RELATIVE EFFECT OF 5E'S INSTRUCTIONAL MODEL ON ANXIETY AND RETENTION OF CELL DIVISION AMONG SENIOR SECONDARY SCHOOL STUDENTS IN SOKOTO STATE, NIGERIA

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Abstract

The study aimed to determine the relative effect of the 5E's (Engage, Explore, Explain, Elaborate, and Evaluate) instructional model on anxiety levels and retention of the concept of cell division among senior secondary school students in Sokoto State, Nigeria. A quasi-experimental design was employed, targeting all SSII students across the six educational zones of Sokoto State, totaling 14,567. A proportionate sample of 512 students was selected for the study. The instrument used for data collection was an adapted version of the State-Trait Inventory for Cognitive Anxiety (STICA) developed by Mack Ree (2000) to measure test anxiety. The instrument underwent validation by experts from the Faculty of Education and Extension Services at Usmanu Danfodiyo University, Sokoto. The reliability of the instrument, as reported by the developer, was established using the test-retest method, with a four-week interval between the first and second administrations. The reliability results yielded an alpha coefficient of 0.90, indicating the instrument's reliability and its adoption for the study. The study was guided by three objectives, three research questions, and three null hypotheses. Descriptive statistics, specifically mean and standard deviation, were used to answer the research questions, while Analysis of Covariance and t-tests were employed to test the hypotheses at a 0.05 alpha level of significance. The study's findings revealed that female students demonstrated higher retention ability and anxiety levels than their male counterparts when taught using the 5E's instructional model. Conversely, male students exhibited a higher and significant anxiety level compared to their female counterparts when taught using cooperative methods. The study recommended, among other suggestions, the adoption of the 5E's instructional model by biology teachers due to its enhancement of biology knowledge retention. Additionally, considering the higher anxiety levels found among females, teachers should ensure that male students receive the necessary motivation to encourage positive anxiety.

Keywords: 5E's instructional model, Anxiety and Retention

Introduction

The 5E instructional model originates from constructivist learning theory, which asserts that students independently construct their own knowledge. Bybee (2002) contends that implementing the 5Es instructional model can aid students in redefining, organizing, examining, and altering existing ideas through interaction with peers and the environment. It's a technology-enriched model that enables learners to develop 21st-century skills and allows teachers to effectively teach specific concepts in biology, fostering reform-based instruction.

The cycle encompasses cognitive learning stages starting with the engagement, exploration, explanation, elaboration, and evaluation phases. Science educators and

curriculum developers can integrate or apply this model across various levels, including organizing a sequence of daily lessons, individual units, or yearly plans. Each phase of the 5E Instructional Learning Cycle is outlined as follows:

The engage phase enables the teacher to start a lesson by initiating activities or posing questions to captivate students' interest and encourage them to share their existing knowledge. This phase aims to assess students' prior knowledge and uncover potential misconceptions. It's a student-centered phase that motivates students to delve deeper into the upcoming concept. Students might brainstorm an opening question or evaluate their existing knowledge about the concept. Discrepant events, demonstrations, questioning, or graphic organizers may be included to generate curiosity or interest. Students are encouraged to brainstorm and document what they already know, what they want to know, and eventually, what they've learned about the concept.

The exploration phase, succeeding the engagement phase, centers on a mental focus on the concept and provides students with a collective, tangible learning experience. This phase is also student-centered and emphasizes active exploration. Students are prompted to employ process skills such as observation, questioning, investigation, prediction testing, hypothesis formulation, and communication with peers. This phase generally involves the primary inquiry-based activity or experience, fostering the development of skills and concepts. The teacher's role shifts to that of a facilitator or consultant. Furthermore, students are encouraged to collaborate in a learning environment devoid of direct teacher instruction. This phase is distinct because it offers students a 'hands-on' experience before any formal explanation of terms, definitions, or concepts by the teacher.

