EFFECT OF PEER-BRAINSTORMING INSTRUCTIONAL STRATEGY ON SENIOR SECONDARY STUDENTS' PSYCHOMOTOR SKILLS IN BIOLOGY

[1*]Felix Sesugh Kpiranyam, [2]Joy Okache Omaga and [3]Peter Ogbu Agogo

1*. Postgraduate Student, Department of Science and Mathematics Education, Benue State University, Makurdi-Nigeria

2&3. Department of Science and Mathematics Education, Benue State University, Makurdi, Nigeria

sughkpiranyam@gmail.com; joyokache@yahoo.co.uk; poagogo2007@gmail.com

Abstract

This study examined the effect of peer-brainstorming instructional strategy on senior secondary students' psychomotor skills in Biology in Makurdi Metropolis of Benue State, Nigeria. It was guided by two research questions, while two null hypotheses were formulated and tested. Quasi-experimental design, specifically the pre-test, post-test non-equivalent control group design was adopted. The population consisted of 2,647 (1,545 male and 1,102 female) Senior Secondary II students out of which 77 (49 male and 28 female) Senior Secondary II students offering Biology in two intact classes from two schools were sampled using multi-stage sampling procedure. Biology Psychomotor Skills Test (BPST) constructed by the researchers was validated by three research experts and its internal consistency was determined using Pearson Product Moment Correlation Coefficient. The reliability coefficient was 0.84. The duration of the study was seven weeks. Two trained research assistants taught the groups using the lesson plans prepared by the researchers. For data analysis, mean and standard deviation were used to answer the research questions, while the hypotheses were tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). Findings revealed significant difference between the mean psychomotor skills scores of students taught Biology using Peer-Brainstorming Instructional Strategy and Demonstration Strategy ($F_{1,74}=188.418$; $P=0.000<0.05$). Findings revealed no significant difference between the mean psychomotor skills scores of male and female students taught Biology using peer-brainstorming instructional strategy ($F_{1,33}=3.333$, $P=0.077>0.05$). Based on the findings of this study, principals, Science Teachers Association of Nigeria and National Teachers Institute should encourage Biology teachers' usage of peer-brainstorming instructional strategy to help male and female students acquire psychomotor skills.

Introduction

The economic, scientific and technological advancements of a nation largely depend upon the quality of education, knowledge and skill level of its citizens. Science education, emphasized in the 21st century, has the potential to shape intellectual growth and nurture learners with knowledge, skills and competencies needed for productive life. To effectively carry out this task, teachers need to

embrace hands-on and minds-on approach to teaching and learning of science especially Biology. Emphasizing this view, Wagbara (2020) observed that the idea whereby the teacher is seen as a repository of knowledge or owner of fact with all knowledge of a particular phenomenon to impart students is outdated. In this regard, there is need to engage students in hands-on and minds-on learning activity in the classroom.

The fact that students benefit more by actively partaking in hands-on and minds-on learning is not in dispute. Psychomotor skills deal with learning activities that requires coordination of fingers of the human hand as a result of cognitive planning (Gambari, Balogun & Alfa, 2014). To Odoh (2016), psychomotor skills are abilities learned by making use of the hands. These skills can best be acquired by engaging students in hands-on minds-on activities. Nicholls, Sweet, Muller and Hyett (2016) identified five points to bear in mind when teaching to enhance complex psychomotor skill to include: do not teach a whole complex skill in a single session; break down a skill into knowledge and skill sub-parts; limit verbal input throughout skill practice; correct all skill errors immediately as they occur and use multiple short practice sessions to develop a skill. During these activities, students carefully manipulate equipment to present an idea and express understanding of the world around them. Such learning activities in Biology include: manipulating equipment like lancet, microscope, drawing of diagram, dissecting and observing amphibian and reptiles. Shoval and Shachaf (2023) stated that physical-motor domain supports an individual's learning of verbal-academic aspects of a subjects. The author noted that psychomotor skills promote success because of its ability to enhance independence and enables learners to acquire meta-motor skills which ensure continuity of learning. They also enhance abilities common to movement on the physical as well as other domains such as personal-emotional, ability of learners to socialize and work with peers or that relating to acquisition of information and display of creativity.

