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EFFECTS OF MEANING FOCUS, PRACTICE AND INVENTION, STRATEGIES ON PROBLEM-SOLVING SKILLS OF SENIOR SECONDARY SCHOOL STUDENTS IN ECOLOGY

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Abstract: *Learners should not be in position of passive recipient of fact handed down by the teacher. Hence, there is need to expose students to strategies which makes students demonstrate mastery and be a problem solver. This study, determined effects of meaning focus strategy, Practice and Invention strategy, on senior secondary school students problem solving skills in ecological aspect of Biology. This study employs pretest, posttest, control group, quasi-experimental design.. The sample consists of 254 Senior Secondary Schools II students from Six Senior Secondary in Ibadan Municipality. Four instruments were used, it include Problem Solving Skills on Ecological Concept (PSSEC),Cognitive Style Test (CST),Teacher's Guide on Meaning Focus Strategy (TIGMFS),Teacher's Guide on Practice and Invention Strategy (TIGPIS),Teacher's Guide on Conventional strategy(TIGCS),Evaluation Sheet for Assessing Teachers Performance on the use of the strategies (ESAT) . .Two null hypotheses were tested at 0.05 level of significance. Data collected were analysed using ANCOVA. There was a significant main effect of Treatment groups on the students' posttest Problem solving skills scores ($F(2,242) = 55.116$, $P<.05$, $\eta^2 =.318$). Practice and Invention Strategy had the highest Problem solving skills mean score of ($\bar{x} = 14.815$) followed by Meaning focus Strategy by ($\bar{x} = 13.893$) and lastly followed by Conventional Strategy ($\bar{x} = 8.139$). This is a pointer to the urgent need for efforts in Nigerian schools to concentrate on the use of Meaning focus and Practice and Invention Strategies particularly in the teaching of problem solving skills in ecological concepts in biology.*

Keywords: Meaning focus and Practice and Invention Strategies, Ecology, and Problem solving skills.

Introduction

Science is a process used to investigate natural phenomena, resulting in the formation of theories verified by direct observations. Inquiry challenges students to solve problems by observing and collecting data and constructing inferences from those data, through this process, students also acquire knowledge and develop a rich understanding of concepts, principles, models and theories. Science as a discipline stands out as a major factor in developmental effort of a nation. It is very crucial to human living. No wonder, the relevance of science to national goals, aspirations and economy dictates to a large extent the huge commitment and support which most nations make and give to science and technological development. The knowledge of science is used in the production of materials that reduce people's stress, suffering and hunger, protects as well as make life more enjoyable and secured. Biology as a science of life is concerned with characteristics of living things, their forms and functions including relationship with one another and with their environment. It is a subject that engages the students in varied process skills such as observation, clarifying, interpreting predicting events, designing experiments, organizing information and reporting adequately. Furthermore one primary function of Biology teaching is to help the students understand biology concepts, principles, theories and laws.

FME (2009) state the following objectives in its curriculum for Biology:

1. Understanding of the structure and function of living organisms as well as appreciation of nature;
2. Acquisition of adequate laboratory and field skills in order to carry out and evaluate experiments and projects in Biology;
3. Acquisition of necessary scientific skills for example observing, classifying and interpreting biological data;
4. Relevant knowledge in Biology needed for future advanced studies in biological science; acquisition of scientific attitude for problem solving;
5. Ability to apply biological principles in everyday life in matters that affect personal, social, environmental, community health and economic problems.

The new 2009 edition of the Biology curriculum (NERDC, 2009) now has only four themes namely:

i) Organization of life,
ii) The organism at work,
iii) The organism and its environment
iv) Continuity of life.

