

Impact of Wait-Time Variations on Retention Ability and Gender Performance among Low Achievers in Ecology at Senior Secondary Schools in Zaria

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Abstract

The study investigated the Impact of Wait-time Variations on Variations on Retention Ability and Gender Performance among Low Achievers in Ecology at Senior Secondary Schools in Zaria. One objective, one research question, and one hypothesis guided the research. The hypothesis was tested at $p \leq 0.05$ level of significance. A quasi-Experimental design involving pretest, posttest, and post-posttest experimental control groups was used for the study. The population comprised all 2,138 senior secondary school Biology students in Zaria. A sample consisting of 168 students randomly selected from two coeducational schools in Zaria Education Zone was used for the study. The experimental group was taught Ecology concepts using Wait-time while the control group was exposed to lecture method. One validated instrument called the Ecology Performance Test (EPT) with $r = 0.81$ was used to collect data. The collected data were analysed using t-test statistic. The results of the study reveal that there is a significant difference when low achievers are exposed to extended wait-time and lecture teaching methods in favour of the experimental group, and this could be a result of the use of extended wait-time to teach the experimental group. Based on the findings, the researchers recommend that wait time variation be encouraged in secondary school ecology instruction because it significantly improves academic performance for both male and female students.

Keywords: Wait-Time, Variations, Retention Ability, Gender, Low Achievers, Ecology.

Introduction

Science uses observation to create basic laws about why things happen. Science underpins most technological advances. Since the world is growing scientifically and life depends on research, nations like Nigeria are working hard to develop scientifically (Mormina, 2019). Science seeks to explain events and personal experiences. Mormina (2019) stated that some see science as a tool for technical and economic progress. Biology underpins science education. Wrenn and Wrenn (2009) stated that exposing students to many possibilities in the classroom and field can help them learn new concepts, principles, and theories. According to Etobro and Fabinu (2017), biology topics can be difficult to explain, especially abstract or new notions. Teacher effectiveness and classroom variables are being studied to improve science education outcomes. Wait-time is one of several variables that affect scientific education (Ingram, 2018). Most classes use verbal communication; therefore, teacher demeanour might affect learning. Wait time affects science classroom verbal interaction and achievement (Iksan & Daniel, 2015).

Teachers use questions to assess whether students have learned and how much. It can evaluate instructional techniques and place students. WAEC and NECO can use it to provide generic certificates. Shanmugavelu, Ariffin, Vadivelu, Mahayudin and Sundaram (2020) says questioning works locally, nationally, and worldwide to elicit inquiry. A teacher who understands question taxonomy can use it to improve his students' intellectual atmosphere. When teachers employ questions to help students build cognitive thinking skills, learning improves. Teachers pose questions to engage students in class. A response to a question always takes time. When higher cognitive domain objectives are asked, students use this time for cognitive processes. Increasing lapse time makes replies more meaningful, directed, and deliberate (Adams, 2015).

Adams (2015) defines wait-time as the number of seconds between the teacher asking a question and the student responding or the teacher speaking again. Wait-time occurs when the teacher asks a question, pauses, calls on a student, and pauses again. Wait-time is the time a teacher takes to answer a question, repeat, rephrase, add information, or accept a student's response. It includes all teachers pauses before speaking (Adams, 2015). Mental processing takes time. Thus, teachers must give kids time to process the material. Wait-time controls classroom speech and engagement by emphasising questions. Students who realise the teacher answers many of his or her own questions without waiting for a response often become dependent on the teacher to think for them. If the teacher quickly accepts an answer, the class can skip additional information processing and analysis. Thus, the teacher must actively increase wait time to provide students with enough time to process material (Wrenn, 2009).

Iksan and Daniel (2015) defined wait-time as the time a teacher must wait before calling on a student, repeating the question, rephrasing the inquiry, or answering. Coristine, Russo, Fitzmorris, Beninato, and Rivolta (2022) found that the length of the teacher-student break affects classroom conversation. Even if the instructor has mastered inquiry and is teaching a highly attentive class, failing to manage wait-time properly may result in little or no learning, she says. Rowe (1974) found two wait times. Wait-time I and II. After asking a question, a teacher waits I. Teacher wait-time. Wait-time II is the time an instructor pauses after a student responds before commenting or asking another question. Learner wait-time.

