EFFECTS OF PROBLEM-SOLVING INSTRUCTIONAL TECHNIQUE AND COGNITIVE STYLE ON SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN GENETICS IN ANAMBRA STATE

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ABSTRACT

The study investigated the effect of problem-solving technique and cognitive style on students' academic achievement in genetics in Onitsha Education Zone. Four research questions guided the study while four hypotheses were tested at 0.05 level of significance. Quasi-experimental research design was adopted for the study. The population of the study consists of 5,397 Senior Secondary school students in the 20 co-educational secondary schools in 32 public Secondary Schools in Onitsha Education zone. A sample consisting of 120 (52 Male and 68 Females) SSII biology students from two schools was used for the study. Two instruments tagged Group Embedded Test (GEFT) and Genetics Achievements Test (GAT) were used to collect data for the study. Data were collected with a 40-item genetics achievement test and 20-item group embedded figure test. Kuder-Richardson (KR-20) reliability method was used to determine the reliability of the instrument. Mean was used to answer the research questions. The null hypotheses were tested at 0.05 level of significance using analysis of covariance (ANCOVA). Findings of the study revealed that students' with field independent and field dependent cognitive style taught genetics using problem-solving technique achieved higher than those taught using the expository method. Problem-solving technique had more effect on students' achievement in genetics than expository method. Gender was not a significant factor in determining students' achievement in genetics. Based on the findings of the study, it was recommended among others that teachers should use problem-solving technique as one of the instructional strategies for teaching biology since it has been found to be more effective in enhancing students' academic achievement in biology (genetics) than the expository methods.
Keywords: Problem-solving, cognitive style, achievement, genetics

Introduction
Science is the bedrock upon which the modern day technological breakthrough is built. Countries all over the world, especially the developing ones like Nigeria, are striving hard to develop technologically and scientifically. Nwagbo in Usman (2010) explained science as an intellectual activity carried out by humans, designed to discover information about the natural world in which we live and to discover the ways in which this information can be organized to benefit human race. According to Feynman (2011), science has become such an indispensable tool that no nation,

developed or developing, wishing to progress in socio-economic sphere will afford to relegate the learning of science in schools to the background.

Biology as defined by Ramalingam (2003), is one of the branches of science that involves the study of living things ranging from microscopic cellular molecules to the biosphere which encompasses the earth surface. Importance of biology includes helping individuals to understand the parts of his/her body and their functions; bringing into focus the need to maintain good health; promoting the individual for choice of careers; to inculcate in the individual scientific skills and attitudes in his approach to personal and societal problem; enabling one to question superstition due to sustained interest arising from comprehension of the cause of events, understanding and appreciating life (Maduabum, 2009). In spite of these enormous importance that biology provides, biology results in most certified examinations such as the Senior School Certificate Examination (SSCE) conducted by both the West African Examinations Council (WAEC) and the National Examinations Council (NECO) have not been satisfactory in Nigeria (Asika, 2009). Parents and government are in total agreement that their huge investment on education is not yielding the desired dividend and that students' achievement still remains poor.

According to Wikipedia (2010), achievement means a thing that somebody has done successfully especially using one's own effort and skills. Aniekwe (2006) also sees achievement as a test for the measurement and accomplishment of skills in various field of academic study. Academic achievement of students in biology is needed to erase the record of poor performance of students in external examinations. Government, teachers, parents and the general public are greatly worried about students' poor performance in biology. Most State Ministries of Education have taken additional steps in the recent times on school comparison to measure progress in solving the national crisis.