Environmental Education is one of the concepts infused into the theme as 'The organism and its environment'. Many Environmental Education concepts such as ecology, pollution, conservation techniques and population are found in the Biology Curriculum of West African Senior School Certificate Examinations (WASSCE) /National Examinations Council (NECO) Senior School Certificate Examinations syllabuses (Obioma, 2007). The utility of ecological concepts in biology has made it an important topic in biology. Ecology is one of the branches of Biology that deals with the study of interrelationship among plants, animals and their non-living environment. According to Ige (2001), ecology provides knowledge and understanding of the mechanism of change brought about by the interaction of the living things and its effects on their external environment. Ecology gives the students an opportunity to meet with some of the most important ecological issues affecting the environment. These include the influence of human activity in altering human ecological relationship and difficulties arising from the stress of modern day life. In the secondary school biology curriculum, it was observed that ecological concepts play very important role in scientific advancement that affects the lives of mankind. Despite its importance in the society, available statistics from the West Africa Examination Council (WAEC 1999; 2003; 2004, 2006; 2007; 2008) on senior secondary school students' achievement in Biology revealed that although Biology had the highest enrolment relative to other science subjects, it had recorded very poor achievement at senior school certificate examination. The poor achievement in ecological concept as observed from chief examiners report (2003) which was supported by Oyeleke (2011) indicated that the ecological questions asked in WAEC 2003, on five important uses of water to organism in the rainforest was wrongly answered. Chief examiners report (2007) further revealed that some candidates wrote on the uses of water to man for example "drinking, washing and cooking," rather than maintaining body temperature, essential for plant turgidity, necessary for photosynthesis etc. Also in 2007 WAEC question, students were asked to describe briefly three ways each by which animals in Arid habitat are adapted to drought and high temperature. The chief examiners report (2007) shows that the students' performance on the question was very poor. Hence, Oyeleke (2011) was of the opinion that teachers who wish to impact ecological concept knowledge meaningfully, so that their students can achieve conceptual comprehension will often employ metacognitive teaching strategies. This is supported by Adegbile (2002). Metacognition according to Adegbile (2002) is defined as the knowledge of one's knowledge, processes, including cognitive, affective states and the ability to consciously and deliberately monitor and regulate them. With the ability to assess their knowledge in this way, students can study accordingly. Unless the teacher is environmentally inclined or trained, he or she is not likely to significantly improve or impart the teaching and learning of Environmental Education (Eguabor, 2012). Biology teaching involves exposing students to several opportunities to understand different types of concepts and principles. The implication is that biology teaching must be effective and meaningful to achieve its goals. Biology is the most favoured among other science subjects by the students, as it is usually the science subject which non-science or art-inclined students commonly select considering the number that offer it in public examination (Danmole & Adeoye 2004) in spite of its popularity the performance in this subject is not encouraging.

In science, problem-solving ability is usually developed in the students through the introduction of practical in the normal setting of teaching and learning processes. This is because they provide the students with the required opportunity to experience and build a feeling and interest in the phenomenon being studied (Raimi, 2003). Furthermore, (Raimi, 2003) noted that practical develop competence of specific skills required by students to perform specific roles in life task. According to Ogundiwin (2013), critical thinking skills, creativity ambiguity and tolerance are fundamental skills which problem-solving strategy training will help to develop in the learner. Other qualities like being an adaptive problem-solver (Brown, 2005) demonstrating the ability to think cross-functionally across various problems (Giges, 2000) and ability to transfer the skills to real-life situations (Brawer, 1997). In science, problem-solving ability is usually developed in the students through the introduction of practicals in the normal setting of teaching and learning processes. This is because they provide the students with the required opportunity to experience and build a feeling and interest in the phenomenon being studied (Adegoke 2000; Raimi, 2003). Furthermore, (Raimi, 2003) noted that practicals develop competence of specific skills required by students to perform specific roles in life task. Problem-solving abilities will enable the students tackle some of the prevailing biological problems being experienced today. Problem-solving abilities will help the students explore the situation and reflect on their experiences because elaboration and reflection improve learning (Giges, 2000). Reflective skills are also part of effective problem-solving and group abilities. The teacher need to monitor the students' progress because monitoring is a key component in developing effective environmental problem-solving abilities. Other qualities like being an adaptive problem-solver demonstrating the ability to think cross-functionally across various problems (Giges, 2000) and ability to transfer the skills to real-life situations Raimi, (2003).posited that problem-solving skills must be based on the prior attainment and recall of the rules that are combined in the achievement of the solution. Problem solving has a special importance in the study of the sciences. Proficiency in problem solving requires practice and when the learner is given enough opportunities for practice this results in acquisition of self ability and competence which in most cases could lead to invention. Problem solving has been regarded as the linking ties between context and applications in a learning environment for the development of basic skills and their uses in various dimension. (Kare,2002).Students appreciate algorithms because they are easily applied. However, students may "algorithmize" methods they have observed others using and bring them to bear in a given situation whether applicable or not. Algorithmic methods are limited to low-level tasks and tend to be domain-specific. Heuristic methods, general schemes used to derive solutions to problems, are more useful than algorithms. Hence, there are a variety of heuristics that can be useful to students.

