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EFFECT OF DEEP CONCEPTUAL AND THINK-PAIR-SHARE STRATEGIES ON STUDENTS ACADEMIC ACHIEVEMENT IN BIOLOGICAL CONCEPT OF BLOOD CIRCULATION IN AWKA METROPOLIS

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ABSTRACT

This study investigated on effect of deep conceptual and think-pair-share strategies on students' academic achievement in biological concept of blood circulation in Awka metropolis. Three purpose of studies, three research questions and three hypotheses tested at .05alpha level guided the study. A quasi- experimental design using 3×2 factorial was adopted, specifically the pretest-posttest non-equivalent control group was used. Population of the study was 4023 SS 2 students offering Biology for 2021/2022 academic section in the Awka metropolis. A sample of 141 SS2 Biology students from three schools obtained using multi sampling technique was used in the study. The instrument used for data collection was Biology Achievement Test (BAT), validated by two lecturers from Departments of Science Education and one lecturer from Educational Foundations all from Nnamdi Azikiwe University, Awka. The reliability of the instrument was established using Kuder Richardson 21(KR-21) which yielded coefficient of .71. The two experimental groups were taught biological concept of blood circulation using deep conceptual and think-pair-share strategies respectively while the control group was taught the same concept of Biology using conventional strategy. The data collected were analysed using mean and standard deviation for research questions while analysis of covariance was used to test the null hypotheses. The study revealed that there are significant differences in the mean academic achievement scores of Biology students taught blood circulation using three instructional strategies in favour of the treatment groups. The study also revealed that there is no significant effect on male and female Biology students taught blood circulation in the treatment groups. It was recommended that seminars, workshops and conferences should be organized by school heads to orient Biology teachers on how to use deep conceptual and think-pair-share strategies in teaching Biology concepts in secondary schools.

Keywords: Science Education, Biology, Deep Conceptual Strategy, Think Pair Share and Achievement

Introduction

Science is seen as a body of knowledge, a way of investigation and thinking in pursuit of an understanding of nature. The way this science is being taught and learned in school is called science education (Ogunyebi, 2018). Science education plays a vital role in the lives of individuals and the development of a nation because it enhances nation's technological development. Obikezie et. al. (2022) averred that a well developed and implemented science and technology education programme of a country will not only produce knowledgeable and skilled

manpower for the workforce but also usher in sustainable socio-economic growth and political stability in that country. Science educations to which Physics, Chemistry and Biology form the bases focus not only on producing excellent scientists but also, to produce citizens who use their knowledge to advance the society (Obikezie & Abumchukwu 2021). As a result, students are being encouraged to take up science-related courses within the content of science education which Biology subject is one of them.

Biology has been identified as a very important subject and as a core subject taught at the senior secondary school in Nigeria. Biology is the study of living things which includes plants and animals (Michael, 2015). It deals with living organisms including their structure, function, evolution, distribution and inter-relationships. Biology curriculum is designed to continue students' investigation into natural phenomena, deepening students' understanding, achievement, interest and retention in biological science and to encourage students' ability to apply scientific knowledge to everyday life because of its importance to humanity. Furthermore, Obikezie et. al. (2022) asserted that importance of Biology to humanity includes it helps man understand the living world and the ways its many species function, evolve, and interact. But despite all these importance of Biology to humanity, the West Chief examiners' reported weaknesses in some concepts of Biology.

West African Examination Council Chief examiners' reports averred that from year 2011 to 2022, individually summarized that weaknesses of students in Biology subject includes (i) poor performance in questions that require application knowledge (ii) inability to identify the samples skeleton parts (iii) poor knowledge in cell structure and functions of the cell (iv) poor knowledge in forms in which living cell exist (v) Basic ecological concepts, Ecosystem: components and sizes, (vi)Local biotic communities or biomes: tropical rain forest, Northern guinea savanna, sahel, desert, (vii) Population studies by sampling method: population size, dominance, density, factors that affect population (viii) inability to identify concept in ecological factors: aquatic, terrestrial and factors common to all habitats (ix) transport system (Blood circulation) (x) respiration and (xi) respiratory mechanism in man. One could imagine while WAEC Chief Examiners' should be reporting these weaknesses in Biology concepts every year from 2011 to 2022. The question now is what could be the causes of these under achievement and weaknesses among secondary school students in Biological concept of blood circulation also known as transport system for these twelve years?

Osuafor and Ogbaga (2016) opined that the major causes of weaknesses in secondary school Biology especially in the areas of blood circulation in senior secondary school examination is lack of use of innovative instructional strategy in teaching the students. The authors stated that innovative instructional strategies like deep conceptual and think-pair-share may help to improve the achievement of secondary school students in science related subject especially in teaching Biological concept of blood circulation.