Actively engaging in activities during learning provide students offering Biology opportunity to understand Biological concepts and acquire psychomotor skills. It has been observed that most psychomotor skills are unique to each discipline (Nicholls, Sweet, Muller & Hyett, 2016; Hill, Fadel & Bialik, 2018). Hence, students who wish to become professionals in areas such as Microbiology, Pharmacy, Nursing, Forestry, Biotechnology, Nanotechnology, Botany, Zoology, Phycology, Mycology, Ornithology should be guided to develop relevant psychomotor skills. This is due to the fact that such skills help on to become better in dealing with the theory and practice. Odoh (2016) asserted that physically manipulating instruments or equipment could aid acquisition of psychomotor skill. Measures of psychomotor performance include several attributes such as precision, accuracy, speed, and consistency, as well as physical abilities such as strength, flexibility, balance, and stamina (Hill, Fadel & Bialik, 2018). Engaging students offering Biology in frequent practical activities requiring the use of equipment may foster acquisition of psychomotor skill. However, in some secondary schools in Nigeria, students rarely engage in hands-on activities except during preparation for practical aspects of

external examinations (Achor & Agamber, 2013; Odoh, 2016).

The amount of time used to practice a skill may improve learners' effectiveness in dealing with such skills. Inability to practice may thus limit a learners' ability. This could be the reason for the possession of poor psychomotor skills among students offering Biology in some senior secondary schools in Nigeria as reported by the West African Examination Council (WAEC, 2018) For instance, WAEC Chief Examiner's Report (2018) reported that students display weaknesses in drawings of diagrams with loss of details, with wholly or broken lines; poor performance in questions that require application of knowledge and inability to use technical terms to describe some processes. This shows that students have poor psychomotor skills. Thus, indicating that the aims of secondary education as stated in the National Policy on Education (FRN, 2013) to promote functional education for skill acquisition and inspire students with a desire for self-improvement and achievement of excellence are not satisfactorily met. Furthermore, the poor psychomotor skills acquisition is disturbing as it could hinder the aspiration of Nigeria to attain sustainable national development as it may hinder production of manpower in applied science and technology**.**

Researches indicate that poor psychomotor skills in science (Biology) is as a result of inability of students to understand the concepts (Cimer, 2012), poor teaching strategy (Omorogbe & Ewansiha, 2013; Achor & Agamber, 2013), lack of emphasis on learning by doing (Delmang & Odoh, 2018) and poor study habits by students (WAEC Chief Examiner's Report, 2018). However, the impact of instructional strategy on inculcating creative skills and enhancing competencies is not in doubt (Samba & Kpiranyam, 2021; Kpiranyam, Ode & Ajio, 2023).

Instructional strategy such as peer-brainstorming strategy is advocated. Brainstorming strategy was introduced by Alex Osborn, an American in 1938 (Al-khatib, 2012). With cross-breeding of ideas, the strategy which was introduced for business has been applied in education. Al-khatib (2012) opined that brainstorming strategy can provoke creativity and help students solve problems in educational and real life settings. Thus, engaging in brainstorming may foster innovation and high thinking skills. Owoyomi (2015) asserts that brainstorming is a creative strategy which aids learning to generate ideas for problem solving in groups or individually during teaching and learning. Such problem solving may involve practical activities that promote development of psychomotor skills. Brainstorming instructional strategy can be used to engage students in pre-writing or drawing exercises hereby helping students improve their psychomotor skills.

Researches abound on the effect of brainstorming on students' learning outcomes in Kuwait by AlMutairi (2015), in Chemistry in South-South Nigeria by Owo, Idode and Ikwut (2016), in nutrition in Bandung, Indonesia by Hidayanti, Rochintaniawati and Agustin (2018) and in Chemistry in Rivers State, Nigeria by Wagbara (2020). The studies indicated that brainstorming instructional strategy was effective in in chemistry and

nutrition which are science subjects perhaps it may be effective in biology too, hence this study.

Another variable of interest in this study is gender. Gender could influence students' ability to acquire knowledge, skills and generate ideas. Adekola (2014) observed that both male and females differ significantly in the way they think, reason and cope with learning. Oludipe (2012) noted that certain vocations and professions are 'reserved' for certain gender. This may lead to gender preference for some learning activities. Such activities may include: manipulating equipment, drawing of diagram, dissecting and observing amphibian and reptiles. Furthermore, male or female students may consciously or unconsciously withdraw from engaging in classroom activities that involve practicing these psychomotor skills especially if taught using teacher dominated methods. Hence the need to research into innovative and constructivist strategies. Moreover, studies on secondary school students' psychomotor skills acquisition in Biology based on gender are scarce to the best of the knowledge of the researchers. This study therefore, aimed at providing empirical evidence regarding the gender difference in students' psychomotor skills acquisition in Biology. This study thus filled these gaps by investigating the effect of peer-brainstorming instructional strategy on secondary school students' psychomotor skills acquisition in Biology.

