

IMPACT OF 5ES STRATEGY ON PERFORMANCE AND RETENTION IN ECOLOGY CONCEPTS AMONG FIELD-DEPENDENT AND FIELD-INDEPENDENT SECONDARY SCHOOL BIOLOGY STUDENTS IN THE POST PANDEMIC ERA

Fatima Jummai ISAH

Department of Primary Education Studies, School of Education,
Niger State College Of Education, Minna.

Abstract

The study investigated the Impact of 5Es problem solving Strategy on Performance and Retention in Ecology Concepts among Field-Dependent and Field-Independent Secondary School Biology Students in the Post Pandemic Era. The population of the study was one thousand four hundred and forty-nine (1,449) senior secondary school students. Two intact classes were used. A sample of one hundred and twenty-six (126) SS II students were drawn from the population using simple random sampling technique through balloting. Two research questions were raised with their corresponding null hypotheses formulated to guide the study. The study employed quasi – experimental, control group involving pretest, posttest and post posttest design. Three instruments used for data collection were Group Embedded Figures Test (GEFT 0.82), Ecology Performance Test (EPT 0.81) and 5Es Instructional Package (5-EIT). The experimental group was taught using Problem Solving model while the control group was taught using Lecture method. Research questions raised were answered using mean, standard deviation and mean difference while null hypotheses were tested using 2-way Analysis of Co-Variance (ANCOVA) and t-test analysis at $P \leq 0.05$ level of significance. Research findings revealed significant difference between performance and retention mean scores in favour of the experimental group. It was therefore recommended that secondary school biology teachers should frequently employ 5Es problem solving model in teaching difficult and abstract concepts in biology like ecology concepts.

Keywords: 5Es Problem Solving, Performance, Retention, Field–Dependent, Field–Independent and Covid – 19 Pandemic Era.

1. Introduction

Teaching effectiveness at any level of education is measure in terms of knowledge of what to teach, how to teach it and when to teach it (Isah 2017). The “how” of teaching constitutes what is called teaching strategy or methodology. Studies of teaching strategies especially in science, have received greater attention now than before as many science educators have shown interest in improving the teaching and learning of science content from factual knowledge to classroom instruction that allows student active participation in learning process. Ecology is one of the branches of biology that deals with the study of interrelationship among plants animals and their non-living physical environment. Abdulrahman, Taiwo and Abimbola (2019) indicated poor performance and retention level of students is as a result of over lapping and abstract nature of ecology concept. However, students by nature are curious and need to be actively involved in the learning process.

Inquiry based learning is a students' centered approach that required student to find out for themselves. It is an instruction through problem solving activities. Constructivist teaching is based on the fact that skills and knowledge acquisition are not passive receiving of information and rote learning but involves active participation of learners through knowledge construction, hands on and minds on activities (Chijioke, & Okoli, 2019). Therefore, biology teachers need to employ instruction that develop connectional understanding and thinking skills that helps students to learn better, retain more knowledge and apply what is learnt to real life situations. This is why Chijioke and Okoli (2019) suggested that the 5Es problem solving model offer a promising opportunity in this respect. The 5Es instructional model is defined as a constructivist problem solving and inquiry-based strategy that uses five phases of instruction namely: engagement, exploration, explanation, elaboration and evaluation (5Es). According to Muhammad, Omwirhiren and Abubakar (2021), the 5Es teaching is an instructional strategy for designing series of experimentally rich lessons that are conceptually linked and developmentally sequenced, to support the ongoing progressive refinement in student understanding as it develops over time.

However, one of the major issues that seems to bother students, parents and stakeholders in education today is the academic performance and retention of concepts learnt by the students. Academic performance is the outcome of learning experiences or training programme, the extent to which student achieved educational goals. In science instruction for instance, if a student accomplishes a task successfully and attains the specific goals for a particular learning experience, he/she is said to have performed academically good (Garba, 2020). Nevertheless, scientist and educators have realized that many science students perform poorly in their academic work as a result of insecurity and the post covid-19 pandemic.

