



Nexus of Peer Assessment and Critical Thinking on Students' Academic Performance in Mathematics and Basic Science in Ekiti State, Nigeria

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Abstract

This study investigated the nexus of peer assessment and critical thinking on academic performance of students in Mathematics and Basic Science in Ekiti state, Nigeria. The study adopted an ex post facto research design. Intact class was used to select the participants within the schools in the state. The instruments used to determine the veracity of peer assessment and critical thinking were Mathematics and Basic Science performance Test'' (MBSPT) and Questionnaire on Nexus of Peer Assessment and Critical Thinking (QNPACT). The validation of QNPACT and MBSPT were ensured by using face and content validity, while test re-test method was used to ascertain the reliability of the instruments and yielded a co-efficient of 0.82 and 0.85 respectively. Data collected were subjected to descriptive and inferential statistics. The findings of the study revealed that peer assessment and critical thinking can significantly influence students' performance in Mathematics and Basic Science. It was recommended that adequate measure should be taken by the teachers to ensure that students practice peer assessment and critical thinking in order to develop positive attitude towards learning of Mathematics and Basic Science.

Keywords: Peer Assessment, Critical Thinking, Performance, Teacher Characteristics,

INTRODUCTION

The word science was coined from Latin scientia knowledge'' which is a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe. (Harper, 2014). Science is a systematic innovative that builds and organizes knowledge in the form of testable explanations and predictions about the universe. Science has been variously defined by different scholars. Science is the intellectual and practical activity encompassing systematic study of structure and behavior of the physical and natural world through observation and experiment. Science is a system of knowledge covering general truths or the operation of general laws especially as obtained and tested through scientific method. In a natural phenomenon, science deals with the observation, identification, description, experimental investigation, and theoretical explanation about the world at large.

Obviously, Basic Science is seen as one of the subjects that is crucial in Nigeria Junior Secondary Schools. Basic Science is the composition of Biology, Chemistry and Physics at the senior level. At every stage of academic ladder, Basic Science can be referred to as a fundamental scientific knowledge acquired to obtain a better understanding of natural phenomena. It also referred to as a subject that looks for knowledge and discovery of facts that enable someone to understand the natural things that are in existence around him/her (Simbo, 2012). Basic science is formerly known to as integrated science. Therefore, Basic science is seen as a bedrock for all science subjects in senior secondary school curriculum (Agbidye, 2015). Basic Science is taught in the lower classes of Education such as primary and junior secondary schools to lay a solid foundation for pure Sciences. Mathematics also is a subject that investigates abstract structure and creates itself for the properties and patterns. It is a subject that seeks out patterns and uses them to formulate new conjectures. Uwaezuoke & Charles-Ogan (2015) emphasized the need to promote mathematics education globally

especially in the developing countries. Learning of Mathematics cut across all the classes both in the primary and secondary levels of education. Mathematics is a subject that deals with assumptions, properties and applications. Therefore, the study of Mathematics and Basic Science depend on mental ability which improve the quality of teaching and learning in the classroom. In order to make students effective in their learning and have excellent performance in these two subjects, efforts should be made to see that students are well engaged through series of methods such as Peer assessment and critical thinking in the classroom. Mathematics teachers are supposed to reflect on all innovative and creative ways through which students can make the best of the learning process for optimum performance

Peer assessment be termed as peer editing. It is a process in which students constructively evaluate the work of other students. At any level of learning, peer assessment can be used in a variety of courses and disciplines (Topping, 2019). This process allows students to submit their work to peers, who will help review it and give feedback to each other. Although, peers may and may not assign grades but engage in correcting peers when need arises. Peer assessment also involves small groups of three to five students to carry out the critical thinking of the work through various attempts. This exposed students to different working styles and provide a network of peers work which are important factors to students cognitive development and retention. The application of Mathematics and Basic Science could enable students to think and reason in a new dimension, improving social interaction and deeper reasoning among peers which allows for critical thinking and good performance.

Adeyemi (2015) found that friend assessment in secondary mathematics corridor indicated that their intercession had beneficial outcomes on the understudies learning consistency.

