EFFECT OF GUIDED-DISCOVERY STRATEGY ON ACADEMIC PERFORMANCE IN CELLULAR RESPIRATION AMONG SECONDARY SCHOOL STUDENTS IN KATSINA STATE, NIGERIA

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Abstract

This study investigated the effect of guided-discovery strategy on academic performance in cellular respiration among secondary school students in Katsina State, Nigeria. The study specifically achieved 2 objectives, two research were answered and 2 null hypotheses were tested. A quasi-experimental design involving pretest, posttest, and post-posttest was employed. The population of the study consisted of 5,795 SSII students (3,206 males and 2,589 females). A sample of 115 SSII students (53 males and 62 females) was selected from two schools using simple random sampling technique. The sample was assigned to two groups: one experimental group and one control group. All groups were pretested and post-tested before and after the treatments. one instrument, duly validated by experts, was used for data collection: The Cellular Respiration Performance Test (CRPT), with a reliability coefficient of r = 0.95. The data collected was analyzed using descriptive statistics (mean and standard deviation) to answer the research questions and inferential statistics (ANCOVA and Independent Sample t-test) to test the hypotheses at a significance level of $P \leq 0.05$. The findings revealed that the Guided-discovery Strategy was more effective than the Conventional Method students taught using the Guided-discovery strategy achieved significantly higher scores in their academic performance compared to those taught using the lecture method. While there were no significant gender differences in academic performance between male and female students. The study recommends that teachers should be encouraged to use Constructivist teaching strategies like guided discovery strategy in teaching of cellular respiration concepts over lecture method to improved students' academic performance. Universities and colleges of education should also incorporate the use of guided-discovery strategy in training their teacher trainees as this will enable Biology teachers to know the effectiveness of the strategy and get squinted with it; who will in turn apply this knowledge and strategy in teaching their students at the secondary school level.

Keywords: Academic performance, Biology, Cellular Respiration, Guided-discovery Strategy, Gender

Introduction

Biology is the scientific study of living organisms and their interactions with each other and their environment (Abdurrashid, 2021). It encompasses a wide range of topics, including Respiration, genetics, evolution, ecology, and physiology among others, to understand the complexities of life on earth. Biology is one of the core science subjects taught at the senior secondary level of Nigerian

Educational system. It is a subject that permeates all other science subjects and therefore, its knowledge and skill when acquired and applied in any society can bring about rapid growth and development. Biology learning has a very important role in order to establish a scientific attitude, analytical thinking, and foster the creativity of students (Ashiq, Muhammad, & Azra, 2018).

Cellular respiration as an aspect of biology is described by Dam, Ottenhof, & Boxtel (2019) as a set of metabolic reactions occurring inside the cells to convert biochemical energy obtained from the food into a chemical compound called adenosine triphosphate (ATP). Metabolic refers to a set of chemical reactions carried out for maintaining the living state of the cells in an organism. These can be divided in two categories: Catabolic is the process of breaking molecules to obtain energy, while anabolic is the process of synthesizing all compounds required by cells Therefore, respiration is a catabolic process, which breaks large molecules in to smaller ones, releasing energy to fuel cellular activities.

Kingdom-Aaron et al (2019) stated that lecture method is not efficient for improving students' academic performance as it does not give enough room for active participation of students which lead to their poor academic performance.

Federal Ministry of Education in its National Policy on Education (2014) has discouraged the use of lecture method and therefore recommended students oriented and activity-based methods such as cooperative learning, concept mapping, simulation games and Guided-Discovery method among others. Guided-Discovery method is defined by Dajal, Mohammed and Adamu (2019) as an approach to teaching in which students are guided by the teacher to find facts by themselves. Guided-Discovery method gives students the opportunity to investigate, use their discretion, contribute to knowledge, and get information individually or collectively to find a solution to a given task. Guided-Discovery is a teaching technique that encourages students to take a more active role in their learning process by answering series of questions or solving problems to help them understand a concept. Therefore Guided-Discovery is student-Centered and activity oriented where the teacher assists students to discover facts about problems and gain experience. In Guided-Discovery, teaching is viewed as a process of Student-Teacher interaction, teachers serve the dual role of a teacher and facilitator of learning, and students are considered participants in the process and knowledge is constructed by students within the teachers' framework.