The education arm of the government and educators recently have shown concern about how well the students score in biology (Adeyemo, 2010). The observed decline in students' performance in SSCE Biology may not be unrelated to their perception of difficulties in comprehending certain areas of biology which are regarded as complex and abstract e.g. genetics. As a result, the students tend to dislike certain topics in biology hence the tendency to avoid such areas during examinations (Tamarin, 2007). This fact is supported by Amoebi (2007), who worked on the identification of difficult concepts in senior secondary biology curriculum in Anambra State. The researcher stressed that among the biology topics teachers and students find difficult were nervous system and hormonal coordination, basic ecology, genetics, evolution and energy transfer. The Anambra State WASSCE May/June (2018) statistical data on students' performance in biology also indicated poor performance in biology with particular reference to genetics questions which were poorly attempted by many students. This poor achievement of students in

biology shows that some of the students that enroll for biology in public examination, graduate without grasping the fundamentals of the subject. Research reports (Agba, 2004) have shown that most teachers prefer the use of conventional teaching methods in curriculum delivery. This invariably leads to poor achievement particularly in biology. It is being advocated that teachers should use varieties of innovative teaching methods such as problem-solving in delivering biology lessons to serve as intervention (Efe & Efe, 2011).

Genetics which is the focus of this study is the branch of biological science that studies the process or mechanism of heredity. It focuses on establishing the scientific basis for understanding of how characteristics or traits are being transferred from parents to their offspring from one generation to another. The scientific understanding of genetics principles had also lead to the application of genetics in industry. For instance, in modern times, genetic engineering is used to improve the quality of crops and domestic animals (Tamarin 2007). Another interesting application of genetics to solve problems is when deoxyribonucleic acid (DNA) is used in crime detection and establishing of paternity where there is dispute.

Cognitive styles are psychological constructs which describes individuals mode of information perception, organization and representation. Also Emmanuel (2003) stated that cognitive style is a continuum and there is actually no low or high end of it, however, at the extreme ends there are field-dependent and field-independent individuals. A Field independent (Fl) cognitive style learner is described as analytic, competitive, individualistic, task-oriented, internally referent, intrinsically motivated (self-study), self-structuring, detail oriented and visually perceptive, prefers individual project work and has poor social skills, while a field dependent (FD) cognitive style learner is described as global (holistic), group-oriented sensitive to social interactions and criticisms, externally motivated, externally referential, not visually perceptive, a non-verbal and passive learner who prefers external information and group projects (Hall, 2000).

Good-enough and Cox as cited by Onyekuru (2015) revealed that students who preferred a field-dependent learning style tend to perceive the world globally, found it difficult to solve problems, tend to favour the Specter approach to learning and would adopt the organization of information to be learned while students who preferred a field-independent learning style tended to view the world analytically, found it easier to solve-problem and are more likely to favour inquiry and independent study. They also tend to provide their own structure to facilitate learning.

The teaching of science in general and biology in particular in school enable students to acquire broad knowledge, skills and attitudes that would equip them to solve their personal and societal problems as they develop into adults. Problem-solving

techniques are used to inculcate these knowledge, skills and general disposition or attitudes which individuals need, to be able to identify and tackle observed or perceived problems in the environment with a view to finding solution to them. An individual with the requisite knowledge, skills and disposition to identify and solve a problem is said to be competent in that area of socio-economic life. The different subjects which they are taught in the school are intended to equip them with different kinds of knowledge, skills and dispositions for problem recognition, identification and solving within the environment. It is therefore important to investigate the effects of problem-solving teaching technique on students' achievement in genetics.

Purpose of the study

The main purpose of this study was to determine the effect of problem solving technique and cognitive style on students' achievement in biology. Specifically, this study sought to determine the effect of problem solving technique on:

1. The mean achievement scores of students with field independent cognitive style taught genetics using problem-solving technique and those taught with expository method.
2. The mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving technique and those taught with expository method.

Research Questions

The following research questions guided the study

1. What are the mean achievement scores of students with field independent cognitive style taught genetics using problem-solving technique and those taught with expository method?
2. What are the mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving technique and those taught with expository method?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance.

1. There is no significant difference in the mean achievement scores of students with field independent cognitive style taught genetics using problem-solving technique and those taught with expository method.
2. There is no significant difference in the mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving technique and those taught with expository method.