Rowe (1974) found a correlation between teacher wait-time and science achievement in SS1, SS2, and SS3. The study found that wait-time fluctuations helped concrete-stage students. Wait-time changes increased students cognitive complexity. Alsaadi and Atar (2019) found that teacher wait-time helped explain classroom processes. However, poor achievers struggle with some or all learning processes and do worse than their classmates. Low achievers have an I.Q. of 75–90%, read a year later than most, and learn at 4/5 to 9/10 the normal pace of 2.4 syllables per second. Poor achievers react slowly, express themselves awkwardly, and have low self-esteem. They also have trouble thinking abstractly. Low-achievers have trouble following multi-step instructions (Njoroge, 2022). Low achievers

score low on achievement tests and perform below grade level in all subjects. Low achievers are hindered in the ordinary classroom to the same extent as average students.

According to Njoroge (2022), low achievers are students with IQs of 75 to 90% who take longer to learn a concept or principle than normal children due to cognitive development delays. As the cognitive demands of the content increase, wait-time variation can help senior secondary school low achievers improve their intellectual development and academic performance in the subject. The researcher therefore seeks to determine the impact of wait-time variations on low achievers' academic performance and retention ability in ecology at the senior secondary school level in Zaria.

Statement of Problem

Parents, teachers, government, and the public worry about biology students' low academic achievement (Nsofor, 2006). Table 1 shows that Kaduna State students performed poorly in WAEC Biology May/June 2012-2016. Table 1.1 shows performance fluctuations over time.

Table 1: Kaduna State Students' Performances in WAEC Biology May/June, 2012-2016

Year	Total sat	% with A1-C4 (% Passed)	% with D7-F9 (% Failed)
2012	126, 821	47.04	52.96
2013	134, 852	41.95	58.05
2014	130, 653	42.98	57.02
2015	150, 896	47.85	52.17
2016	143, 936	43.08	56.92

Source: West African Examination Office, Kaduna Office (2016)

Biology has a higher failure rate than Chemistry and Physics, despite its importance as one of the major science subjects that determines whether students are admitted to a number of major professional science-based courses at the university (Lawal, 2010). Since Oloyede (2008) believe various variables contribute to Biology students' low academic performance, it's crucial to find a remedy. The curriculum, cultural values, class size, and rush to cover the syllabus are among these influences. Several studies have sought remedies for mass failure in biology. Wait-time management is one of them. Olajide (2012) recommends appropriate teaching approaches, including lecture, inquiry, guided discovery, project laboratory, field trip or excursion, and cooperative education.

Despite these efforts to improve teaching and learning, biology and other scientific students still do poorly. Mosadimi (2015). Students' poor public exam performance needs better instructional methods. To improve Biology performance, new teaching methods must be tested. Iksan & Daniel (2015) advised teachers to understand the wait time to successfully implement it and improve results. Therefore, the researcher seeks to determine the impact of wait-time variations on retention ability and gender among the low achievers in ecology at a senior secondary school in Zaria.

Research Objective

Determine the impact of wait-time variations on retention ability and gender among the low achievers in ecology at senior secondary schools.

Research Question

What is the difference between the academic performance and retention ability of male and female subjects exposed to wait-time in ecology at senior secondary schools?

Hypothesis

There is no significant difference between academic performance and retention ability of male and female low achievers exposed to wait-time variation of 3,4, and 5 seconds in ecology at senior secondary schools.

Literature Review

Concept of Wait Time

Effective learning requires time for thought, reasoning, and relating new information to previous knowledge, especially if the topic is cognitively demanding. Thus, learning during a presentation of new facts or discourse depends on whether the learner can follow and process the material (Olajide, 2012). Giving students enough time to answer questions. The questioning approach requires waiting. After posing a question, a teacher waits for students to react (Olajide, 2012).

Wait-time is the period between a question being asked and the teacher answering, repeating, rephrasing, or accepting a student's response. Iksan & Daniel (2016) defined wait time as the pause before a student answers a teacher's inquiry. Olajide (2012) defines wait time as the number of seconds between the teacher asking a question and the student responding or the teacher speaking again. Wait time is added if the teacher asks a question, pauses, calls on a student, and pauses again. Rowe (1974) defined wait time I and II. Wait time I is the time between a teacher query and a student answer, whereas II is the time between a student answer and the next teacher feedback or question.