In this method of teaching, the principal content of learning is not directly exposed by the teacher but left to be discovered by the learners, making the teacher a guardian and students' active participants in the learning process, Guided-Discovery method is a student-Centered method that may enhance the students' academic performance. The inconsistent results on gender generated the need for further study. Because of these controversial issues with respect to students' academic performance with preference to gender in science subject especially biology, the researcher is inspired to conduct this study to observe the interaction impact of guided discovery and gender on students' academic performance in biology. Also evidence from literature available to the researcher does not show that any conclusion has been reached on the impact of gender on biology students' academic, performance in cellular respiration.

According to Kumar (2021) performance refers to the measurement of students' achievement across various subjects. Academic Performance is described by Narad and Abdullahi (2016) as the extent to which a student has achieved in educational goal by meeting both short and long term. In other words, it is seen as the manifestation by an individual that he can reason and solve problems. This development can be taken as satisfactory evidence that some learning has taken place. Academic performance was defined by Abdurrahman (2021) as the exhibition of knowledge attains or skills developed by students in a subject designed by test scores assigned by teachers. Ya'u (2020) also defined academic

performance as an outcome that indicates the extent to which a person has accomplished specific goal that constitutes the focus of activity of instructional environment, especially in school, college and university. It can be a person's strong performance in a given academic arena. For instance, a student who earn good grades in biology has achieved in the academic field of science. Educationist and school authorities monitor the overall level of academic performance of students to determine the success and failure of a given program. Owenubiugie and Iyoha, (2019) found that persistent low academic performance in biology is attributed to teachers' instructional strategies in teaching/learning among others. These instructional strategies used by teachers in the teaching-learning process have a significant influence on learners' academic performance. Some of the factors identified as opposing effective biology teaching in Nigerian secondary school include, lack of appropriate learning environment under which science teaching can take place, inadequate equipment and facilities, lack of opportunity for the child to have direct experience with learning materials and inappropriate use of teaching strategies. In order to minimize the failure rate in biology, teachers should be well armed with various teaching strategies which can be used for teaching of different concepts in cellular respiration improve students' academic performance with no regards to gender.

Gender according to Ozioko (2015) is a psychological term used in describing behaviors and attributes expected of individuals on the basis of being born either male or female. There have been a lot of arguments on the effect of gender on academic performance of students in science. Salisu (2015) reported that male students perform better than females in Ecology. On the contrary, Sukola, Abdumalik and Yunusa (2016) revealed that female students' achievement scores in biology, were slightly better than those of their male counterparts. However, Onyejekwa, Uchendu and Nmom (2018) showed that gender has no significant effect on students' performance in biology. From the aforementioned, there have been contradictory reports on the influence of gender on academic performance of students in biology. Hence, the study investigated the effect of guided-discovery strategy on academic performance in cellular respiration among secondary school students in katsina state, Nigeria.

Biology instruction in most secondary schools has generally been dominated by teachers mostly using Conventional Instructional Method which are mainly lectures, few demonstrations and drilling of students using past papers (Kayode, 2020). These methods of instruction expose students to minimal group discussions and practical activities. However, Biology being one of the basic and core science subjects which is designed to prepare students with the knowledge and skills of relevant scientific concepts such as cellular respiration its content, despite the richness of the curriculum of biology and its importance on academic aspiration of students, empirical evidences have shown that the performance of students in the subject most importantly in cellular respiration that has paramount important in today's real life is worrisome, revealed that the students' academic achievement in Katsina is fluctuating and not encouraging. West African Examinations Council (WAEC) Chief Examiners' report (2023) highlighted a significant gap in students' knowledge of cellular respiration. Some candidates lost marks because they could not write an equation for anaerobic respiration and candidates struggled to accurately differentiate between gaseous exchange and aerobic respiration leading to recommendation that students utilize past examination papers for practice. The researcher made an effort to acquire the WAEC Biology examination results summary in the study area, which is presented in Table 1:

Table 1: Students Performance in SSCE Biology (2014 – 2023)

Year	Students Registered	Students Passed		Students Failed	
		N	%	N	%
2014	10,234	4,001	39.10	6,233	60.90
2015	8,221	2,994	36.42	5,227	63.58
2016	9,166	3,911	42.67	5,255	57.33
2017	8,648	3,184	36.82	5,464	63.18
2018	7,118	2,108	29.62	5,080	70.38
2019	9,217	3,681	39.94	5,536	60.06
2020	9,883	4,218	42.68	5,665	57.32
2021	6,871	2,723	39.63	4,148	60.37
2022	8,152	3,118	38.22	5,034	61.78
2023	7,992	2,866	35.86	5,126	64.14

Source: Ministry of Basic and Secondary Education, 2023

From the above Table 1 could be seen that the students that passed at credit level and above were below 50% of the total that sat for the examination year – in year – out. Although there were several studies (Adayemi (2013), Nneji (2015) & Ekenobi et al (2016) carried out in order to address the students' poor performance in Biology, still the poor performance persists. Several factors have been found to account for students' poor performance in Biology at the SS level (poor teacher's performance interms of accomplishing teaching task, lack of instructional materials and poor teaching habits.). The major one is inappropriate teaching strategies and lack of student's interest toward the content which may lead to poor academic performance of the students

Research Questions

Based on the stated objectives, the following research questions were put forward:

1. What is the difference between the mean academic performance scores of secondary school Biology students taught cellular respiration using guided discovery strategy and those taught the same concept using lecture method?
2. What is the difference between the mean academic performance scores of male and female secondary school Biology students when exposed to guided-discovery strategy in teaching cellular respiration concept?

Hypotheses

In accordance with the research questions, the following null hypotheses were formulated and tested at a significance level of $p \leq 0.05$:

Ho1: There is no significant difference between the mean academic performance scores of secondary school Biology students taught cellular respiration concepts using guided-discovery and their counterparts taught the same concepts using lecture method.

Ho2: There is no significant difference between the mean academic performance scores of the male and female secondary school biology students when exposed to guided-discovery in teaching cellular respiration concepts.

Methodology

The study adopted the pretest-posttest nonequivalent control group quasi-experimental design utilizing intact classes, which allows nonrandomization of subjects. Two groups, one experimental and one control, were used. The experimental group received instruction on cellular respiration concepts one using Guided-discovery while the control group was taught the same concepts using the lecture method. A pretest assessed group equivalence before treatment, followed by a posttest for both groups.

The population comprised 5795 SS II science students in public co-educational and single sex senior secondary schools within Rimi Zonal Education Quality Assurance, Katsina State. The sample for the study was 115 students selected from two secondary schools using cluster and simple random sampling technique (balloting) in the population of the study. Two (2) co-educational schools were selected from the two (2) Local Government areas based on cluster, one school from Rimi Local Government, and another one school from Charanchi Local Government areas.

The choice of co-educational schools is because the researcher wants to cater for the issue of gender. The first school picked was tagged as experimental group and the second school picked was assigned as control group (2). From the first school selected, one intact class was selected using simple random sampling (balloting), one intact class from Government Senior Secondary School Abukur assigned to be experimental group (Guided-discovery Strategy) represented with a latter "A" and the other intact class from Government Senior Secondary School Radda assigned as control group (Conventional Teaching Strategy) represented with a letter "B". Mean, and standard deviation were used to answer research questions, while ANCOVA and independent t-test were used to test the null hypotheses.