The explanation phase, a 'minds-on' phase following exploration, is more teacher-directed and guided by students' previous experiences from the exploration phase. This phase allows students to articulate their understanding and pose queries about the explored concepts. It's probable that new questions will arise. The explanation phase is a critical, minds-on segment of the 5E lesson. Before the teacher provides an explanation, students must first have the opportunity to express their explanations and ideas. Hence, the initial part of this phase involves the teacher acting as a facilitator, inviting students to describe and discuss their exploration learning experiences. Following the students' expression of their own explanations, the teacher introduces scientific and technical information directly. This phase encompasses addressing student misconceptions that may have surfaced during the engagement or exploration phases. Formal definitions, notes, and labels are offered. The teacher may opt to incorporate video presentations, computer software, PowerPoint slides, or other visual aids to aid student comprehension. Subsequently, students should be able to effectively articulate crucial concepts to both the teacher and their peers.

The elaboration phase's activities in the learning cycle aim to prompt students to apply their newfound understanding of concepts while reinforcing acquired skills. Students are encouraged to verify their comprehension with peers or design new experiments or models based on the newly acquired skills or concepts. The objective of this phase is to foster deeper and broader comprehension of the concepts. Students might conduct further investigations, create products, exchange information and ideas, or employ their knowledge and skills in other disciplines. It's a prime opportunity to

integrate science with other subject areas. Elaboration activities may also incorporate technology, such as web-based research or Web Quests.

Evaluation phase is the assessment inquiry-based setting which is very different from traditional science lessons. Both formal and informal assessment approaches are appropriate, and should be included. For instance, the use of non-traditional forms of assessment, such as portfolios, performance-based assessment, concept maps, physical models, or journal logs may serve as significant evidence of student learning. During an inquiry-based lesson, assessment should be viewed as an ongoing process, with teachers making observations of their students as they apply new concepts and skills and looking for evidence that the students have changed or modified their thinking. Students may also have the opportunity to conduct self-assessment or peer-assessment. However, the evaluation may also include a summative experience such as a quiz, exam, or writing assignment. The cycle is very flexible and dynamic. It may take many days to complete the lesson or unit. It is not necessary to complete one learning cycle each day that science is taught. The model is designed to facilitate conceptual change and contribute to more consistent and coherent science instruction (Bybee, 2002).

Anxiety, as a variable in this study, refers to an uneasiness or overreaction students experience when learning cell division using the 5E's and cooperative methods. Academic anxiety results from biological or emotional reactions that reduce students' concentration levels during learning. Research has proven that biology anxiety contributes to poor performance in the subject and is associated with related variables such as test anxiety, worry, and prior performance. Lowe and Ang (2012) conducted a survey among secondary school students in southern Nigeria to demonstrate the anxiety levels between male and female students. Their study revealed that males demonstrated higher anxiety levels than females, concluding that untreated anxiety in male students may lead to behavioral, physical, and mental difficulties hindering academic performance. Mohammed, Hailu, and Muhammad (2017) examined the effects of examination anxiety on the academic performance of male and female students in the Northwest region of Bauchi, Nigeria. They established that male students with heightened anxiety levels scored lower grades compared to their female counterparts, who achieved higher grades with moderate anxiety levels. Thus, it's evident that academic anxiety affects the academic achievement of secondary students. Additionally, the study noted that academic institutions play a key role in assisting students in handling academic anxiety through well-implemented guidance and counseling programs.

Most students experiencing anxiety in biology encounter it from their elementary school days. According to Moneil (2009), factors contributing to students' anxiety in biology include curriculum weaknesses, negative experiences, pressure and family expectations, teachers' personalities, and teaching methods. The work also found an inverse relationship between the level of biology anxiety and students' biology performance. This finding aligns with Zacharia and Nor's (2008) study on two semesters of matriculation students, revealing a significant negative relationship between biology anxiety and students' performance. Similarly, Fulya (2008) and Matazu & Ismail (2023) showed that male students with biology anxiety exhibit poor achievements in biology, while the work also confirmed that female students with less anxiety achieve encouraging results in the subject.