Peer assessment is used effectively and gives opportunity for students to work together in team and promote higher-order learning level. Peer assessment is much more than students marking books. It can be a very powerful way to bring about learning, although the set-up needs careful consideration to be effective. One of the key advantages of peer assessment is that it focuses student attention on what is actually important. According to Gulsen and Mehtap (2007) Learning is driven by what teachers and pupils do in classrooms where teachers have to manage complicated and demanding situations, channeling the personal, emotional and social pressures amongst a group of students in order to help them to learn now, and to become better learners in the future. Peer assessment also encourages students to develop professional behaviors and as well possess the ability to reconcile multiple perspectives by developing social skills. Peer assessment is capable to teach some of the topics in Basic Science that include mathematics such as period table, length, mass, time, measurement and unit, quantity of scalar and vector, energy, balancing of equation among others. Al Deeb (2006), states that peer teaching is one of the most effective strategies in the teaching and learning process because it deals with the social as well as the academic side of learning by creating a comfortable environment for teaching and learning

Peer assessment provides meaningful feedback and peer critiques. Some researchers referred to feedback as a central component of educational practice and fundamental part of learning and development (Reinholz, 2018). According to Black & William (2009), the provision of feedback is only one of many strategies for formative assessment; nonetheless, it is probably the most distinctive and object of in-depth studies. To help peer assessment, teachers may direct their students to assess each other, and this seems to be considerably more efficient and impactful in Mathematics and Basic Science. Feedback seems to be delivered in form of written comments, grading, or verbal feedback to influence peer assessment. Mostly, students are allowed to assess

themselves and this enables them to gain more information for their own learning (Reinholz, 2018).

Basic Science and Mathematics learning is the bedrock of civilization, expected to produce individual capable of solving problems (Ekwueme et.al, 2015). Teachers of Mathematics and Basic Science assessed the peer group to correlate and determine whether peer feedback has a positive decisive effect on the academic performance of students. Also, peer assessment includes several narrative evaluations which are made to draw out positive significant effects it. Working together of peer groups involves introduction of challenging tasks that require assistance from other students. However, this seems to increase Mathematics and Basic Science students' critical thinking and academic performance. Introducing assignment to peers also seems to be an active form of learning that helps students to critically evaluate and reflect on course content.

However, teachers avoid given assignment to students appears to affect their learning abilities in the classroom. In view of this, Althausser and Darnall (2001) commented that the way some of these teachers treated assignment does not reflect the potential for active learning experience for students. Teachers ought to give frequently assignment to student. They are supposed to organize assignments in a simpler form that can be reviewed by student peer to effectively promote learning. Simplified assignment and peer assessment supposed to increase student's critical thinking and their performance if properly implemented. Massengill (2011) noted that the provision of qualitative evidence of solving assignment together can aid the intellectual capacity of students. He stressed further that this can also help the students to recall and apply the knowledge gained. This implies that assisted performance is achieved through critical thinking and assistance from other students

Today, critical thinking skills are crucial in multiple areas to possess the knowledge and skills to be competitive in a rapidly changing world. For instance, critical thinking is acquired to foster the academic success in higher level of degree and to support lifelong learning. However, the study of Arum and Roksa, (2014), reported that a deficit still exists among newly graduates as large proportion of them are unable to exercise skills to analyze and solve problems in their area of specialization. They stressed further that, to propose innovative solutions to scientific problem were also difficult to them, despite the knowledge they are supposed to acquire in school. Peer assessment needs to be adapted to influence critical thinking and this should also influence students to possess the scientific and technical core skills necessary to the profession they selected.

To make teaching and learning strategies not to continue in relying on a more or less passive knowledge transfer due to students only focusing on the ability to memorize information (Blttler, Rapp, Solà, Davies, & Teixeira, 2013). Curriculum therefore, has to be developed and gear towards providing strategies to develop the ability for critical thinking (Ennis, 1996). Students need basic competencies to become a critical thinker in order to identify the problem and finding relevant solution to it. They also need information which could be used for them to recognize of inferences, the formulation of hypothesis, drawing of conclusions and establishment of judgments on the inferences (Ennis, 2011). All these appear to be focusing on effective way of decision making on based critical thinking. McCollister and Saylor (2010) suggested that critical thinking may be imbued in all subjects inform of diverse learning strategies which include class discussions, cooperative learning strategies, and the use of peer evaluation.

Peer group learning is an active pedagogy which fosters the procurement of knowledge and of personal and social skills through working together of students as a team (Tsay & Brady, 2010). The benefits and difficulties of peer review and feedback provision have been studied by different scholars. However, the reports of (Arum & Roksa, 2014), were contrary to this and said that insufficiency still exists in this type of skill especially in newly graduates (Blättler, Rapp, Solà, Davies, & Teixeira, 2013). For these authors, a large proportion of students are deprived of skills to analyze, solve and to propose innovative solutions to some problems despite possessing the scientific and technical core skills necessary to the profession they selected.