The concept of insecurity connotes the state or quality of being insecure, insecurity can be seen as a feeling of uncertainty, a lack confidence or anxiety about one's self. Iwogbe and Awwal (2021) asserted that security in Nigeria is being socio-political in nature, as without security there should be political instability, chaos and social vices. Thus, there is connection between the security of Nigerian's and their survival of the adverse of Covid-19 pandemic. The covid-19 pandemic is a disease caused by novel coronal virus now called Severe Acute Respiratory Syndrome Coronavirus 2 (SARS – COV₂) was first identified in Wuhan – China on December 31, 2019. The emergence of the Covid-19 pandemic exposed weaknesses in all aspect of national and economic lives of nations, some include leadership, government and education, research and development, health care and social protection. The education sector at all levels experienced increased number of out of school children. Awwal and Munir (2020) asserted that total closure of school and programme was affected from pre-school to higher education. At the resumption of schools, it was observed by Mahdy (2020) that students' poor performances were at the increase, this may be due to many factors which include: lapidated science laboratories caused by insecurity, poor teaching method of ecology, lack of practical lessons.

Adegoke (2017) observed the way we learn things in general and the particular approach we adopt in problem solving depend on some mysteries link between personality and cognition; this link according to him is called cognitive style. Adegoke (2017) defined cognitive style as an individual's preferred and habitual approach to problem solving, thinking perceiving and remembering of information. One of the most common conceptualizations of cognitive style is associated with field dependent and field-independent. Students are called Field-Dependent (FD) if they are unable to trace out an element from its context or background field. While Field-Independent (FI) are students who are able to trace out an element or figure from its context or background field. However, for effective teaching and learning to take place there is a need for teacher to identify each of these personality traits of their students and then apply the most appropriate teaching method such as 5Es strategy for effective cognition and conceptualization (Adegoke, 2017). Therefore, the researcher investigates the impact of 5Es problem solving strategy on performance and retention in ecology concepts among field-dependent and field-independent secondary school biology students in the post COVID – 19 Era.

2. Statement of the Problem

Ecology being the last concept in biology curriculum content is usually rushed through teachers' centered mode of instruction in pandemic era. However, this recall that knowledge acquired and retained by the students is very low. This is because a specific instructional material in teaching ecology which may help students to build the knowledge during teaching and learning process is inadequate. Lack of participation limits students' retentiveness (Muhammad, Omwirhiren, & Abubakar, 2019). Performance and retention may be related to understanding and students' cognitive style. It was observed that lack of attention by biology teachers to handle FD and FI students in learning situation is responsible for low retention ability. Chijioke and Okoli (2019) opined that every child has a unique pattern of ability, interest and natural endowment. This uniqueness implies that different learners adopt varying approach to learning consistently with their qualities. However, studies from Abimbola and Abidoye (2013), Ibrahim (2015) as well as Umar (2017) revealed that biology teachers do not plan instruction that bring about adequate organization, stability and clarity of knowledge with which students can build their knowledge. If students' cognitive style (field dependence) and field independency) is not taken into consideration, it can possibly affect their retention and academic performance.

Covid-19 pandemic era forced the school management and educators especially in science to adopt a holistic method of instructional delivery such as 5Es. There was need to maintain social distancing during the pandemic in the schools which negatively affect quality teaching and learning process especially science subjects like biology. Therefore, this study employed the use of 5Es learning model to determine its impact on retention and academic performance in ecology among FD and FI secondary school biology students in post COVID-19 pandemic.

3. Objectives of the Study

The objectives of this study are to:

1. Find out the impact of 5Es Model on academic performance in ecology concepts among field dependent and field independent senior secondary school students.
2. Determine whether 5Es model has effect on retention ability in ecology concepts among field dependent and field independent senior secondary school students.

3.1 Research Questions

The following research questions are answered:

1. What is difference between the performance mean scores of field dependents and field independent students taught ecology concepts using 5Es problem solving model and those taught using lecture method?
2. What is the difference between the retention mean scores of field dependents and field independents students taught ecology concepts exposed to 5Es model and those taught using lecture method?