Results

Answering of Research Questions

Research Question One: What is the difference between the mean academic performance scores of secondary school Biology students taught cellular respiration concept using guided-discovery strategy and their counterparts taught the same concept using lecture method?

Table 2: Mean and Standard Deviation of Academic Performance Scores for the Experimental and Control Groups

Group	N	Mean	Std. Deviation	Mean Difference
Experimental	66	33.92	3.69	
				11.59
Control	49	22.33	5.07	

Table 2 presents the data analysis on the mean academic performance score difference across the experimental and control groups. The table shows that the Guided-discovery strategy has mean academic performance score of 33.92 and a standard deviation of 3.69. Meanwhile, the control group has a mean academic performance score of 22.33 and 5.07 standard deviation. The mean difference between the two groups is 11.59.

Research Question Two: what is the difference between the academic performance scores of male and female secondary school students when exposed to guided-discovery strategy in teaching cellular respiration concept?

Table 3: Mean and Standard Deviation of Male and Female Students' Academic Performance Scores in Cellular Respiration using Guided-discovery

Group	N	Mean	Std. Deviation	Mean Difference
Male	39	33.34	3.35	
				1.04
Female	37	34.38	3.92	

Table 3 presents the data analysis on the mean academic performance scores of male and female students in cellular respiration using guided-discovery. The table shows that the male has mean academic performance score of 33.34 and a standard deviation of 3.35. Meanwhile, the female has a mean academic performance score of 34.38 and 3.92 standard deviation. The mean difference between the two groups is 1.04.

Hypotheses Testing

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

H01: There is no significant difference between the mean academic scores of secondary school Biology students taught cellular respiration concepts using guided-discovery strategy and counterparts taught the same concepts using lecture method.

Table 4. ANCOVA on Students' Academic Performance levels in Cellular Respiration between the Experimental and Control Groups

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Remark
Corrected Model	3818.769a	4	954.692	50.411	.000	Sig.
Intercept	6970.720	1	6970.720	368.078	.000	Sig.
Groups	3199.526	1	3199.526	168.946	.000	Sig.
CRPT Pretest	18.016	1	18.016	.951	.332	Not Sig.
Group * Gender	7.089	1	7.089	.374	.542	Not Sig.
Gender	6.246	1	6.246	.330	.567	Not Sig.
Error	2083.197	110	18.938			
Total	102501.000	115				
Corrected Total	**5901.965**	**114**				

Significant at p≤ 0.05 level

Table 4 shows that the difference between mean academic performance scores of the students taught cellular respiration concepts with Guided-discovery strategy and Conventional Method is significant (F= 168.946).The P-value observed is less than the alpha value which is 0.05, meaning that there is significance difference between the mean academic performance scores of secondary school Biology students taught Cellular Respiration Concepts using Guided-discovery strategy and those taught the same concepts using Conventional method. Therefore, the null hypothesis which stated that there is no significant Different Between the mean Academic Performance Scores of Secondary School Biology students taught Cellular Respiration Concepts using Guided-discovery Strategy and those taught the same concepts using Conventional method is rejected, meaning that Guided-discovery strategy enhances secondary school Biology students' academic performance in Cellular Respiration Concepts than the Conventional method.

H02: There is no significant difference between the mean academic performance scores of the male and female secondary school biology students when exposed to guided-discovery in teaching cellular respiration concepts.

Table 5: t-test Analysis of Academic Performance Scores of Male and Female Secondary School Biology Students in Experimental Group

Group	N	Mean	Std. Dev.	Df	t-value	P-value	Remark
Male	29	33.34	3.35				
				64	-1.132	.417	Not Significant
Female	37	34.39	3.92				

Significant at P > 0.05

Table 5 shows that the t-value obtained is -1.132 and P-value of .417 is observed at the degree of freedom of 64. This P-value is greater than the alpha value which is 0.05, indicating that there is no significance difference between the mean Academic Performance scores of male and female secondary school Biology students taught Cellular Respiration Concepts using Guided-discovery strategy.