Statement of the Problem

Despite efforts by the Science Teachers Association of Nigeria, government and Biology curriculum developers to improve science education in Nigeria to foster creativity, imagination, manipulation, critical thinking and high cognitive skills, learners still display poor psychomotor skills. Reports indicate that secondary school students still exhibit poor psychomotor skill (Delmang & Odoh, 2018; WAEC, 2018). Poor psychomotor skills could affect the realization of the objectives of teaching and learning Biology, the gender of the students nonetheless. If not addressed, male and female students will be deficient in observational skills, high manipulative ability, imagination and critical thinking and may fail to realize their dreams to become pharmacist, gynecologist, engineers, nurses, food technologist, zoologist, botanist and Biology educators. Research findings indicate that if students are provided opportunity to interact, apply the right measurement, draw and label Biology diagrams properly and make connections, organise and integrate Biology concepts it will facilitate curiosity, creative thinking, reasoning and may improve students' psychomotor skills in Biology. Thus the researchers sought to find out if the use of peer-brainstorming instructional strategy can foster acquisition of psychomotor skills by secondary school students in Biology in Makurdi Metropolis of Benue State, Nigeria.

Research Questions

The study was guided by the following research questions:

1. What is the difference between the mean psychomotor skills scores of students taught Biology using peer-brainstorming instructional strategy and those taught using demonstration strategy?
2. What is the mean psychomotor skills scores of male and female students

taught Biology using peer-brainstorming instructional strategy?

Hypotheses

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

1. There is no significant difference between the mean psychomotor skills scores of students taught Biology using peer-brainstorming instructional strategy and those taught using demonstration method.
2. Male and female students do not significantly differ in their mean psychomotor skills scores when taught Biology using peer-brainstorming instructional strategy.

Research Method

This study adopted quasi-experimental design, specifically the pre-test, post-test non-equivalent control group type. The design enabled the researchers to administer treatment to students in classroom setting to both experimental and control groups without randomization so as not to disrupt the intact classroom arrangement by schools. The researchers used two groups. Group one was taught using peer-brainstorming instructional strategy. The second group was taught using demonstration strategy. The study was carried out in Makurdi Metropolis of Benue State, Nigeria.

The population consisted of 2,647 (1,545 males and 1,102 females) Senior Secondary II students offering Biology in 24 state government public Senior Secondary Schools in the 2022/2023 academic session (Benue State Teaching Service Board, Makurdi (2023). Multi-stage sampling procedure involving stratifies, purposive and simple random sampling techniques were used to obtain 77 (49 males and 28 females) students offering Biology in two intact classes from two schools that have enrolled students for WAEC for more than five years. Furthermore, only teachers who have taught Biology for five years and who hold B.Sc Ed Biology and B.Ed Biology served as research assistants. One school was randomly assigned to experimental group (taught with peer-brainstorming instructional strategy), while the other group was assigned to control group (taught with demonstration strategy).

Biology Psychomotor Skill Test (BPST) was constructed by the researchers. The topics selected were based on Ecological Management Concepts in the SS II Biology curriculum. The BPST was had three sections. Section A had five questions requiring students to fill in with short answers about manipulation of the microscope while B required students to draw a toad and an earthworm. In section C, students were observed by the teacher and awarded marks during the pre-test and post-test based on their ability to manipulate equipment, draw diagrams, dissect and observe specimens. The instrument was administered as pre-test and post-test and the total score was 100.

The content and face validation of Biology Psychomotor Skills Test (BPST) was done by three research experts in science education and necessary comments and corrections by these experts were adequately effected. The BPST was trial-tested on 32 SS II students offering Biology in one intact class and scores

from BPST was subject to internal consistency check using Pearson product moment correlation coefficient. Reliability index of 0.84 was obtained. This was considered high enough as Emaikwu (2015) asserted that reliability coefficient of 0.60 and above indicates that the instrument is reliable.

The entire duration of the study was seven weeks. In the first week, Biology teachers teaching in the sampled schools were trained as research assistants and pre-test administered. Teaching began in the second week and lasted for 80 minutes (double period) for five weeks. The lesson plans prepared by the researchers covered Ecological Management Concepts. Students in the experimental group were taught using Peer-Brainstorming Instructional Strategy (PBIS) during which the students were encouraged to actively engage in thinking, generating ideas, solving problems, drawing diagrams, labelling, describing and answering questions on some organs of respiratory and human digestive systems. Learners were guided by the teacher to interact, share, discuss their ideas and engage in the hand-on minds-on activities like manipulating and observing specimens on the microscope, drawing diagrams and observing organisms using hand lens.