Retention, as another variable in this study, closely relates to memory but differs in that for information to be deemed retained, students must recall it appropriately in response to prompts typically found in academic settings and not solely based on experiential cues. It refers to the ability to retain and recall the concept of division by individual learners when taught and evaluated. Retention and knowledge significantly influence the teaching and learning of science. Jesulowo (2019) describes retention as the ability to retain and remember learned experiences coded into memory. The scaffolding theory is an adequate retention information processing theory, focusing on how knowledge is centered, stored, and retrieved from students' memory. Cognitive psychologists believe that processes influence what is learned. Jesulowo's (2019) study on the effects of the 5E's learning model on creativity, performance, and retention in ecology among secondary school students in Zaria revealed no significant difference in retention scores between male and female students taught ecology concepts using the 5E's learning model compared to those taught using the lecture method. Several studies on retention have been conducted, such as Amosa, Akawo, Elis, and Ugguono's (2014) examination of the effects of video-based multimedia instruction on secondary school students' achievement and retention in biology in Nigeria. Their results showed no statistically significant difference among the experimental groups, with students under multimedia instruction generally performing better than those under conventional teaching methods.

Zaitoun (2016) discovered a significant difference in the retention abilities of male and female students when taught biology using the Integrating Instructional Model. However, there was no significant difference in the retention abilities of male and female students taught biology using the lecture method. Among students taught using the Integrating Instructional Model, female students exhibited notably higher retention abilities compared to their male counterparts. In contrast, Ibrahim's (2015) findings indicated no significant difference in the mean scores between male and female pre-NCE biology students of varying abilities when taught using the 5E teaching cycle.

Patrick (2017) and Abdalla (2017) conducted a study comparing the effect of three teaching methods (lecture, cooperative, and independent study) on the recall of facts, understanding of content, and application of principles based on gender. Their findings revealed that, in the cooperative method, female mean scores for recall and understanding surpassed those of males, contrasting with the lecture method. The cooperative method fostered active and creative student participation. Abdalla (2017) concluded that females performed significantly better than males. Jesulowo (2019) investigated the effect of gender on the academic performance of students taught ecology using the 5E learning model. The study found no significant difference in academic performance between male and female students taught ecology using the 5E Learning model. Both male and female students exhibited relatively similar increased performance levels.

Similarly, Ibrahim's (2015) investigation demonstrated no significant difference in the mean performance scores between male and female pre-NCE students of varying abilities taught using the 5E teaching cycle. Thus, suggesting that the 5E teaching cycle does not differentiate the academic performance of male and female pre-NCE biology students with varying abilities.

The present study aims to explore whether gender significantly affects anxiety and retention among senior secondary school students studying cell division concepts when exposed to the 5E Instructional model in Sokoto.

Statement of the Problem

Anxiety and low retention abilities are increasingly prevalent in today's world, exerting a significant psychosocial toll on students. These challenges, when present in a student's life, detrimentally impact academic performance. The fluctuating trend in the performance of Senior Secondary School Students in external biology examinations has become a concern for researchers in science education. Multiple factors contribute to this challenge. Secondary school studies are fraught with severe challenges and demanding processes necessary to achieve educational objectives. Consequently, students often grapple with anxiety and low retention abilities in their academic pursuits, leading to several complications in their academic lives. At times, these pressures lead to the abandonment of academic work. (Moneil, 2009). The table below shows some of fluctuations in result of May/ June Senior Secondary School Certificate Examination

Table 1: Summary of Trends of Students' Performance in May \ June Senior Secondary School Certificate Examination in Biology, 2017 to 2021.

Year	Total Students that Sat	No of Students with C6 and above	% Percentage Pass	% Parentage Fail
2017	1646150	587040	35.66	64.34
2018	1648363	736970	44.70	55.30
2019	1365384	685970	50.02	49.98
2020	1471151	583486	39.66	60.34
2021	1572396	758424	48.23	51.77

Source: West African Examination Council (WAEC 2021) National Head Office Yaba, Lagos.