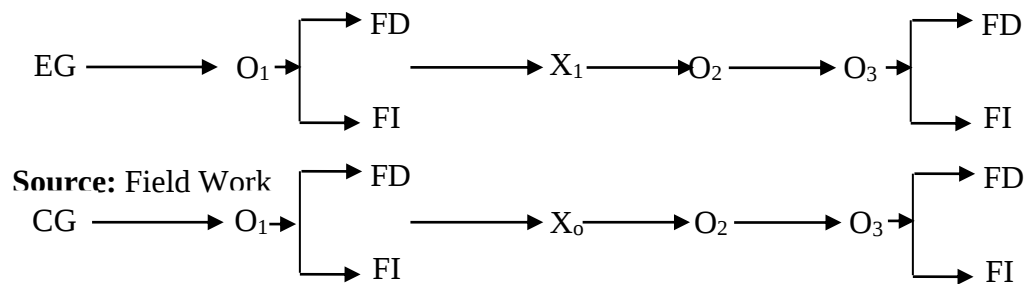
3.2 Null Hypotheses

The following null hypotheses were tested at $p \leq 0.05$ level of significance.

- H₀₁: There is no significant difference between the performance means scores of field dependent and field independent students taught ecology concepts using 5E model and those taught using lecture methods.
- H₀₂: There is no significant difference between retention means scores of field dependent and field independent students taught ecology concepts using 5Es model and those taught using lecture methods.

3.3 Research Design

The research design for this study is Quasi-Experimental Control Groups design involving pretest, posttest, and post posttest as recommended by Kerlinger (1973). More recently, Best and Kahn (2014), observed that a Quasi-Experimental design is often used in classroom experiments and does not involve the random assignment of participants into treatment groups. Intact classes were used since the school will not allow some students outside while the lesson is on. Pre-test (O_1) was administered to both groups to establish their equivalence as well as measure students' initial level of learning style and academic performance in ecology. The Group Embedded Figure Test (GEFT) was administered to the study subjects to categorize them into field dependent and field independent groups after which the pretest was given. Group Embedded Figure Test (GEFT) adapted from Witkin, Dyk, Faterson, Good-Enough and Karp (1962), Adamu (2010) and Adegoke (2012). The Experimental Group (EG) was taught ecology concept using 5Es Instructional Model (X_1) while the Control Group (CG) was taught same concept using lecture method (X_0) for the period of six weeks each. After the treatment, post-test (O_2) was carried out using EPT to both groups to determine the effect of 5Es model on academic performance of the students. Post-Posttest (O_3) was conducted two weeks later to determine students' retention ability using same EPT. The design of the study is presented in Figure 3.1



3.4 Population of the Study

The population of the study comprised of all SS II students in the thirteen (13) co-educational public schools in Minna metropolis of Niger State. The reason for using co-educational schools is that gender is one of the variables in the study. The thirteen co-educational schools are located in Minna metropolis. According to Secondary Schools Board Minna (2020), the number of SS II students in the population were 808 Males and 641 Females making a total of 1 449.

3.5 Sample and Sampling Techniques

The sample for this study comprised SS2 Biology students (males and females) from 2 randomly selected public co-educational Senior Secondary Schools in Minna Metropolis, Niger State, Nigeria. Simple random sampling with replacement through the Balloting Method was used to select four (4) schools from the thirteen (13) co-educational Senior Secondary Schools in the study area. According to Anikweze (2013), this technique ensures that each element in a population has equal chance of being selected and the resulting sample is representative of the population. Pre-test was administered to the SS2 Biology students in each of the four schools randomly selected to determine their learning styles in terms of cognitive style and academic performance in ecology. Two schools (i.e. G.S.S. Bahago and G.S.S. Kangiwa) were therefore used for the study. There are 65 students (32 males and 33 females) in the experimental group and 61 students (32 males and 29 females) in the control group. The sample size for this study is in line with the Central Limit Theory which Tuckman (1975) and Sambo (2008) who recommended a minimum of 30 sample size for experimental study of this nature.