Therefore, the null hypothesis which stated that there is no Significant difference between the mean Academic Performance scores of Male and Female Secondary School Biology Students taught Cellular Respiration Concepts using Guided-discovery Strategy is retained, meaning that gender has no significant influence on secondary school Biology students' academic performance when taught Cellular Respiration Concepts using Guided-discovery strategy.

Summary of Findings

The study investigated the impact of Guided-discovery Strategy on Academic Performance in Cellular Respiration Concepts among Secondary Biology Students in Katsina State, Nigeria. The followings are hereby the summary of the findings:

1. The result shows that students in the experimental group with higher mean performed better than those in the control group. This indicates the efficacy of using Guided-discovery strategy over Conventional method in enhancing the academic performance of secondary school Biology students in Cellular Respiration Concepts.
2. The result shows that male students in the experimental group with higher mean performed slightly better than their female counterparts. This higher mean score of female students over their male counterparts indicates slight superiority of female students over male students in their academic performance when taught Cellular Respiration concepts using Guided-discovery strategy.
3. There is significant difference between the mean academic performance scores of secondary school Biology students taught Cellular Respiration Concepts using Guided-discovery strategy and those taught the same concepts using Conventional method.
4. There is no significant difference between the mean academic performance scores of male and female secondary school Biology students taught Cellular Respiration Concepts using Guided-discovery strategy.

Discussion of Findings

The first finding of the study revealed that students in the experimental group had a higher mean academic performance score (33.92) than those in the control group (22.33). This different was significant as shown in the result of t-test analysis in table 4. This means that students taught using guided-discovery strategy have significantly performed better than those taught using Conventional method. By implication, guided-discovery strategy had significantly enhanced interest, academic performance and retention of students than the conventional method.

This finding is in line with the findings of Cendika and Yustinus (2024), Whose findings suggest that guided-discovery is an effective instructional tool that promotes meaningful learning, especially in subjects like biology that involve abstract and complex content, developed students' interest and enhancing their cognitive learning outcomes in the ecosystem subject. This finding also is line with Mgbomo, Joseph & Agwu, (2024) whose findings revealed that students instructed with guided-discovery strategy outperformed significantly better than those instructed with traditional method. Also, Mahmud (2022) whose finding revealed that discovery strategy has positive and significant effect on students' retention ability when taught genetics concept of biology than the lecture method.

Similarly, the second finding revealed that male students in the experimental group had a higher mean academic performance score (33.34) than their Females counterparts (34.38). However, this different was not significant as shown by the result of t-test analysis in table 5. This means that male and female students taught Cellular Respiration Concepts using guided-discovery strategy do not significantly differ in their mean academic performance scores. This implies that guided-discovery strategy is gender-friendly as both male and female academic performance was improved without any significant

difference. This finding is in line with the findings of Tofi, Achor and Eje (2023) which showed that the male and female students taught through guided-discovery strategy performed better than the students taught the same concepts through traditional teaching method. However male and female students taught through guided-discovery performed significantly.

Conclusion

The study concludes that Guided-discovery Strategy significantly enhance students' academic performance in cellular respiration compared to traditional lecture methods. This strategy enables students to engage actively in learning, fostering critical thinking and discover the facts by themselves. Guided-discovery Strategy positively influence students' academic performance towards cellular respiration. Therefore, the Guided-discovery Strategy has a greater impact on improving students' academic performance compared to Convectional method. Female students outperformed better towards cellular respiration than male students when taught cellular respiration concepts using the Guided-discovery strategy.

Recommendations

Teachers should be encouraged to use Constructivist teaching strategies like guided discovery strategy in teaching of cellular respiration concepts over lecture method to improved students' academic performance.

Universities and colleges of education should also incorporate the use of guided-discovery strategy in training their teacher trainees as this will enable Biology teachers to know the effectiveness of the strategy and get squinted with it; who will in turn apply this knowledge and strategy in teaching their students at the secondary school level.

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