Students in the conventional strategy were taught using lesson plans on the same contents. The teacher used demonstration strategy during the lesson and allowed students to ask questions at interval which were answered by the teacher. Post-test was administered in the seventh week. The data obtained were analyzed using mean and standard deviation to answer research questions while the hypotheses where tested at 0.05 level of significance using Analysis of Covariance (ANCOVA). ANCOVA was considered appropriate to take care of the initial difference arising from use of intact classes, between the two groups investigated through experimental design.

Results

The pre-test and post-test data collected from the experimental and control groups are presented and analysed in tables below:

Research Question One

What is the difference between the mean psychomotor skills scores of students taught Biology using peer-brainstorming instructional strategy and those taught using demonstration strategy?

Table 1: Mean and Standard Deviation of Psychomotor Skills Scores of Students Taught Biology Using Peer-Brainstorming Instructional Strategy and Demonstration Strategy

Group		Pre-BPST		Post-BPST		Mean Gain
	n	$\bar{x}$	σ	$\bar{x}$	σ	
Peer-Brainstorming	36	38.39	4.82	73.14	5.03	**34.75**
Demonstration	41	39.68	3.22	63.21	4.90	**23.53**
Mean Difference		**1.29**		**9.93**		**11.22**

Note:$\bar{x}$ = mean; σ= standard deviation

Table 1 reveals that students taught Biology using Peer-Brainstorming Instructional Strategy had 38.39 and 73.14 as Pre-BPST and Post-BPST mean scores with Standard deviation of 4.82 and 5.03, while students taught using the Demonstration Strategy had Pre- BPST and Post- BPST mean scores of 39.68 and 63.21 with standard deviation of 3.22 and 4.90 respectively. Result in the table shows that the mean gain value of 34.75 was obtained for students taught Biology using Peer-Brainstorming Instructional Strategy while that of students taught using the Demonstration Strategy 23.53. The mean gain difference was 11.22 in favour of students taught using Peer-Brainstorming Instructional Strategy.

Research Question Two

What is the mean psychomotor skills scores of male and female students taught Biology using peer-brainstorming instructional strategy?

Table 2: Mean and Standard Deviation of Psychomotor Skills Scores of Male and Female Students Taught Biology Using Peer-Brainstorming Instructional Strategy

Group	**N**	**Pre- BPST**		**Post- BPST**		**Mean Gain**
		$\bar{x}$	σ	$\bar{x}$	σ	
Male	22	38.41	4.64	73.41	4.64	**35.00**
Female	14	38.36	5.29	72.71	5.76	**34.35**
Mean Difference		**0.05**		**0.70**		**0.65**

Table 2 indicates that male students taught Biology using peer-brainstorming instructional strategy had 38.41 and 73.41 as Pre-BPST and Post-BPST mean scores with Standard deviation of 4.64 and 4.64, while female students had Pre- BPST and Post-BPST mean scores of 38.36 and 72.71 with standard deviation of 4.23 and 5.76 respectively. Result in the table further establishes mean gain of 35.00 and 34.35 for the male and female students with a mean gain difference of 0.65 in favour of male students.

Hypothesis One

There is no significant difference between the mean psychomotor skills scores of students taught Biology using peer-brainstorming instructional strategy and those taught using demonstration strategy.

Table 3: ANCOVA Result for Students Taught Biology Using Peer-Brainstorming Instructional Strategy and Demonstration Strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	2836.426[a]	2	1418.213	116.998	.000	.760
Intercept	915.338	1	915.338	75.513	.000	.505
Pre-BPST	950.328	1	950.328	78.399	.000	.514
Group	2283.934	1	2283.934	188.418	.000	.718
Error	897.002	74	12.122			
Total	358287.000	77				
Corrected Total	3733.429	76				

Table 3 reveals that $F_{1,74}$ = 188.418; P=0.000<0.05 which signifies that the observed difference is significant. Hence, the null hypothesis is rejected. This means that significant difference exists between the mean psychomotor skills scores of students taught Biology using Peer-Brainstorming Instructional Strategy and those taught using demonstration strategy.

Hypothesis Two

Male and female students do not differ significantly in their mean psychomotor skills scores when taught Biology using peer-brainstorming instructional strategy.

