK

The constructivists theory states that a learner could create or construct new ideas and concepts of solving problems by using his past and current knowledge. Brunner (1966) asserted that the fulcrum of constructivism is that people construct their own understanding and knowledge of the world, by experiencing things and reflecting on those experiences. This theory is relevant to this study because it encourages students to be creative and independent in solving problems, and indeed all mathematical problems.

PURPOSE OF THE STUDY

The purpose of this study includes the following:

1. To examine the difference in mean post-test scores of Mathematics Performance Test between students exposed to training on Peer Assessment and those in the control group.
2. To determine the difference in post-test Mathematics Performance scores of students due to gender and experimental conditions.
3. To establish the difference in post-test scores Peer Assessment of students exposed to experimental condition.

RESEARCH HYPOTHESES

The following three research hypotheses were formulated and tested:

1.There is no significant difference in post-test scores Mathematics Performance Test between students exposed to training on Peer Assessment and those in the control group.

2. There is no significant difference in post-test Mathematics Performance scores of students due to gender and experimental conditions.

3. There is no significant difference in post-test scores Peer Assessment of students exposed to experimental condition.

LIMITATION OF THE STUDY

The study was done in Delta State, which is located in South west region of Nigeria in West Africa. The study was limited to selected senior secondary school two (SSII) students from public schools in Kwale Educational Zone in Delta North Senatorial District of Delta State.

METHODOLOGY

Research Design

The research designs for this study is Quasi-experimental pre-test/ post test control group design.

Sample and Sampling Procedure

Simple random sampling was used to select Kwale Educational Zone out of the 12 Educational Zones in Delta state. Four public Senior Secondary Schools in Delta State were selected through Hat and Draw methods. In selecting the schools, all the Senior Secondary Schools in Kwale zone were first stratified into three groups- Co-educational, boys' school and girls' school. From the list of schools, 2 schools from co-educational were randomly selected as a results of large number of co-educational schools in the zone, one school from single boys and one school from single girls were randomly chosen using Hat and Draw method. The stratified random sampling technique was used to obtain the sample of two hundred and twelve students (212) from the four senior secondary schools selected for the study. The stratification was based on school type and gender consisting of 115 males and 97 females.

Research Instruments

1. Personal Data Questionnaire (PDQ): This was designed by the researcher to generate the participants' bio-data which include: gender, school type, class type, and age.

2. Mathematics Performance Test (MPT): Fifty Multiple Choice item tests with 4 options was developed by the researcher which attracted 50 marks. The items has a high stability co-efficient of 0.87 when tested during the pilot study. The MPT was used as pre-test to measure the entry behaviour of the students before exposing them to training and the same instrument was used for post test to measure performance after being exposed to training.

Peer-Assessment Mathematics Scale (PAMS): This is a 15-item Peer Assessment instrument on 4-point options developed by the researcher. The instrument was designed to assess the level of students' interest and cooperation on how to grade each other without

bias in Mathematics exercises using Instructional Rubrics. The responses ranged from Strongly Agree to Strongly Disagree. A test-retest reliability of the instruments was obtained as 0.76 through the pilot study. The scoring of the instruments was by assigning 4, 3, 2 and 1 for positive statements where responses are SA, A, D and SD. The points were awarded in the reverse order for the negative statements. The addition of the direct and reverse will give overall scores. The maximum scores is 60 while the minimum scores is 15.

VALIDITY AND RELIABILITY OF INSTRUMENTS

A pilot study was carried out before the main study to have a tryout of the instruments and to determine their psychometric properties. Abraka Grammar School, Abraka, and was randomly selected among the schools in Delta Central of Delta State through simple random sampling. 30 students consisting of 15 boys and 15 girls were randomly selected to participate in the exercise. Two instruments were administered to a set of SSII students and after two weeks it was re-administered to the same set of SSII students. The results of the two tests were collated and analyse using, Pearson Product Moment Correlation statistics to estimate the test-retest reliability coefficient. The test-retest reliability indices of MPT gives 0.87 and PAMS gives 0.76.

PEER ASSESSMENT TRAINING

- Teacher defined Peer Assessment and explained the processes involved in assessing work in Mathematics.
- Distribution of sample work in Series and Sequence (S&S) in Mathematics and instructional guide.
- Teacher discussed how participants can learn from sample responses in (S & S).
- Teacher taught participants how they can assess each other's work in Mathematics.
- Participants worked on the problem on their own.
- Participants worked together to improve their work or sample work.
- Participants exchanged their work to see how they can help each other.
- Participants were graded as: 1 for poor, 2 for fair, 3 for good, and 4 for excellent.