It was also discovered that, development of CT remains underestimated in most curricula, despite it is importance within the educational policies. The educational institutions supposed to provide strategies to develop the ability to critically thinking way of learning in as much CT plays a central role in decision making, innovation, entrepreneurship and problem solving (Butler, 2012). In line with this, McCollister and Sayler (2010) contributed that CT may be infused in all subjects using diverse learning strategies. They also recommended the inclusion of online discussion forums to support CT (Snodgrass, 2011) Lopes & Silva, 2010) suggested the in-class discussions and cooperative learning strategies to boost peer group learning. Peer group learning is a helpful active pedagogy fostering the acquisition of knowledge in students. It also provides personal and social skills resulting from the collaboration between the teacher and students, and students to students' in their working together.

Purpose of the study

The purpose of this study was to examine the influence of peer assessment on critical thinking and academic performance of students in Mathematics and Basic Science. The study also examines the interaction effects of peer assessment and critical thinking on students' performance in Mathematics and basic science.

Research Questions

The following questions were raised in the study.

1. What is the level of peer assessment on students' academic performance in Mathematics and Basic Science?
2. What is the influence of critical thinking on students' ' academic performance in Mathematics and Basic Science?

Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance.

1. There is no significant nexus between peer assessment and students academic performance in Mathematics and Basic Science
2. There is no significant nexus between critical thinking students academic performance in Mathematics and Basic Science
3. There is no significant difference in the male and female students peer assessment and their academic performance
4. There is no significant difference in the male and female students critical thinking and their academic performance

Methodology

This study employed partly descriptive and partly experimental research design to examine the nexus of peer assessment and critical thinking on students' performance in Mathematics and Basic Science. The design is suitable because it enabled the researchers to gather relevant information from Mathematics and Basic Science students' using qualitative measure of survey. The sample of the study comprised 480 Junior Secondary School students' offering Mathematics and Basic Science using multistage sampling procedure. The first stage involved the random selection of two local government areas in Ekiti State. The second stage involved the selection of two public secondary schools from each of the local government areas making a total number of four public secondary schools. Stage three involved selection of intact class of students from each of the selected schools.

Results

1. What is the level of peer assessment on academic performance of students in Mathematics and Basic Science?

In order to answer the question, scores of Mathematics and basic science students in MBSPT were distributed into low, moderate and high levels, with minimum and maximum scores of 1.00 and 12.00 respectively resulting to the level of peer assessment in Mathematics and Basic science with students that score below 33.3% as low while those score above 66.6% as high

Table 1: Frequency count and percentage on the level of peer assessment in MBSPT

Source of variation	Range	Frequency	Percentage
Low	1.00-4.00	187	39.0
Moderate	4.01-7.91	293	61.0
High	7.92-12.00	-	-
Total		480	100.0

Table 1: shows that 187 students representing 39% of the total sample had low level of peer assessment on academic performance while 293 students representing 61% had moderate level of peer assessment. This implies that the students have moderate peer assessment

2. What is the influence of peer assessment and critical thinking on students performance in Mathematics and Basic Science?

In answering the question, scores relating peer assessment and critical thinking in QNPACT were distributed using negative and positive scores with 65.42 cut off point .students who scored below the mean score on relating peer assessment and critical thinking were categorized into negative, while those exhibit positive had scores above the mean.

Table 2: Frequency count and percentage on critical thinking in QNPACT

Source of variation	Range	Frequency	Percentage
Negative	0.00-65.41	243	50.6
Positive	65.42-84.00	237	49.4
Total		480	100.0

The result in Table 2 reveals that 243 students representing 50.6% had the critical thinking that had negative influences while 237 respondents representing 49.9% exhibit positive critical thinking skill.

Testing of Hypotheses

1. There is no significant nexus between peer assessment and academic Performance of students in Mathematics and Basic Science

In order to test the hypothesis, scores in Mathematics and Basic education were taken after subjecting the participants to peer assessment using MBSPT.

Table 3: ANOVA summary on peer assessment and academic performance

Source of variation	SS	Df	MS	F_{cal}	F_{table}
Between groups	68.085	6	11.348	2.869	2.100
Within groups	1870.906	473	3.955		
Total	1938.992	479			

The result in Table 3 reveals that $F_{cal} = 2.869 > F_{tab} = 2.100$ at 0.05 level of significance. This implies that there is significant nexus between peer assessment and academic performance of students in Mathematics and Basic science, hence, the null hypothesis is rejected. Therefore, there is a significant nexus between peer assessment and academic performance of students in Mathematics and Basic Science.