Table 1 illustrates the fluctuating trend in Nigerian Secondary Student Performance in the West African Senior School Certificate Examination in Biology from 2017 to 2021. In 2017, only 35.66% of students passed out of a total enrollment of 1,646,150. Subsequently, there was an increase in pass rates to 44.70% and 50.02% in 2018 and 2019, respectively, followed by a decline to 39.66% and 48.23% in 2020 and 2021. The 2020 performance recorded a decrease with only 39.66% achieving a credit pass. However, the performance remains unsatisfactory as 64.34%, 55.3%, 60.34%, and 51.77% of students failed, indicating a considerable failure rate. This concerning trend calls for concerted efforts from all education stakeholders to enhance students' performance in Biology, aiming to reduce failure rates and improve passing percentages. WAEC chief examiners consistently stress the need for students to improve their understanding and application of concepts like cell division, genetics, laws, and theories. Despite the emphasis on various teaching methods and scientific facilities, there persists a high failure rate in biology.

The current teaching methods might not effectively cultivate positive anxiety and strong retention abilities in biology lessons. Students tend to memorize and reproduce

facts and concepts without truly grasping them. Moreover, some teachers lack awareness of suitable methods due to inadequate knowledge or insufficient professional training. This leads to teachers' incompetence in employing effective teaching approaches. Thus, this study aims to investigate the effects of the 5E's instructional model on anxiety and the retention of the concept of cell division among senior secondary school students in Sokoto State, Nigeria.

Objectives of the Study

The objectives of this study were to:

Determine the anxiety level of male and female students taught cell division using 5E's instructional model.
Determine the anxiety level of male and female students taught cell division using cooperative method
Find out the retention abilities of male and female students taught cell division using 5E's instructional and those taught using cooperative method

Research Questions

The following research questions were guided the study:

i. What is the Effects of 5E's instructional model cooperative method on students' academic performance in cell division?
ii. What is the difference in the performance of male and female students taught cell Division using 5E's instructional model?
iii. What is the difference in the performance between male and female students taught cell Division using cooperative method

Null Hypotheses

The following null hypotheses were formulated and tested in the study.

HO_1: There is no significance difference in the anxiety level of male and female students taught cell division using 5E;s instructional model.
HO_2: There is no significant difference in the anxiety level of male and female students taught cell division using cooperative method.
HO_3: There is no significant difference in the retention abilities of male and female students taught cell division using 5E;s instructional model and those taught using cooperative method

Methodology

The study employed a quasi-experimental design utilizing intact classes, categorizing subjects into two groups: an experimental and a control group. The experimental group was exposed to the 5E's instructional model, while the control group underwent the cooperative method. The researcher opted for the cooperative method instead of the commonly used traditional lecture method. Both groups underwent pre-tests and post-tests. The population consisted of 14,567 SSII students drawn from the six educational zones in Sokoto State, spanning a total of 118 schools. One school was

randomly selected from each zone, with two intact classes utilized in each school, comprising 123 males and 389 females, resulting in a total sample of 512 participating students in the study. For data collection, the instrument used was the adopted Version of Mack Ree's (2000) State-Trait Inventory for Cognitive Anxiety (STICA) to measure test anxiety. The instrument underwent validation by experts from the Department of Science and Vocational Education and the Department of Biological Sciences at Usmanu Danfodiyo University Sokoto. The instrument's reliability was established using the test-retest method, with a four-week interval between its first and second administrations, resulting in a reliability index of 0.90, indicating its reliability and suitability for the study. Due to the instrument's rigorous scrutiny and high coefficient endorsed by its developer, no further reliability testing was conducted. Descriptive statistics such as mean and standard deviation were utilized to address the research questions, while inferential statistics, specifically Analysis of Covariance (ANCOVA) and t-tests, were deemed appropriate for testing the null hypotheses related to performance, anxiety, and retention. These statistical methods were chosen as the subjects were not randomized, and the data included pre-test and post-test measurements.

Results

HO_1: There is no significance difference in the anxiety level of male and female students taught cell division using 5E;s instructional model.