Method

The study adopted the quasi-experimental research design. Specifically, the study adopted a non-randomized pretest-posttest control group design. The population of

the study comprised of 5,397 SSII students in the 20 co-educational schools in 32 public secondary schools in Onitsha Education Zone. The sample consisted of 120 SSII biology students, which include 52 male and 68 female students drawn from two schools out of 5,397 in the 20 co-educational of 32 public schools in the Onitsha South Local Government area. Onitsha South Local Government Area was sampled from Onitsha Education Zone. Two instruments were employed for data collection. These are the Group Embedded Figure Test (GEFT) and Genetics Achievement Test (GAT).

The GAT and GEFT instruments were subjected to face and content validation by two experts. One experts was from Science Education department and one from measurement and evaluation in the department of Educational Foundations, all of Nnamdi Azikiwe University, Awka.Kudar-Richardson (KR-20) was used to calculate the reliability of the scores gotten from the test. This method was used because it is best suited in checking the internal consistency of tests with dichotomous choices. A reliability coefficient of 0.73 was obtained. Two pieces of papers were drawn randomly from a hat containing names of all the thirty-two secondary schools in Onitsha education zone. The two pieces of papers picked out represented the two secondary schools selected for the study. The researcher then organized 2 weeks briefing exercise two days per week) for the biology teachers in the schools participating in the study. These teachers served as the research assistants. The research assistants must have taught for 5 years and must have a Bachelor of Science in Education (B.Sc.Ed) inBiology. One of the research assistants taught the experimental group while the other taught the control group so as to avoid teacher bias. The lesson plan and how to use the problem-solving instructional technique in the classroom lessons as well as the general requirements of the research was thoroughly explained to the experimental group teacher. The control group teacher on the other hand only received information about the general requirements of the research since students in the control group where taught with the usual expository method. Then a pretest was administered to the students using Group Embedded figure Test (GEFT) and Genetics Achievement Test (GAT) in both intact groups respectively with the aid of the research assistants before beginning of the treatment. The pretest indicated the level of performance of students before the manipulation of experimental variables. Both groups received the same content area of instructional material using the same length of time. Problem-solving instructional steps used by Alan (2013) which includes defining the problem, planning a solution, solving the individual part which involves sketches, diagram and grouping, putting it all together and evaluation were used in treating the experimental group. The control group was taught using the expository method. Teaching lasted for four weeks, each school where taught once a week with each lesson lasting for ninety minutes. A reshuffled GAT and GEFT was administered as post-test to students of both group (experimental and control) after treatment.The hypotheses were tested at 0.05 level of significance using analysis covariance

(ANCOVA). The decision rule was to reject the null hypothesis when it is less than 0.05, and to uphold the null hypothesis when it is greater than 0.05 level of significance.

Research Question 1

What are the mean achievement scores of students with field independent cognitive style taught genetics using problem-solving technique and those taught with expository method?

Table 1: Pretest and posttest mean achievement scores of students with field independent cognitive style taught genetics using problem-solving technique and those taught with expository method.

Source of Variation	N	Pre-test Mean	SD	Post-test Mean	SD	Gain in mean	Remark
Problem-solving (FI)	33	35		54.5		19.5	Effective
Expository method (FI)	34	35.02		37.05		2.03	

Results in Table 1 show that the field independent group taught genetics using problem solving technique had a pretest mean of 35 and a posttest mean of 54.5. The difference between the pretest and posttest mean was 19.5. The field independent group taught genetics using expository lecture method had a pretest means of 35.02 and a posttest mean of 37.05. The difference between the pretest and posttest means was 2.03. However, for each of the groups, the posttest means were greater than the pretest means with the group taught using problem solving teaching method having a higher mean gain. This is an indication that students' with field independent cognitive style taught genetics using problem-solving technique achieves higher than those taught using the expository method.

Research Question 2

What are the mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving technique and those taught with conventional lecture method?

Table 2: Pretest and posttest mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving technique and those taught with expository method.