3.6 Instrumentation

The instruments used for data collection were: -

1. Group Embedded Figure Test (GEFT). This is an instrument used in categorizing students into FD and FID
2. Ecology Performance Test (EPT) was used for pre-test, post-test and post-tested.
3. 5Es instructional package (5-EIP)

3.6.1 Group Embedded Figure Test (GEFT)

The GEFT is a non-verbal test that requires minimum language proficiency for carrying a task (Ashiru & Sadiq, 2016). Its psychometrical properties are practical and sensible for cross – cultural settings such as the context of the present study (Aktar & Afri, 2011). The Group Embedded Figures Test (GEFT) was developed by Witkin, Oltman, Raskin and Karp (1971)

and was adapted in this study to determine the students' cognitive styles. The test contains four sections. Total time for completing the test was ten (10) minutes. A figure traced out has to be different from the subsequent ones thereby having different simple figures. Any student who scores 0 – 11 was classified as Field – Dependent (FD) while those who score 12 – 18 were classified as Field independent (FI). The marking scheme is provided in Appendix C. The instrument had been validated by Witkin et al and was said to have the reliability of $r = 0.82$ (Witkin, Oltman, Raskin & Karp, 1971; Adegoke 2012).

3.6.2. Ecology Performance Test (EPT)

The Ecology Performance Test (EPT) was an instrument developed by the researcher; it is an objective test which consists of 50 objective test items using content on ecology to determine the academic performance of SS II biology students. The EPT was used at 3 levels, Viz:

1. Pretest, to determine group equivalence;
2. As Post-test to determine performance and
3. As Post-posttest to determine retention ability of students.

3.6.3 5Es Instructional Package (5-EIP)

The 5-EIP consists of six (6) lessons designed by the researcher to present contents in Ecology Concept following the five phases of the 5Es Instructional Model as adopted from Bybee et al (2006). These phases include engage, explore, explain, elaborate and evaluate. The package is meant to guide the treatment of the experimental group by the researcher. Each lesson in the package is activity-based and was designed for 80 minutes (double period) to cover a topic in Ecology Concept. The entire package, comprising six topics, was covered in six weeks (one topic per week). Lessons in the package were guided by the content and objectives specified in the senior secondary Biology curriculum for the concept taught.

3.7 Validation of the Instruments

The validity of the instruments was achieved by presenting the instruments to panel of experts comprising:

1. Three professors from the Department of Science Education, Ahmadu Bello University, Zaria.
2. A Chief Lecturer from the Department of Educational Psychology, Niger State College of Education, Minna.
3. Two experienced biology teachers from Government Day Model Secondary School Zarmai and Government Day Secondary School, Bosso with a minimum qualification of B.Sc (Ed) Biology with at least five year teaching experience.

3.8 Pilot Testing

Pilot testing was conducted using the Ecology Performance Test (EPT) on 62 SS II Biology students. EPT consists of 50 multiple-choice items were administered to the students by the researcher and was assisted by the biology teacher of the school. Instructions were given to the students on how respond to the questions and were also allowed to ask questions for further understanding. A period of 1 hour 30 minutes was allocated for the completion of the test. Challenges encountered during the pilot testing were noted to improve the final

instrument. At the completion of the instrument, the answer sheets were retrieved from students, marked and scored according to the marking schemes designed by the researcher to ensure scoring objectively. The instrument was administered to the students and data generated were analyzed to determine:

- Item analysis of EPT
- Appropriateness of length time require to take the test
- Calculate the reliability coefficient of the EPT

3.9 Reliability of the Instruments

The data obtained from pilot testing were analyzed to establish the reliability of the instruments as follows:

i. EPT: The test re-test method was used to determine of the reliability of EPT. The test and re-test were conducted within an interval of two weeks as recommended by Tuckman (1975) and Sambo (2008). Pearson Product Moment Correlation (PPMC) statistics was used to estimate the degree to which the two set of scores are associated. The reliability of coefficient r of EPT was found to be 0.81 which indicate a high coefficient of stability of the instrument and therefore used in this study. The test re-test reliability analysis of EPT is presented in Appendix J.

ii. GEFT: The Group Embedded Figures Test has been validated by Witkin et al (1971) and was said to have a reliability of $r = 0.82$ which mean the instrument was reliable for use.