Deep conceptual instructional strategy is an integrated understanding of important concept. Ogbaga (2022) reported that students who learn via deep conceptually are

likely knowledgeable than those who only learn theoretical fact and procedures. Dehghan (2013) outlined the following rule in deep conceptual strategy as: withhold criticism within the session, Focus on the number of ideas generated by its group or individual members, documentation of ideas generated. Combine and improve ideas. These rules help use of deep conceptual strategy in classroom to be more effective. Deep conceptual strategy encourages learner to express their suggestion or ideas quickly and easily without much processed thought or reflection (Peter, 2016; Jacob et. al., 2016; Drits-Esser & Stark 2015). Most researchers believed that deep conceptual strategy is effective in enhancing students' achievement and interest in Biology, but had no significant effect on male and female students in the said subject (Hoffman & Turner 2015; Osuafor & Ogbaga 2016). Based on the findings, the researchers concluded that deep conceptual strategy is effective in improving students' achievement in Biology. Bilal-Adel (2012) observed that there are statistical significant differences at the level of ($\alpha = 0.05$) between the experimental group and the control group in the total score and the sub scores of the creative thinking in the favor of the experimental group indicating the effectiveness of using deep conceptual strategy in developing creative thinking skills. Owo et. al. (2016) observed that there is a statistical significant difference in both mean knowledge and mean academic achievement of students taught sciences with deep conceptual strategy and those taught with conventional strategy in favour those taught in deep conceptual group and there is no statistical significant difference in the mean academic achievement of male and female students taught Biology using deep conceptual instructional strategy. Hidayanti et. al. (2018) reported that there is a statistical significant differences between experimental and control group in creative thinking skills test with the score of 0.70. The result is in favour of the experimental group, indicating there was effectiveness of deep conceptual strategy in developing students' creative thinking skills in learning nutrition just as when think pair share instructional strategy was used to teach the same concept (Hidayanti et. al. 2018).

Another concept under study is think-pair-share (TPS). Think-pair-share (TPS) strategy is one of the group discussion strategies and diverse method of learning collaboratively. This strategy was developed by Frank Lyman in 1981. Andrew and Alexandra, (2015) defined think-pair-share as a cooperative learning strategy that encourages students to work together to solve problems or answer questions on an assigned topic. TPS is used to keep all students actively involved in class discussion and provides an opportunity for everyone to share their idea and answer to every question posed by the teacher. Some researchers believed that think pair share effectively enhances students' achievement in science subjects (Drits-Esser & Stark 2015). Ogunyebi (2018) observed that there is a significant difference between the posttest means scores of students exposed to think-pair share and conventional strategies. The researcher revealed that there is no significant difference between the posttest means scores of male and female students exposed to think-pair and conventional strategies. Nwaubani et. al. (2016) averred that both Think-pair-share (TPS) and student teams-achievement (STAD) significantly improved students' achievement in economics. The researchers also revealed that female students achieved better than

their male counterparts when both instructional strategies were used. The researchers concluded that both TPS and STAD could enhance students' achievement in economics with female students making more significant gain than their male counterparts. Bamiro (2015) observed that students taught with guided discovery and think-pair-share strategies obtained significantly higher posttest mean scores than those in the lecture strategy. The researcher concluded that the use of guided discovery and think-pair-share strategies had great potential for improving achievement in Chemistry.

Most of the study studies reviewed where done under other science subject areas that are not Biological concept of blood circulation. However, despite its importance and usefulness of Biology especially in the areas of blood circulation to humanity and other animals there is still weaknesses in the Biology concept of blood circulation as summarized by WAEC examiners' report from 2011-2022. One of the major contributing factors to this ugly state of learning as revealed by most studies and WAEC chief examiner's report is the teachers' instructional strategy of instruction. The conventional instructional strategies adopted by most Biology teachers fail to help students make connections between what is learnt and the real. The resultant effect is further decline in academic achievement after learning Biology. Deep conceptual and TPS instructional strategies have been found effective in improving students' achievement of learning materials in some subjects like Mathematics, Chemistry, Nutrition science, Computer science, Integrated Science and even in some Biology concepts but no such study known to the researchers has been carried out in Biological concept of blood circulation (Common Core State Standards Initiative, 2016). On this note the researchers investigated on the effect of deep conceptual and think-pair-share strategies on students' academic achievement in biological concept of blood circulation in Awka metropolis.