Table 4: ANCOVA Result for Male and Female Students Taught Biology Using Peer-Brainstorming Instructional Strategy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	851.414[a]	2	425.707	402.629	.000	.961
Intercept	625.805	1	625.805	591.879	.000	.947
Pre-BPST	847.284	1	847.284	801.351	.000	.960
Gender	3.524	1	3.524	3.333	.077	.092
Error	34.892	33	1.057			
Total	193461.000	36				
Corrected Total	886.306	35				

Table 4 shows that $F_{1,33}$=3.333, P=0.077>0.05. This implies that the observed difference is not significant. Hence the null hypothesis is not rejected. By implication, there is no significant difference between mean psychomotor skills scores of male and female students taught Biology using peer-brainstorming instructional strategy.

Discussion of Findings

From the results of the analysis, it is found that significant difference exists between the mean psychomotor skills scores of students taught Biology using peer-brainstorming instructional strategy and demonstration strategy. This finding is in consonance with

the finding of Al-Khatib (2012) which showed that there are statistical significant differences in creative thinking skills between students taught using brainstorming instructional strategy and those in the control group. The result is in line with the research finding of Al-Mutairi (2015) which shows that, there are statistical significant differences in scores of the creative thinking in favor of group taught using brainstorming strategy. This finding collaborates that by Owo, Idode and Ikwut (2016) which showed statistically significant difference in both mean knowledge and mean academic performance in favour of the brainstorming group. This finding is also in agreement with the result of the study by Hidayanti, Rochintaniawati and Agustin (2018) which showed statistical significant differences between students taught using brainstorming strategy and control group in creative thinking skills test. This finding was also consistent with the result from Wagbara (2020) which indicated that significant difference exist between the mean performance scores of students exposed to brainstorming strategy in Chemistry and those of lecture method in favor of brainstorming strategy. Abaver, Kpiranyam and Ode (2023) found statistically significant difference in the mean academic performance in Mathematics. This finding is due to the fact that brainstorming enhances students' creative thinking skills and create opportunity to students to share ideas with their peers in class and generate creative ideas as they actively participate in teaching and learning with criticism, this may account for the improved psychomotor skill ability in the experimental group.

The implications of this finding for the Biology teachers, students, government and administrators of secondary schools, curriculum planners and the society is enormous. The implication of these findings is that students offering Biology will learn better, develop more psychomotor skills and retain their learning better when peer-brainstorming strategy is used for teaching and learning Biology. Furthermore, Biology teachers have to adopt the use of peer-brainstorming strategy to create student-oriented classroom environment in the learning of Biology at the secondary schools.

Finding of this research also showed that there is no significant difference between the mean psychomotor skills scores of male and female students taught Biology using peer-brainstorming instructional strategy. The result is in line with the research finding by Owoyomi (2015) which shows that, gender had no significant effect on students' performance when brainstorming strategy was used. The finding also agrees with the result by Owo, Idode and Ikwut (2016) which showed no statistically significant difference in the mean academic performance of male and female students in brainstorming group. The finding was also consistent with the result from Wagbara (2020) that significant gender difference was not recorded with the use of brainstorming strategy. As seen in the results, even though there were significant differences in male and female students' psychomotor skills in the pre-test such differences were not observed in the post-test. The use of peer-brainstorming strategy during teaching and learning of Biology requires providing adequate opportunity for students to interact,

think critically and bring up ideas as they solve problems. This will enable male and female students to become independent learners, improve their psychomotor skills and become self-reliant thus reducing the frustration of students and parents due to students' inability to fit into a society that is skills oriented. The findings provide curriculum planners and educational administrators with information to reference in review of curriculum and formulate other educational policies where necessary.

Conclusion

Based on the findings of this study, use of peer-brainstorming strategy in teaching and learning of Biology fostered the acquisition of psychomotor skills among secondary school Biology students with no observed gender disparity. Thus, in order to ensure that students adequately acquire psychomotor skills at the secondary school, this strategy should be used.

Recommendations

Based on the findings in this study, the following recommendations were advanced:

1. Biology teachers at the senior secondary school level should be encouraged by school administrators to use peer-brainstorming as an instructional strategy for teaching and learning to help male and female students acquire psychomotor skills.
2. Principals, teacher training institutions, Science Teachers Association and National Teachers Institute should organize workshops and conferences to sensitize teachers on the use of peer-brainstorming instructional strategy to enable Biology students acquire psychomotor skills.

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