4 Result and Discussion

The analysis on the research questions and hypotheses were discussed. The scores of the students in pretest, posttest and post posttest were analyzed using statistical package for social science (SPSS 23.0 Version) for testing the hypotheses stated in the study. The hypotheses were retained or rejected at $p \leq 0.05$ level of significance.

Answering Research Questions and Hypothesis

Question One: What is the difference between the performances mean scores of Field dependent and field Independent students taught ecology concepts using 5Es problem solving model and those taught using lecture method?

Table 1: Mean, Standard Deviation and Mean Difference between the performance mean scores of Field Dependent and Field Independent students taught ecology concepts using 5Es problem solving model and those taught using lecture method

Cognitive	Study Groups	N	Mean	Std. Deviation	Mean Difference
FI	Experimental	31	25.93	3.77	4.15
	Control	32	21.78	4.23	
	Total	63	23.82	4.50	
FD	Experimental	34	10.73	2.71	-1.02
	Control	29	11.75	3.55	
	Total	59	11.23	3.17	
Total	Experimental	65	18.45	8.33	
	Control	61	17.01	6.37	

Total	126	17.73	7.42
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Source: Field Work

The result in Table 1 showed that the experimental FI group with mean of 25.93 at standard deviation of 3.77 while the FI control group had mean of 21.78 at standard deviation of 4.23 with mean difference of 4.15. Nevertheless, the FD in experimental group had a mean of 10.73 at a standard deviation of 2.71 while the FD in the control group with a mean of 17.01 at standard deviation of 6.37 with mean difference of -1.02 respectively.

Question Two: What is the difference between the Retention mean scores of Field dependent and field Independent students taught ecology concepts using 5Es problem solving model and those taught using lecture method?

Table 2: Mean, Standard Deviation and Mean Difference between the Retention mean scores of field dependent and field Independent students taught ecology concepts using 5Es problem solving model and those taught using lecture method

Cognitive	Study Groups	N	Mean	Std. Deviation	Mean Difference
FI	Experimental	31	26.93	4.47	7.12
	Control	32	19.81	4.26	
	Total	63	23.31	5.62	
FD	Experimental	34	9.56	4.32	0.67
	Control	29	8.89	3.40	
	Total	59	9.23	3.88	
Total	Experimental	65	18.39	9.78	
	Control	61	14.62	6.70	
	Total	122	16.50	8.56	

Source: Field Work

The result in Table 2 showed that FI experimental group with a mean scores of 26.91 at a standard deviation of 4.47 and FI control group with a mean of 19.81 at standard deviation of 4.20 with a mean difference of 7.12; however, the FD experimental group had a mean score of 9.56 at a standard deviation of 4.32 while the FD control group had a mean of 8.89 at a standard deviation of 3.40 with a mean difference of 0.67 between them.

Hypotheses Testing

Hypothesis One: There is no significant difference between the performance mean scores of Field dependent and field Independent students taught ecology concepts using 5Es problem solving model and those taught using lecture method.

Table 3: 2-Way ANOVA statistics on significant difference between the performance mean scores of field dependent and field Independent students taught ecology concepts using 5Es problem solving model and those taught using lecture method

Source	Type III Sum of Squares	Df	Mean Square	F	P	R
Corrected Model	5115.090 ^a	3	1705.030	129.550	.000	S
Intercept	37535.058	1	37535.058	2851.95	.000	S

Cognitive		4845.183	1	4845.183	368.143	.000	S
Groups		74.551	1	74.551	5.664	.019	S
cognitive	*	204.284	1	204.284	15.522	.000	S
Groups							

Source: Field Work

Significant ≤ 0.05

Result of the 2-way ANOVA statistics in Table 4.3.1 showed that significant difference exists between the performance mean scores of field dependent and field Independent students taught ecology concepts using 5Es problem solving model and those taught using lecture method. Reasons being that the P-value of 0.000 obtained was lower than the 0.05 level of significance. This clearly showed that the experimental group Field Independent students had significantly higher mean performance scores than their counterparts in the control group. Therefore, the null hypothesis which stated that there is no significant difference between the performance mean scores of field Dependent and field Independent students taught ecology concepts using 5Es problem solving model and those taught using lecture method, is consequently rejected.