Research Questions

The following three research questions guided this study:

1. What is the difference in the mean achievement scores of three groups of students taught Biological concept of blood circulation using deep conceptual strategy, think-pair-share (TPS) strategy and those taught using conventional strategy?
2. What is the difference in the mean achievement scores of male and female students taught Biological concept of blood circulation using deep conceptual strategy?
3. What is the difference in the mean achievement scores of male and female students taught Biological concept of blood circulation using TPS strategy?

Hypotheses

The following null hypotheses were tested in this study at 0.05 alpha level of significance. They are:

1. There is no significant difference in the mean achievement scores of three groups of students taught Biological concepts of blood circulation using deep conceptual strategy, think-pair-share strategy and that of those taught using conventional strategy.
2. There is no significant difference in the mean achievement scores of male and female students taught Biological

concept of blood circulation using deep conceptual strategy.

3. There is no significant difference in the mean achievement scores of male and female students taught Biological concepts of blood circulation using TPS.

Research Method

This study employed a quasi-experimental design which involved 3X2 factorial study. The 3×2 factorial indicates the three levels of treatment (deep conceptual, think-pair-share and conventional strategies) and two levels of gender (male and female). The sample consists of 141 SS 2 Biology students selected from co-educational public school in Awka metropolis. Multi-stage sampling technique was used to draw three co-educational public secondary schools from the sixty co-educational public secondary schools in Awka metropolis. First, the co-educational schools were listed out according to locations. Secondly, three co-educational schools were purposively selected. The purpose of selecting choice of school was based on coeducational to ensure a balanced representation of gender variable in study. Finally using three ballot papers representing each of the three schools, one of the schools was used as the first experimental group, second one was used as the second experimental group, while and the third was used as control group. First School was assigned as the deep conceptual strategy (1st experimental group, 26 male and 24 female). Second was assigned as TPS (2nd experimental group, male 21 and female 25) and third was assigned as control group (20 male and 25 female) using flip of a coin. The study covered a period of five weeks. First week and first day of second week were used for familiarizing visit and training of the Biology teachers in the selected schools who act as research assistants and issuing of pre achievement test. Second day of the second week was used to teach the Biology concepts of transport system (Blood circulation) in three selected schools using deep conceptual instructional strategy, TPS instructional strategy and control group using conventional strategy for three weeks using plan for each instructional strategy which was prepared by the researchers. At the end of the fifth week, both experimental groups and control group were post tested base on what they are taught. The data collected were used for analysis. The instrument for data collection was named Biology Achievement Test (BAT) which was adopted from West Africa Examination Council (WAEC) past questions from (June 2011 -June 2022). The BAT was produced base on the Biology concept of transport system (Blood circulation) which consisted of twenty-five (25) objective test. To ensure the reliability of the instrument, the twenty-five (25) objective achievement questions were administered on a group of twenty-five students in Aguata metropolis which is outside the place of study. The results were subjected to Kuder- Richardson 21 (KR-21). A mean coefficient of 0.71 was obtained indicating that the instrument was reliable. The date obtained from the pretest and posttest were analyzed using mean, standard deviation for research questions and Analysis of Covariance (ANCOVA) to test the hypotheses.

Presentation of Results

The result of this study was presented in line with the research questions and the hypotheses as follows.

Research Questions 1: What is the difference in the mean achievement scores of

three groups of students taught Biological concept of blood circulation using deep conceptual strategy, think-pair-share (TPS) strategy and those taught using conventional strategy?

Table 1: Mean and Standard Deviation of the Mean Achievement Scores among the Groups

		Pretest		Posttest		
Groups	N	Mean	SD	Mean	SD	Mean Gain
Deep conceptual	50	47.08	10.48	61.33	11.03	14.25
Think-Pair-Share	46	44.00	9.03	63.30	11.94	19.30
Conventional	45	43.33	9.84	50.20	5.38	6.87

The result presented in Table 1 reveals the pretest and posttest mean achievement scores of students taught Biological concept of blood circulation using deep conceptual, think-pair-share and conventional strategies. The pretests mean scores for the groups in the deep conceptual, think-pair share, and conventional strategies are 47.08, 44.00, and 43.33 respectively. The posttest mean scores are 61.33, 63.30, and 50.20 respectively. The mean gain for the three groups are 14.25, 19.30, and 6.87 respectively, which depicts that SS 2 students in the think-pair share strategy have the highest mean achievement score, followed by those in the deep conceptual strategy; while the students in the conventional method have the lowest mean achievement score.