Table 2: Summary of tests Between-Subjects Effects of Gender on Anxiety Level of Students taught Cell Division using 5E's Instructional Model

Source of Variance	Type III Sum of Squares	Df	Mean Square	F	*p*	ɳ
Corrected Model	6438.407	2	3219.203	375.913	.000	.731
Intercept	17.321	1	17.321	2.023	.156	.007
Pre-Anxiety	6412.794	1	6412.794	748.835	.000	.731
Gender	200.655	1	200.655	23.431	.000	.078
Error	2363.579	279	8.564			
Total	524501.000	281				
Corrected Total	8801.986	280				

ɳ= Eta Squared

Table 2 presents a Summary of tests on Between-Subjects Effects of Gender on Anxiety Level among Students taught Cell Division using 5E's Instructional Model. A one-way between-group analysis of covariance was conducted to assess gender differences in anxiety levels among students taught cell division using the 5E's instructional model. Gender (male & female) was the independent variable, and post-test anxiety scores obtained after the intervention constituted the dependent variable. Pre-intervention anxiety scores were used as the covariate in this analysis. Following the adjustment for pre-test anxiety scores (covariate), the analysis revealed a significant difference between the post-test anxiety scores of male and female students taught using the 5E's instructional model ($F(1, 276) = 23.431$, $p = .000$, $p < .05$, partial eta squared = .078). The obtained p-value being less than .05 led to the rejection of the null hypothesis. This outcome suggests a noteworthy disparity in the anxiety levels of male and female students taught cell division using the 5E's

instructional model. Gender was able to explain 7.8% of the observed variance in the dependent variable.

HO_2: There is no significance difference in the anxiety level of male and female students taught cell division using cooperative method.

In order to test null hypothesis (HO_2), post-test anxiety scores of male and female students taught cell division using cooperative were subjected to a one-way Analysis of Covariance test while their respective pre-test anxiety scores were used as the covariate. The results are presented in Tables 3.

Table 3: Summary of Tests Between-Subjects Effects of Gender on Anxiety Level of Students taught Cell Division using Cooperative Method

Source of Variance	Type III Sum of Squares	Df	Mean Square	F	*p*	ɳ
Corrected Model	10842.680	2	5421.340	46.264	.000	.287
Intercept	3755.924	1	3755.924	32.052	.000	.122
Pre-Anxiety	217.856	1	217.856	1.859	.174	.008
Gender	10476.926	1	10476.926	89.407	.000	.280
Error	26951.869	229	117.182			
Total	568882.000	231				
Corrected Total	37794.549	230				

ɳ= Eta Squared

Table 3 presents the Summary of Tests on Between-Subjects Effects of Gender on Anxiety Levels among Students taught Cell Division using the Cooperative Method. A one-way between-group analysis of covariance was performed to assess gender differences in anxiety levels among students taught cell division using the cooperative method. Gender (male & female) served as the independent variable, and post-test anxiety scores obtained after the intervention constituted the dependent variable. Pre-intervention anxiety scores were utilized as the covariate in this analysis. Upon adjusting for pre-test anxiety scores (covariate), the analysis revealed a significant difference between the post-test anxiety scores of male and female students taught using the cooperative method ($F(1, 230) = 89.407$, $p = .000$, $p < .05$, partial eta squared = .280). The obtained p-value being less than .05 led to the rejection of the null hypothesis. This outcome suggests a substantial discrepancy in the anxiety levels of male and female students taught cell division using the cooperative method. Gender was able to explain 28.0% of the observed variance in the dependent variable.

HO_3: There is no significant difference in the retention abilities of male and female students taught cell division using 5E's instructional model and those taught using cooperative method.