Biological meaning plays a vital role in student solution of problems in every day activities, especially compared to in-school problem solving activities that depend more on health and life relationships in which the environment must be conducive and habitable for all organisms concerned. (Olaseinde, 2009}. The strategies and solutions students construct to solve problems in real-world contexts are meaningful and correct, while the rules used by students in school are devoid of meaning and lead to errors undetected by the student. Meaning focus strategy encompasses learning how to discriminate and categorize things (with critical attributes). It also involves recall of instances, integration of new examples and sub-categorization. The goal of this strategy is to reduce overgeneralization, under-generalization and misconception. It is through the Meaning Focus that the teacher can choose instructional activities that integrate everyday uses of Biology into the classroom learning as they improve students' interest and performance in Biology. According to Alessi and Trollop (2001) an appropriate meaning focus design is to first teach *relevant* (essential) features, e.g. by stating a definition of the concept in terms of these features. Next simple instances are given and that contain all or many of the relevant features. E.g. for "mammal", we could show a horse, a dog and cow. All the same, these examples should not contain irrelevant or incidental features. In meaning focus, all learners need to see examples and non-examples. Therefore in the next step, non instances are shown, e.g. a tree, a bird and a fish for the "mammal" concept. These examples contain few relevant feature and many irrelevant and incidental features. Finally, the same procedure has to be applied to difficult instances and non-instances, e.g. This shows dolphines and whales for instance are mammals while sharks are not mammals respectively. Abimbola (2013) in his study of analysis of errors and misconception in Biology amongst senior secondary schools students found out that lack of pre-requisite knowledge affects the conceptual understanding of students in biological concepts. There is evidence that students can learn new skills and concepts while they are working out solutions to problems. For examples, a teacher armed with only the knowledge of basic ecological concepts, can make students extend their knowledge by developing informal knowledge of feeding relationship between organisms. In addition to choosing non-routine problems, students can develop an understanding of many important ecological ideas, such as predation/prey relationship. Development of more sophisticated ecological problem solving skills can be approached by treating their development as a problem for students which is accordance with Okurumeh (2009) in which Instruction can begin with an example for which students intuitively know the answer, from there, students are allowed to explore and develop their own meaning. Students need to build meaningful connections between their informal knowledge and their formal knowledge about Biology or they may end up building misconception. One of the focuses of this study is therefore to advocate the need to up grade Meaning Focus approach to the status of pedagogy in Biology. This will enhance the bridging of Biology in the classroom to that of outside classroom, the place where the student operates. Agoro (2013) agreed that students need to discuss and reflect on connections between scientific ideas, but this does not imply that a teacher must have specific connections in mind; the connections can be generated by students. He went further to say "a scientific connection that is explicitly taught by a teacher may actually not result in being meaningful or promoting understanding but rather by one more piece of isolated knowledge form the students point of view. Therefore,. It is a way in which the students can make contributions to teaching activities in the classroom.

Practice and Invention involves structuring instruction around carefully chosen problems, whereby learners develop their method and solutions to the problems. Research evidence suggests that, students need opportunities for both Practice and invention. The findings from okurumeh (2009) shows that, when students discover ideas and invent procedures, they have a stronger conceptual understanding of connections between the ideas. According to Boarler, (1998) a balance must be maintained between the times students spend practicing routine procedures such as abiotic and biotic component of the ecosystem and the time they devote to inventing and discovering new ecological ideas. To increase opportunities for invention in ecological concept, teachers should frequently use non-routine problems; periodically introduce a lesson involving new manipulative skills embedded in ecological concepts by posing it as problem to be solved (Backhouse,1999). In addition, Grouws & Cebulla (2000) believed that structuring around carefully chosen problems, allowing students to interact when solving problems, and providing opportunities for them to share their solution and methods resulting in increased achievement and problem solving measures. Okurumeh (2009), used Practice and invention strategy with other retention enhancing strategies to teach the concepts of the sets statistics and probability to 346 SS2 students from Delta State, Nigeria. He reported that the treatment had a significant effect on students achievement in mathematics. The result analysis showed that students in the Practice invention strategy group obtained the highest post-test mean score than the other strategies. Based on his analysis he concluded that Practice invention strategy is most effective in improving students' achievement in mathematics than the traditional instructional strategy. The finding of Okurumeh (2009) study makes the investigation of the effect of this strategy on ecology imperative in the sense that the strategy may also improve the performance of students in statistical concept in ecology such as population studies, distribution of Organisms etc. Abimbola (2013) has shown that, when students have opportunities to develop their own solution methods, they are better able to apply mathematical knowledge in biological science.