SEQUENCE AND SERIES (S&S): ARITHMETIC PROGRESSION

- Teaching of the new topic; Sequence and Series (Arithmetic Progression) to the participants using prepared lesson notes with Instructional Materials.
- Teacher gave participants room for questions in areas not clear and later responded.
- Evaluation: Teacher asked participants to solve questions relating to Arithmetic progression. E.g. Find the 5^{th} and 8^{th} terms of the sequence whose nth terms is (a) 2n + 1 (b) 3-5n.
- Assessment: Teacher distributed Instructional Rubrics on Arithmetic Progression to participants for grading.
- Participants exchange their solved work on Arithmetic Progression for grading using Instructional Rubrics as a guide. 1 for poor, 2 for fair, 3 for good, and 4 for excellent.
- Teacher collected the scripts and explained further on how to answer difficult areas in the questions
- Teacher gave out assignments to the participants on Arithmetic Progression.

DATA ANALYSIS AND PRESENTATION

Hypothesis One: There is no significant difference in post-test Mathematics scores of students exposed to Peer Assessment training and those not exposed to the training.

Table 1: ANCOVA Test of Difference in Post-test Mathematics Performance between Training and Control Groups

Source	Type 111	Sum of Squares	df	Mean of Squares	F	Sig
Corrected Model	14721.22	2	7360.61	92.63	.000	
Covariates	686.09	1	686.09	8.63	.004	
Experimental Group	14128.68	1	14128.68	177.80	.000	
Error	16607.31	209	79.46			
Corrected Total	31422.08	211				

*Significant at 0.05; df=1 & 209

The ANCOVA results presented in Table 1 shows that for the Experimental condition, the F–value obtained was 177.80 as P-value < 0.005, given 1 and 209 degrees of freedom at the .05 level of significance. This therefore suggests that training on Peer Assessments was effective in improving the Mathematics performance of the students. Therefore hypothesis 1 was rejected. This also showed that Peer Assessment Training had impact on the participants than their Control Group counterparts.

Hypothesis Two: There is no significant difference in post-test Mathematics Performance scores of students due to gender and experimental conditions.

Table 2: 2 x 2 ANCOVA Tests of the Effects of Experimental Condition and Gender on Post-test Mathematics Performance of Students

Source	Type III Sum of Squares	df	Mean of Squares	F	Sig
Corrected Mode	14957.59	4	3739.38	47.28	.000
Covariates	652.95	1	652.95	8.25	.004
Gender	185.98	1	185.98	2.35	.127
Experimental Group	13930.83	1	13930.83	176.14	.000
Gender/ Experimental	47.01	1	47.01	0.59	.442
Error	16370	207	79.08		
Corrected Total	31328.54	211			

***Not significant at 0.05; df =1 & 207; F-critical= 3.89**

Table 2 shows that a calculated F-value of 2.35 for gender was not significant at 0.05 level of significance with degree of freedom 1 and 207 because P-value > 0.05, while F-value of 176.14 for experimental condition was significant at 0.05 with degree of freedom 1 and 208 since P-value is < 0.05. The F-value of 0.59 for interaction between gender and experimental was not significant with degree of freedom 1and 207 since P-value > 0.05. Hypothesis two was therefore accepted. It was concluded male students did not do better in Mathematics tests than their female counterparts.

Hypothesis Three: There is no significant difference in post-test scores Peer assessment of students exposed to experimental conditions.

Table 3: ANCOVA Test of Difference in Post-test Peer Assessment between Training and Control Groups

Source	Type III Sum of Squares	df	Mean of Squares	F	Sig
Corrected Model	1549.00	2	774.50	50.97	.000
Covariates	1172.24	1	1172.24	77.15	.004
Experimental Group	499.05	1	499.05	32.84	.000
Error	3175.50	209	15.19		
Corrected Total	4846.79	211			

*** Significant at 0.05;df=1 & 209, ; F-critical= 3.89**

The ANCOVA results presented in Table 3 shows that for the Experimental Condition, the F-cal value obtained was significant at 32.84 as P-value is < 0.005, given 1 and 209 degrees of freedom at the .05 level of significance. Hypothesis three was rejected, therefore there is significant difference in the posttest scores of peer assessment among the experimental conditions. This therefore suggests that the training was effective in improving the Peer Assessment scores of the students.