Hypothesis Two: The null hypothesis state that there is no significant difference between the Retention mean scores of field dependent and field Independent students taught ecology concepts using 5Es problem solving model and those taught using lecture method

Table 4: 2-Way ANOVA statistics on significant difference between the Retention mean scores of field dependent and field independent students taught ecology concepts using 5Es problem solving model and those taught using lecture method

Source	Type III Sum of Squares	Df	Mean Square	F	P	R
Corrected Model	6845.690 ^a	3	2281.897	132.459	.000	S
Intercept	32381.711	1	32381.711	1879.692	.000	S
Cognitive	6092.009	1	6092.009	353.629	.000	S
Groups	462.462	1	462.462	26.845	.000	S
cognitive * Groups	317.074	1	317.074	18.406	.000	S

Source: Field Work

Significant $\alpha \leq 0.05$

The result of the, 2-Way ANOVA statistics in Table 4.3.2 showed that significant difference exists between the Retention mean scores of field dependent and field Independent students taught ecology concepts using 5Es problem solving model and those taught using lecture method. Reasons being that the P value of 0.001 obtained was lower than the 0.05 level of significance. This clearly showed that the experimental group Field Independent students had significantly higher mean Retention scores than their counterparts in the control group. Therefore, the null hypothesis which stated that there is no significant difference between the Retention mean scores of field Dependent and field independent students taught ecology concepts using 5Es problem solving model and those taught using lecture method is consequently rejected.

5. Summary of Major Findings

The major findings of the study are summarized below:

1. There is significant difference between performance mean scores of field dependent and field independent students taught ecology concepts using 5Es problem solving model and those taught using the same concepts using lecture method in favour of the experimental group.
2. There is significant difference between retention mean scores of field dependent and field independent students taught ecology concepts using 5Es problem solving model and those taught using the same concepts using lecture method in favour of the experimental group.

5.1 Discussion of Finding

The first finding of this study indicated that the experimental group who were taught ecology concepts using 5Es strategy achieved a significantly higher performance than the control group who were taught same concepts using lecture. The significant difference can further be attributed to the fact that the 5Es problem solving model provides the opportunity for students in the experimental group to interact with materials. This finding is in line with findings of Ibrahim (2015), Bunkure (2012) and Mahmud (2017). These researches revealed that students exhibited significant performance as a result of treatment with 5Es problem solving model when compared to the lecture method. The finding of this study also in line with the assertion of CPB (2002) that through constructivist teaching particular with the 5Es strategy promote positive critical and creative thinking as well as problem solving skills which are essential to student-centered minds-on and hands-on mind. The use of 5Es problem solving model removes the barriers associated with teacher-centered instructional methods and offers a very unique learning situation in which students are given opportunities to actively seek for idea and information, analyse it and construct knowledge by themselves. This provides for deep and real understanding and use of knowledge by the students.

The second finding revealed that students taught ecology concepts using 5Es problem solving strategy retend more concepts learnt (knowledge) better than their counterpart students taught using lecture method. This is because the 5Es problem solving model allowed new ideas especially abstract concepts , to be more easily assimilated with the students' prior knowledge, use of real materials in activity; retention is improved through active participation, spoken message, in combination with learning and seeing of material to be learn is more than doubles of comprehension, this finding is in agreement with Rajib (2013), Duyulemi and Bolajoko (2014) who found that real materials aid memory retention resulting in higher attainment of concepts learnt. However, the more active the student is in the learning process, the better he/she retains what is taught (Paul, & Dantani, 2019).

6. Conclusion

Based on the findings of this study, it was concluded that the 5ES strategy has the potentialities of improving secondary school student's academic performance. Also, 5Es strategy promotes meaningful and concrete learning which strengthens the retention of learnt concepts of ecology among secondary school students.

6.1 Recommendations

Based on the findings of this study, the researcher made the following recommendations bearing in mind the objectives and hypotheses raised:

1. Secondary school biology teachers should frequently employ 5Es problem solving model in teaching difficult and abstract concepts in biology like ecology concepts.
2. Biology teachers should improvise where instructional materials are not available or inadequate.

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