Concept of Low Achievers

Low achievers are borderline-intelligent kids with limited academic competence or less academically minded people. Demir, Kilinc and Dogan (2012) defined low achievers as students in ordinary schools who struggle to learn cognitive skills from the curriculum due to their slow achievement pace and language deficiencies. She added that many poor achievers have acquired helplessness, which occurs when children give up because they think they won't succeed. Low achievers react less, have trouble with abstract thinking, and have trouble figuring things out, especially with multi-step instructions. Low achievers perform below grade level in all disciplines and score low on achievement tests. They struggle with some or all learning processes and do worse than their classmates because they engage with their social, cultural, and physical contexts (Servio 2010). Low achievers

are students with distinct perceptual issues and emotional maladjustment, which cause failure or backwardness but can be overcome by average arithmetic or practical skills (Ogenyi, 2007). Some low achievers struggle with reading and writing but excel at memorising, while others struggle with all aspects of learning, from acquiring the necessary knowledge to applying it and storing and remembering it. Low achievers can be divided into learners with learning disabilities, disadvantage learners, and second language learners (Ogenyi, 2007).

The biggest complaint about low performers is poor memory. According to Burt in Lowenstein (2006), long-distance memory is the most common particular mental disability that hinders scholastic development in low achievers. Dull children seem to need to go over material more times before it is fixed in their minds, and more frequent revision is required to prevent forgetting. Teachers often raise the problem of the child who appears to have a markedly poor memory, forgetting words he has supposedly learned from one page to the next or being unable to remember the simplest number facts despite plenty of practise with interesting apparatus. However, such children can remember other things. Children require more repetition, revision, and practise to retain what they learn (Zhan, *et al.*, 2018).

If they learn properly, slow learners can recall as well as quick learners (Ogenyi, 2007). Thus, teachers can use wait time to help slow learners improve their retrieval rate, which may directly boost their intellectual development and academic achievement. Thus, this study will focus on low-achieving students in ordinary schools who struggle to study. This study examined how wait-time fluctuations affect low-achieving secondary school ecological students.

Gender and Low Achievers Academic Performance

Gender variations in school achievement remain unresolved. That inspired innovative projects like GIST (Girls into Science and Technology) and WISE (Women in Science and Engineering) to make science more girl-friendly. Differential gender success in science has been linked to several causes. (Abubakar & Bada 2012). Gender role, model orientation, parent education, peer group expectations, and class extra-curricular are variables. They found no gender influence on life science achievement. Jamaican eighth-graders performed similarly regardless of gender, according to Soyibo (2007). Soyibo (2007) found that males and females perform equally on this standardised test until middle school, when boys gain an edge that lasts through high school. Other studies found a gender gap in science achievement (Soyibo, 2007). Boys excelled in the physical sciences. Girls outperformed guys in academic success.

Teachers need greater teaching skills to aid at-risk students like gender and low achievers. Low achievers require distinct techniques for presenting learning challenges to avoid interfering with their understanding of the task (Clarke, 1980). Balogun (1985) found that 53% of Nigerian secondary biology students were gender-slow learners. Olajide (2012) found that males outperformed girls in science. The gender gap in science achievement has narrowed in recent decades, yet it still exists.

Gender hinders educational and sustainable development in Nigeria. Research showed that gender did not affect brain quality (Mollayeva, *et al.*, 2021). Gender equality may have an impact on performance. From primary school through university, girls and young women outperformed boys in the UK. They indicated this was a global change over the past 25 years. From the U.S. to Japan, Mexico to New Zealand, Portugal to Korea, girls have inverted the picture projected twenty-five years earlier. In contrast to the 1970s, gender studies in education focused on "underachieving" males in the 1990s.

Numerous sociology of education studies have found that girls start adolescence less engaged in success than boys, according to the American Association of University Women. According to Etobro and Fabinu (2017) male students are academically superior to female students and dominate technical and scientific courses like biology, while female students dominate the humanities and social sciences. They also reveal that, despite discrimination, female children were able to succeed academically by defining themselves positively. Thus, this study seeks to clarify the prior findings on low achievers' long wait period. Some research focuses on teaching, instructional material retention, and altitude. This study examined how gender and wait time affect academic performance in secondary schools.