Research Questions 2: What is the difference in the mean achievement scores of male and female students taught Biological concept of blood circulation using deep conceptual strategy?

Table 2: Mean and Standard Deviation of the differences in the mean Achievement Scores of Students in the Deep Conceptual group based on Gender

		Pretest		Posttest		
Gender	N	Mean	SD	Mean	SD	Mean Gain
Male	26	47.14	12.29	61.93	12.43	14.79
Female	24	47.00	7.55	60.50	8.94	13.50

Table 2 reveals the mean pretest and posttest scores of the male and female students taught Biological concept of blood circulation using deep conceptual instructional strategy. The pretest mean score for the male and female students in the group are 47.14 and 47.00 respectively. The posttest mean scores are 61.93 and 60.50 respectively. The mean gains for male and female SS 2 students are 14.79 and 13.50 respectively. This implies that the male students have higher mean achievement score than their female counterpart in deep conceptual strategy.

Research Questions 3: What is the difference in the mean achievement scores of male and female students taught Biological concept of blood circulation using TPS strategy?

Table 3: Mean and Standard Deviation of the differences in Pretest and Posttest Scores of Students in the Think-Pair-Share Group based on Gender

		Pretest		Posttest		
Gender	N	Mean	SD	Mean	SD	Mean Gain
Male	21	44.48	8.76	61.71	12.43	17.23
Female	25	43.60	9.42	64.64	11.59	21.04

Table 3 reveals the differences in the pretest and posttest mean scores of the male and female students taught Biological concept of blood circulation using think-pair-share instructional strategy. The pretest mean score for the male and female students in the group are 44.48 and 43.60 respectively; while the posttest mean scores are 61.71 and 64.64 respectively. The mean gain for male and female students are 17.23 and 21.04 respectively, which indicates that the female students have the higher mean achievement score than the male students taught Biological concept of blood circulation using think-pair share instructional strategy.

HO1: There is no significant difference in the mean achievement scores of three groups of students taught Biological concepts of blood circulation using deep conceptual strategy, think-pair-share strategy and that of those taught using conventional strategy.

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Table 4: The ANCOVA Results of Achievement Scores among the Groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4637.023[a]	3	1545.674	15.685	.000	.258
Intercept	18524.945	1	18524.945	187.982	.000	.582
Pretest	91.838	1	91.838	.932	.336	.007
Group	4402.099	2	2201.049	22.335	.000	.249
Error	13303.768	137	98.546			
Total	491705.000	141				
Corrected Total	17940.791	140				

Data shown in Table 4 reveals the ANCOVA results on the effect of deep conceptual, think-pair share and conventional strategies on students' academic achievement in Biological concept of blood circulation. The results show a significant difference F (2, 135) = 22.335, p = .000< .05, η^2_p = .249 in pretest and posttest mean scores of students taught Biological concept of blood circulation with the three strategies. In all, the null hypothesis is rejected. The result shows that there is a significant difference in the effect of the three strategies on the students' academic achievement in Biological concept of blood circulation.

HO2: There is no significant difference in the mean achievement scores of male and female students taught Biological concept of blood circulation using deep conceptual strategy.

Table 5: The ANCOVA Results of Mean Achievement Scores of Students in the Deep Conceptual Group based on Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	48.968[a]	2	24.484	.194	.824	.009
Intercept	7442.278	1	7442.278	59.111	.000	.568
BS Pretest	25.159	1	25.159	.200	.657	.004
BS Gender	23.477	1	23.477	.186	.668	.004
Error	5665.698	47	125.904			
Total	186280.000	50				
Corrected Total	5714.667	49				

The data presented in Table 5 shows the ANCOVA results on the effect of deep conceptual instructional strategy between male and female students taught Biological concept of blood circulation. The results reveal no significant difference in the pretest and posttest mean scores of between the male and female students taught Biological concepts of blood circulation using brainstorming strategy $F(1, 45) = .186$, $p = .668 > .05$, $\eta^2_p = .004$. Therefore, the null hypothesis is not rejected. Hence, the result shows that there is no significant difference in the pretest and posttest mean cores between male and female students taught biological concepts of blood circulation using deep conceptual method.