2. There is no significant nexus between critical thinking and academic Performance of students in Mathematics and Basic Science

In order to test the hypothesis, scores in Mathematics and Basic education were taken after subjecting the participants to peer assessment using MBSPT.

Table 4: ANOVA summary on critical thinking and performance

Source of variation	SS	df	MS	F_{cal}	F_{table}
Between groups	1438.256	6	239.709	6.681*	2.100
Within groups	16970.892	473	35.879		
Total	18409.148	479			

The result in Table 4 reveals that $F_{cal} = 6.681 > F_{tab} = 2.100$ at 0.05 level of significance. This implies that there is significant nexus between critical thinking and academic performance of students in Mathematics and Basic science, hence, the null hypothesis is rejected. Therefore, there is a significant nexus between critical thinking and academic performance of students in Mathematics and Basic Science.

3. There is no significant difference in the male and female students peer assessment and their academic performance

In order to test the hypothesis, scores of male and female students on peer assessment.

Table 4: t-test summary on gender difference and peer assessment

Source of variation	N	Mean	SD	Df	t_{cal}	t_{table}
Male	279	6.80	2.001	478	0.578	1.960
Female	201	6.69	2.031			

Table 4 shows that $t_{cal} = 0.578 < t_{table} = 1.960$ at 0.05 level of significance. The null hypothesis is not rejected. This implies that there is no significant difference in the male and female peer assessment in Mathematics and Basic Science

4. There is no significant difference in the male and female students' critical thinking and their academic performance

In order to test the hypothesis, scores in Mathematics and Basic education were taken after subjecting the participants to peer assessment using MBSPT.

Table 5: t-test summary on gender difference and critical thinking

Source of variation	N	Mean	SD	df	t _{cal}	t _{table}
Male	279	65.64	6.390	478	0.578	1.960
Female	201	65.12	5.928			

Table 5 shows that $t_{cal} = 0.578 < t_{table} = 1.960$ at 0.05 level of significance. The null hypothesis is not rejected. This implies that there is no significant difference in the male and female critical thinking in Mathematics and Basic Science

Discussion

The result showed that students have moderate peer assessment in their performance in Basic Science and Mathematics. This is in support of the result of Massengill (2011) who noted that the provision of qualitative evidence of solving assignments together can aid the intellectual capacity of students and also help the students to recall and apply the knowledge gained. On the contrast, the study of Danjuma, Obiji and Magai (2021) stated that students are facing difficulty in proposing innovative solutions to scientific problems despite the knowledge they are supposed to acquire through CT in the classroom. The result also showed that more than half of the students exhibit negative attitude towards critical thinking while few of them exhibit positive attitude towards critical thinking skill. This is in line with the study of (Blättler, Rapp, Solà, Davies, & Teixeira, 2013 and Arum & Roksa, 2014) who noted that a deficit still exists among newly graduates as a large proportion of them are unable to exercise skills to analyze and solve problems in their area of specialization

The result also showed that there is a significant nexus between peer assessment and academic performance of students in Mathematics and Basic Science. This contradict the result of Blatter, Rapp et al (2013) that a large number of students are unable to analyze and proffer solution to problems encountered which invariably hinders their academic performances. The result also showed that there is a significant nexus between critical thinking and academic performance of students in Mathematics and Basic Science. The result of Rayhanul (2015) noted that CT enhances academic performance of students at all levels if they can develop the skills. On the contrast, the result of Danjuma, Obiji and Magai (2021) noted that students are facing difficulty in proposing innovative solutions to scientific problems despite the knowledge they are supposed to acquire through CT in the classroom.

The result also showed that there is no significant difference in the male and female peer assessment in Mathematics and Basic Science. The result of Ammons and Brooks (2011) noted that there was no gender bias in the overall ratings of the specific performance allotted to male and female students in a team work in the classroom. On the contrary the result of Angel Nga-Man et al (2015) revealed that female who held feminine role performed better when the same embedded test on spatial ability was framed as measuring empathy for both of them. The result also showed that there is no significant difference in the male and female critical thinking in Mathematics and Basic Science. The study of Ammons and Brooks (2011) supported that there is no difference in the performance of male and female especially in the task assigned to them. But on the contrary, the study of Takeda and Homberg (2014) and Angel Nga-Man et al (2015) noted underperformance of males in collaborative work than females' counterparts.

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