Retention of Learned Concepts among Low Achievers

Kundu and Tutoo (2002) call this retention ability preservation. Knowledge comes through perception and sensation. Bawa (2011) defined retention as the ability to retain and remember things learned or experienced later. Memory encoding occurs. Thus, accurate coding of incoming information gives an index that can be consulted for retention without a lengthy memory search (Bichi, 2002). The meaningfulness, familiarity, concreteness, and visual evolution of the coded information affected retention. According to Goldstain (2010), retention focuses on both functionality and endurance because long-term memory stores manipulation and efficient processing of information.

Kolb (1984) calls retention a mind-preservative. Sensation and perception provide knowledge. Knowledge develops by preserving these acquired materials in images. To memorise, held pictures are revived or replicated when stimulated. Baddeley (2000) suggests that retention is related to academic performance in the physical sciences and enhanced by a number of abilities, including storage, capacities, processing efficiency, the ability to combine storage and processing, the ability to inhibit irrelevant information, the quality of knowledge representation, and the ability to use efficient strategies in the face of interfering processes and distractions.

Retention and performance determinants are complicated and require a coordinated institutional strategy (Martinez & Munday, 1998). A review of student retention literature found that student experience is a major determinant of retention and that teachers can enhance retention rates. Kenwright (1996) found that students would persist through family, health, and financial issues if they liked the course enough. Kenwright (1996) found that poor student experience, inability to cope with course demands, unhappiness with the

social environment, wrong programme choice, financial need, course dissatisfaction, and support structures are key factors in student dropout. Anything that facilitates learning enhances retention, while anything that confuses or interferes with learned material slows learning and accelerates forgetting. Practise can either help or hinder learning, which can increase or decrease amnesia. Emotion can impair retention, especially if traumatic events are repressed. Anxiety hinders remembering.

Methodology

According to Aikenhead (2005), this study used a quasi-experimental design with experimental control group designs for the pretest and posttest. All public senior secondary school two (SS II) students in the 2,138-person Zaria education zone of Kaduna State made up the study's population. Through the use of a balloting system and random sampling methodology, two schools were sampled for the study. For this investigation, the Ecology Performance Test (EPT) and the traffic light device with a 0.81 R-value established that was employed as a wait-time signalling device by Olajide (2012) were adopted. To guarantee group equivalence, the Ecology Performance Test (EPT) was pre-tested on the study sample from the schools (experimental and control groups). For a period of six weeks, the experimental group received lecture-style instruction in ecology with wait times in I, II, and III of 3, 4, and 5 seconds, respectively, whereas the control group received instruction in ecology without wait times. Two switches are included in the manually operated lighting device that will be utilised; one switch controls the red light bulb, and the other switch controls the number of seconds depending on the wait time to be employed. Wait-time I was timed when the teacher asked a question. The observer set the timer to 3 seconds and waited. The observer then turned on a red light bulb. The teacher watched the light bulb as soon as it went off and then called on the student to respond by using the wait time. On the other hand, when students started to ask questions, I turned on the switch for 4 seconds, waited until he stopped talking, and the red light bulb came on. It was on for 4 seconds and turned off automatically when the timer went off. At this point in Wait-Time II, the instructor may ask another student to comment or may choose to do it herself. For wait time III, the observer turned on the switch for 5 seconds as they waited, and as soon as the teacher stopped speaking, a red light bulb lit up for 5 seconds before going out during time out. This is an example of Wait Time III. Another student was asked to speak by the teacher, or occasionally the teacher spoke. Both groups underwent a post-test using the identical instrument that had been rearranged in order to get different results after the six-week period. Using SPSS Version 23, the primary results of the two groups were compiled and subjected to t-test statistics.

Results

Research Question: What is the major difference between male and female students in the Retention ability when exposed to wait time of 3 seconds, 4 seconds, and 5 seconds and those not exposed to wait time?

Table 2: Descriptive analysis on difference between male and female students in the Retention Ability when exposed to wait time of 3 seconds, 4 seconds, and 5 seconds and those not exposed to wait time.