DISCUSSION OF FINDINGS

The findings in hypothesis one showed that there was a significant difference in post test Mathematics scores between the Training and Control Group. The findings of Onuka, (2007); Onuka and Oludipo, (2006) who reported that the performance of students in the experimental group outweighed those from the control. The reason for the difference could be attributed to acquisition of knowledge in Peer Assessment which were infused in the teaching of Mathematics.

The findings in hypothesis two revealed that there was no significant difference in post-test Mathematics Performance of students in the two experimental groups due to their gender. In support of findings, Sprigler and Alsup (2003) carried out a study on gender achievement and found out that there was no gender difference on Mathematical reasoning ability at elementary level. Ding, Song and Richardson, (2007) was also in support of the view that there was no significant difference between male and female students in Mathematics. This can be attributed to the awareness of the importance of the subject by both sexes in the society and that one hardly survives without it.

The findings in hypothesis three showed that there was significant difference in post-test Peer Assessment scores of students exposed to training and those in the control group. It was evident that Peer Assessment training was efficacious in enhancing students in Mathematics because students were able to learn from each other as they grade each other's work. The result supported the findings of Saito (2008) who examined the effects of training on Peer Assessment regarding oral presentations in EFL classrooms. The conclusion of the study was that Peer Assessment is a solid technique, which can be enhanced if assessors are trained suitably and effectively. Again, Peterson and Irving (2008) supported the above findings that the students had a positive view about Peer Assessment because it is a useful strategy for both students and teachers to assessed themselves. After collecting and analyzing data through extensive interviews and classroom observations, the researchers found out that using Peer Assessment is a good technique for achieving academic success

RECOMMENDATIONS

1. Training on Peer Assessment as confirmed by this study is an effective means of improving on low academic performance in Mathematics. Peer Assessment serves as assessment tools, which place students at the center of the learning process. Therefore, secondary school teachers should enforce Peer Assessment when assessing the students.
2. The infusion techniques introduce while teaching in the classroom should be emphasized because it makes the students understand the concept better and teachers should consistently and explicitly emphasize specific Peer assessment process that aid learning.
3. The Ministry of Education and head of schools should ensure that teachers implement the use of Peer assessment to assess their students in schools because it involve self-evaluation which is linked to self-direction.
4. Finally Peer Assessment and Instructional Rubrics should be made compulsory and integrated in all secondary school curriculum, scheme of work, lesson note, lesson plan and in the classroom when teaching and learning take place because the two concepts enhance learning and teaching processes.

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APPENDIX

Instructional Rubrics on Sequence and Series in Mathematics

Class: SSS II
Subject: Mathematics
Topic: Sequence and Series

Sequence and Series: Arithmetic Progression (AP	**1**	**2**	**3**	**4**
Determine the pattern of a sequence in relation to Arithmetic progression(AP)	Is able to determine the pattern of sequence in relation to Arithmetic progression little	Is able to determine the pattern of sequence in relation to Arithmetic progression partially.	Is able to determine the pattern of sequence in relation to Arithmetic progression adequately.	Is able to determine the pattern of sequence in relation to meaning of Arithmetic progression adequately and consistently.
Find the nth term of a Arithmetic progression	Is able to find nth term of AP little.	Is able to find nth term of AP partially.	Is able to find nth term of AP adequately.	Is able to find the nth term of AP adequately and consistently.
Find the nth term of a Geometric progression	Find little or no nth term of GP.	Is able to find partial nth term of GP.	Is able to find adequately the nth term of GP.	Is able to find the nth term of GP adequately and consistently.
Calculate the sum of an AP up to the nth term	Able to calculate little the sum of AP up to nth term.	Is able to calculate partially the sum of AP up to nth term.	Is able to calculate adequately the sum of AP up to nth term.	Is able to calculate the sum of AP adequately and consistently.
Calculate the sum of a GP up to the nth.	Able to calculate little the sum of GP up to nth term.	Is able to calculate partially the sum of GP up to nth term.	Is able to calculate adequately the sum of GP up to nth term.	Is able to calculate the sum of GP adequately and consistently.

Key: 1 = rarely or unacceptable 2 = sometimes or below standard
3 = regularly or satisfactory 4 = consistently or proficient