Source of Variation	N	Pre-test Mean	SD	Post-test Mean	SD	Gain in mean	Remark
Problem-solving (FD)	27	18.07		36.7		18.6	Effective
Expository method (FD)	26	14.6		17.4		2.8	

Results in Table 2 show that the field dependent group taught genetics using problem solving technique had a pretest mean of 18.07 and a posttest mean of 36.7. The difference between the pretest and posttest mean was 18.6. The field dependent group taught genetics using expository method had a pretest means of 14.6 and a posttest mean of 17.4. The difference between the pretest and posttest means was 2.8. However, for each of the groups, the posttest means were greater than the pretest means with the group taught using problem solving teaching method having a higher mean gain. This is an indication that students' with field dependent cognitive style taught genetics using problem-solving technique achieves higher than those taught using the expository method.

Null hypothesis 1
There will be no significant difference in the mean achievement scores of students with field independent cognitive style taught genetics using problem-solving technique and those taught with expository method.

Table 3: ANCOVA of the significant difference in the mean achievement scores of students with field independent cognitive style taught genetics using problem-solving technique and those taught using expository method

Source	SS	DF	MS	F	Sig	Remark
Corrected Model	5339.356[a]	2	2669.678			
Intercept	403.307	1	403.307			
FI pretest	236.376	1	236.376			
GROUP	5112.610	1	5112.610	425.083	.000	Sig
Error	769.749	64	12.027			
Total	145773.000	67				
Corrected Total	6109.104	66				

Result in table 3 shows that with respect to the students with field independent cognitive style groups taught genetics using problem solving teaching method and those taught using expository method, an F-ratio of 425.083 was obtained with associated probability value of .000. Since the associated probability value of 0.01 was less than 0.05 set as level of significance, the null hypothesis (H01) which stated that there will be no significant difference in the mean achievement scores of students with field independent cognitive style taught genetics using problem-solving teaching method and those taught using expository method is rejected. Thus, inference drawn therefore is that there was a significant difference in the mean achievement scores of students with field independent cognitive style taught

genetics using problem-solving teaching method and those taught using expository method.

Null hypothesis 2
There will be no significant difference in the mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving technique and those taught with expository method.

Table 4: ANCOVA of the significant difference in the mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving technique and those taught using expository method

Source	SS	DF	MS	F	Sig	Remark
Corrected Model	5702.857[a]	2	2851.428			
Intercept	1952.361	1	1952.361			
FD pretest	779.021	1	779.021			
GROUP	3602.699	1	3602.699	221.037	.000	Sig.
Error	814.955	50	16.299			
Total	5860.000	53				
Corrected Total	6517.811	52				

Result in table 4 shows that with respect to the students with field dependent cognitive style groups taught genetics using problem solving teaching method and those taught using expository method, an F-ratio of 221.037 was obtained with associated probability value of .000. Since the associated probability value of 0.00 was less than 0.05 set as level of significance, the null hypothesis (H02) which stated that there will be no significant difference in the mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving teaching method and those taught using expository method is rejected. Thus, inference drawn therefore is that there was a significant difference in the mean achievement scores of students with field dependent cognitive style taught genetics using problem-solving teaching method and those taught using expository method.

Discussion
From the analysis, the following findings were made: Students' with field independent cognitive style taught genetics using problem-solving technique achieves higher than those taught using the expository method. Similarly, students' with field dependent cognitive style taught genetics using problem-solving technique achieves higher than those taught using the expository method.
These findings are similar to Agba (2004) who found out that cognitive styles of the students significantly influenced performance in the test of problem-solving in

genetics. The finding is also in line with that ofSafyanu, Maruta and Olarinoye (2016) that also found out that the cognitive styles of field dependence, field-independence and field neutral were significantly related to achievement in science process skills. The study revealed that no significant difference existed between the male and female students in both experimental and control group taught using problem – solving instructional technique.

Conclusion

Based on the findings of the study, it is concluded that problem-solving technique enhances better achievement of students with field independent and field dependent cognitive style than expository method.

Recommendations

Based on the findings of this study, the researcher hereby made the following recommendations:

1. Professional development for secondary school teachers should include training in the identification and characteristics of individual cognitive styles and strategies that will also meet the educational needs of students with different cognitive styles.
2. The study also recommends that teachers should use problem solving techniques as one of the instructional strategies for teaching biology since it has been found to be effective in enhancing students' academic achievement in genetics.

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