Groupings	Gender	Mean	Std. Deviation	N
A 3 Seconds	Male	37.0769	3.12147	13
	Female	37.5000	3.72949	12
	Total	37.2800	3.36056	25
4 Seconds	Male	37.3846	3.68643	13
	Female	37.2308	3.00427	13
	Total	37.3077	3.29568	26
C 5 seconds	Male	41.0769	3.11028	26
	Female	40.5000	3.66450	8
	Total	40.9412	3.19982	34
Control	Male	28.9286	6.73622	56
	Female	28.2963	6.55635	27
	Total	28.7229	6.64485	83
Total	Male	33.8519	7.50678	108
	Female	33.7000	7.09093	60
	Total	33.7976	7.33996	168

According to the results of the aforementioned descriptive mean statistics, there is no significant difference in male and female students' retention abilities when subjected to wait times of 3 seconds, 4 seconds, and 5 seconds compared to those who are not exposed to wait times. Male and female students in each of the four groups had mean retention abilities that were subjected to 3 seconds that were 37.0769 and 37.5000, respectively, when their descriptive performance was examined. The performances of men and women after 4 seconds were 37.3846 and 37.2308, respectively. The student performances for male and female students who were timed for 5 seconds were 41.0769 and 40.5000, respectively. The retention rates for the control group's male and female students were 28,9286 and 28,2968, respectively. This suggests that when subjected to wait-time fluctuations, male and female students retain information relatively similarly.

Hypothesis

Hypothesis: There is no Significant Difference Between Male and Female Students in the Retention Level when Exposed to Wait time of 3 seconds, 4 seconds, and 5 seconds and those not Exposed to Wait time.

To test this hypothesis, the Ancova statistics is used between the two factors of Gender and Groupings on academic performance.

Table 3: Analysis of Covariance (ANCOVA) Analysis on Difference Between Male and Female Students in the Academic Performance when Exposed to Wait time of 3 seconds, 4 seconds, and 5 seconds and those not Exposed to Wait time.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Remarks
Corrected Model	4506.62 ^a	7	643.80	22.93	0.00	S
Intercept	155769.20	1	155769.20	5550.18	0.00	S
Groupings	3774.12	3	1258.04	44.82	0.00	S
Gender	1.65	1	1.65	0.05	0.80	NS
Groupings	*					
Gender	5.74	3	1.91	0.06	0.97	NS
Error	4490.49	160	28.06			
Total	200900.00	168				
Corrected Total	8997.119	167				

a. R Squared = .501 (Adjusted R Squared = .479)

Table 3 outcomes of the Analysis of Covariance ANCOVAR statistics revealed that there is no significant difference between male and female students in retention ability when exposed to wait time of 3 seconds, 4 seconds, and 5 seconds compared to those not exposed to wait time. The computed groupings versus Gender p value of 0.97 is higher than the 0.05 alpha level, and its F value of 0.06 is lower than the 2.60 F critical value. Looking at the descriptive performance of male and female students in each of the four groups showed that the male and female mean retention abilities exposed to 3 seconds were 37.07 and 37.50, respectively. Male and female performances exposed to 4 seconds were 37.38 and 37.23, respectively. The male and female students performances exposed to 5 seconds were 41.07 and 40.50, respectively. This implies that the retention abilities of male and female students are relatively the same when exposed to wait time variations. Therefore, the null hypothesis, which states that there is no significant difference between male and female students in retention ability when exposed to wait time of 3 seconds, 4 seconds, and 5 seconds and those not exposed to wait time, is hereby rejected.

Discussion of Findings

The hypothesis compared students who had wait times of 3 seconds, 4 seconds, and 5 seconds against those who were not exposed to wait times, finding a substantial difference between male and female students' retention abilities. This suggests that when exposed to wait-time fluctuations, male and female students have retention abilities that are roughly comparable. Thus, the null hypothesis that claims there is no discernible difference between poor achievers exposed to wait-time changes and those who are not exposed in terms of retention level is hereby rejected. Bawa's (2011) investigation into the advantages of problem-solving instructional strategies on academic achievement and retention in ecology among senior secondary school students in Kaduna State, Nigeria, who had varying cognitive preferences, supported this. The posttest mean scores of the experimental and

control groups were significantly different from one another, according to the results, favouring the experimental group. Consequently, it is demonstrated by the empirical data in this study that the use of wait-time changes is gender-friendly in learning.

Conclusions

The researchers, on the basis of the results of this study and analysis, arrived at the following fundamental conclusion: the wait time modifications are extremely efficient for improving the retention ability of both male and female students alike.

Recommendation

This study suggests the following:

- i. The wait time variation is particularly helpful for enhancing both male and female students' recall abilities, and it should be encouraged in secondary school ecology instruction.
- ii. The wait time variation should be encouraged in secondary school ecology instruction because it significantly improves academic performance for both male and female students.

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