Table 4: Summary of t-test Analysis of difference in the Retention Abilities of Male and Female Students taught Cell Division using 5E's Instructional Model and those taught using Cooperative Method

Method	Gender	N	Mean	SD	SEM	T	Df	*P*
5E's	Male	69	17.76	3.09	.39	-17.469	277	.000
	Female	212	25.23	2.98	.21			
Cooperative	Male	54	9.98	1.11	.15	-9.593	231	.000
	Female	177	13.82	2.87	.21			

Sig. lev. 0.05

Table 4 illustrates the Summary of t-test Analysis, examining the difference in Retention Abilities between Male and Female Students taught Cell Division using 5E's Instructional Model and those taught using the Cooperative Method. The t-test analysis aimed to identify variations in the retention abilities of male and female students across both instructional approaches. The results indicated a significant difference in the retention abilities scores of male and female students taught using 5E's instructional model ($p = .000$, $p < .05$). Similarly, a notable difference was observed in the retention abilities scores of male and female students taught using the cooperative method ($p = .000$, $p < .05$). This suggests that female students exhibited significantly higher levels of retention ability compared to their male counterparts in both instructional strategies. The mean retention abilities scores for male students taught using 5E's were $M = 17.76$, $SD = 3.09$, while for female students, $M = 25.23$, $SD = 2.98$. For students taught using the cooperative method, the mean retention abilities score for male students was $M = 9.98$, $SD = 1.11$, and for female students, $M = 13.82$, $SD = 2.87$.

Discussion of Findings

Table 2 presents the results of hypothesis 1, aiming to explore the anxiety levels of male and female students taught cell division using 5E's instructional model. Contrary to the null hypothesis, the analysis revealed a significant difference between the post-test anxiety scores of male and female students ($F (1, 276) = 23.431$, $p = .000$, $p<.05$, partial eta squared = .078). This outcome signifies that female students exhibited a significantly higher anxiety level than their male counterparts when taught using 5E's instructional model. This finding contradicts Mohammed, Hailu, and Mohammed's (2017) study, which suggested that male students with elevated anxiety levels scored lower grades compared to females with moderate anxiety. However, it aligns with Kaya's (2004) research, indicating that high test anxiety among females correlated with higher academic achievements.

Table 3 displays the outcomes of hypothesis 2, investigating the anxiety levels of male and female students taught cell division using the cooperative method. The analysis uncovered a significant difference in post-test anxiety scores ($F (1, 230) = 89.407$, $p = .000$, $p<.05$, partial eta squared = .280), revealing that male students displayed a notably higher anxiety level compared to females in this instructional method. These findings resonate with Zacharia and Nor's (2008) study, highlighting a positive relationship between biology anxiety and students' performance. It also aligns with Fulya's (2008) findings, indicating that lower biology anxiety correlated with

poor achievements among male students, while higher anxiety levels were encouraging for females in biology.

Table 4 presents the findings of hypothesis 3, examining the retention abilities of male and female students using 5E's instructional model and the cooperative method in teaching cell division. The results indicated a significant difference in retention abilities for both instructional approaches, signifying that female students exhibited notably higher retention abilities than their male counterparts ($p = .000$, $p < .05$). These results are consistent with prior studies by Patrick (2012), Abdalla (2017), and Zaitoum (2016), emphasizing higher retention abilities among females, particularly in cooperative methods and using 5E's instructional models. However, they diverge from Jesulowo (2019) and Ibrahim (2015), who reported no gender differences in retention abilities with the 5E's instructional model.

Conclusion

Based on the finding of this study, it was concluded that there was a significant difference in the anxiety level of male and female students taught cell division using 5E's instructional model and those taught using cooperative method. Female students in the two instructional methods exhibited a higher and significant level of anxiety than their male counterparts. The result also shows that there was a significance difference in the retention abilities of male and female students taught cell division using 5E's instructional model and those taught cell division using cooperative method. Also, it is implied in the result that female students demonstrated a higher and significant level of retention ability than their male counterparts in the two instructional strategies.

Recommendations

The following recommendations were based on the findings of this study:

Since females are found to have higher Anxiety level, teachers should ensure that male students are giving the necessary motivation to encourage positive anxiety.
5E's teaching strategy, is strongly recommended in teaching biology concepts across board since it has proven very effective in promoting retention among students taught using it.

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