H_{O3}: There is no significant difference in the mean achievement scores of male and female students taught Biological concepts of blood circulation using TPS

Table 6: The ANCOVA Results of Mean Achievement Scores of Students in the Think-Pair Share Group based on Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	295.268[a]	2	147.634	1.038	.363	.046
Intercept	9773.396	1	9773.396	68.731	.000	.615
TPS Pretest	197.575	1	197.575	1.389	.245	.031
TPS Gender	84.375	1	84.375	.593	.445	.014
Error	6114.471	43	142.197			
Total	190752.000	46				
Corrected Total	6409.739	45				

The data presented in Table 6 shows the ANCOVA results on the effect of think-pair share strategy between male and female students in Biological concept of blood circulation. The results reveal no significant difference in the pretest and posttest mean scores of between the male and female students taught Biological concept of blood circulation using think-pair share strategy, $F(1, 43) = .593$, $p = .445 > .05$, $\eta^2_p = .014$. Therefore, the null hypothesis is not rejected. Hence, the result shows that there is no significant difference in the pretest and posttest mean cores between male and female taught Biological concepts of blood circulation using think-pair share strategy.

Discussion of Findings

The finding has shown that Biology students taught blood circulation using deep conceptual and think-pair-share strategies achieved significantly better in Biology Achievement Test (BAT) than those taught with conventional method. The finding is in consonance with Peter (2016), Jacob et. al. (2016) and Bilal-Adel (2012) whom in their different studies observed that deep conceptual and think-pair-share strategies as a lateral thinking process by which students develop ideas or thoughts on solution to problems based on layout criteria. It may also be as a result of new useful ideas and creative thinking that the techniques bring to problems. The result from the conventional strategy suggested the need to also adopt other teaching strategies in addition that would likely develop adequate content understanding in Biology in the secondary schools. This implies that the students in the treatment groups have significant higher gain in their content understanding than those in the control group. Also, the ANCOVA analysis indicated that there is a significant difference between the treatment groups and control group. The findings of this study is not surprising because deep conceptual and think-pair-share encourages students to move from one level of understanding to another as they think out the solution to their problem. More so, the difference may be as a result of the fact that both deep conceptual and TPS provides an opportunity for students to take active role in building their own knowledge. Hence, one would be in a position to say that the students taught using deep conceptual and think-pair-share strategies shifted in their level of understanding as they construct their own knowledge of Biological concepts of blood circulation.

The result of this research shows that there is no significant difference in academic achievement of male and female students taught Biological concept of blood circulation using deep conceptual method. The finding is in line with some researchers' assertion who observed that there was no significant effect on male and female students when taught with deep conceptual instructional strategy (Hidayanti et. al., 2018; Drits-Esser & Stark 2015; Osuafor & Ogbaga 2016; Hoffman & Turner 2015). While the mean gain score of males taught with deep conceptual in this study is presenting a slight mean difference of 1.29 in favour of male student, the slight difference may be as a result level of interaction between the male while learning. But then, deep conceptual strategy has reduced the male domination to the barest minimum by encouraging equal participation.

The result of this research shows that there is no significant difference in the achievement of male and female students taught Biological concept of blood circulation using Think-pair-share. The finding is in consonance with Ogunyebi (2018) observation who revealed that there was no significant difference between the posttest means scores of male and female students exposed to think-pair and conventional strategies. Also the finding of the study is in line with that of Nwaubani et. al. (2016) who revealed that both the Think-pair-share (TPS) and student teams-achievement (STAD) significantly improved students' achievement in some subjects. While the mean gain score of males taught with TPS in the study is presenting a slight mean difference of 2.81 in favour of female students, the slight difference may be as a result level of interaction between the male

while learning. But then, think-pair-share has reduced the male domination to the barest minimum by encouraging equal participation.

Conclusion

The findings of the study revealed that deep conceptual and think-pair-share strategies significantly improved academic achievement of Biology students in blood circulation irrespective of gender. The conclusion is that both deep conceptual and think-pair-share strategies are effective strategies for the teaching and learning of Biology concepts. It can also be concluded that when Biology teachers adopt any or both strategies, student to student interaction increases thereby making students to take responsibility for their learning.

Recommendations

The researcher formulated the following recommendations based on the findings and conclusions made from the study.

1. Teachers should be encouraged by curriculum planners to employ deep conceptual and think-pair-share more often in teaching and learning situation.
2. Higher Institutions involved in teacher education should help to propagate these instructional strategies so as to promote deep conceptual and think-pair-share among the student-teachers of science
3. Curriculum planners and developers in science should include deep conceptual and think-pair-share strategies in restructuring Biology curriculum in the secondary schools in order to help students to be creative and retentive in learning.
4. Ministry of education should help teachers through seminars, conferences, support supervision and journal publication to improve their competencies in the use of deep conceptual and think-pair-share strategies for effective teaching of Biology.
5. Teachers should direct the presentation of Biology lessons away from the traditional methods to a more students-centered approach like deep conceptual and think-pair-share strategies.

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