Cognitive Style refers to a psychological disposition, which shows how an individual is inclined to think, learn and process information. According to Ige, (2001),Student's cognitive styles have been found to mediate learning, most of the differences encountered in students' learning could be described in terms of different manners in which students perceive and analyze a stimulus configuration (i.e. their cognitive styles). Each individual responds differently when exposed to a stimulus world. Some act on first impulse, some examine isolated components of what is presented to them before responding while others respond on the basis of contextual or holistic manner (Awolola, 2009). This calls for its better understanding by the teacher in his/her choice and usage of teaching strategies. Lovelace (2005) concluded that matching a student's cognitive style with the instruction can improve academic achievement and student attitudes toward learning. According to Berg (2001) various cognitive styles or activities that focus on the strengths of how students learn best need to be addressed in the classroom. The study determined the effects of Meaning focus strategy, Practice and Invention strategy, on senior secondary school students problem solving skills in ecological aspect of Biology. The study further investigated the moderating effects of Cognitive style on the dependent measure.

Statement of the Problem

Researchers were of the opinion that it is through problem-solving processes that meaningful learning which is necessary for developing background experience can be acquired to remove overgeneralization, undergeneralisation and the misconceptions found in the learning of ecological concept. The innovative instructional strategies employed by teachers of Biology which should impact a good level of problem solving skills in Ecology on the part of the senior secondary school students who should constitute the technological man power in the nation need to be employed. The study, therefore determined the effects of Meaning focus strategy, Practice and Invention strategy, on senior secondary school students problem solving skills in ecological aspect of Biology. The study further investigates the moderating effects of Cognitive style on the dependent measure.

Hypotheses

Based on the problem stated the following null hypotheses will be tested at 0.05 alpha level of significance.

HO_1: There is no significant main effect of treatment on senior secondary students' problem solving skills in ecology.

HO_2: There is no significant main effect of cognitive style on senior secondary students' problem solving skills in ecology.

Methodology

The study will adopt a pretest, posttest control group, quasi experimental design. The 254 participants for this study were obtained from senior secondary school two (SS2) Biology students in Ogun State. There are three senatorial Districts in Ogun state, which includes Ogun Central, Ogun West and Ogun East. Ogun Central senatorial district was selected from the three. The three local Governments Areas randomly selected from the six local Government Areas of Ogun Central senatorial districts are Abeokuta South, Abeokuta North and Odeda. Twelve schools will be randomly selected from the three local governments' .i.e four schools from each Local Government Area. The schools were randomly assigned to the treatment and control groups i.e. two experimental and one control group.

The criteria for selecting the schools are:

- The school will be [public co-educational secondary school]
- The Senior Secondary two students in the school must have completed their Senior Secondary students' one Biology curriculum at the time of commencement of study.
- The school must have qualified graduate teachers in Biology in the SS2 classes
- The school must have produced candidates for public exams like WAEC and NECO for not less than 5 years.

Selection of Concepts

The concepts selected were based on spiral curriculum of the SSCE as approved by WAEC 2012 and the concepts are

- Ecosystem
- Conservation of natural resources
- Pollution,
- Population

Research Instruments

The following instruments were used in the study to collect data

1. Problem Solving Skills on Ecological Concept (PSSEC)
2. Cognitive Style Test (CST)
3. Teacher's Guide on Meaning Focus Strategy (TIGMFS)
4. Teacher's Guide on Practice and Invention Strategy (TIGPIS)
5. Teacher's Guide on Conventional strategy(TIGCS)
6. Evaluation Sheet for Assessing Teachers Performance on the use of the strategies (ESAT)

Problem Solving Skills Test on Ecological Concept (PSSTEC)

The PSSTEC constitute essay type question. The students solved all questions showing correct sequence required. Section A involves the Demographic data while Section B involves the items on problem solving that were addressed. The students read the passages carefully and answered the questions that followed .The Ashmore, Frazer and Casey Model was adopted in this research.

Ashmore, Frazer and Casey (1979) developed 4-staged model comprising of;

i. Defining the problem
ii. Selecting appropriate information
iii. Combining the separate pieces of information
iv. Evaluating

Ashmore, Frazer and Casey (1979) believed that the success in problem solving would be high when;

(i) There are strong background information and knowledge of the problem;
(ii) There is knowledge of problem-solving strategies and tactics
(iii) There is confidence in the problem solver

This model which is presented in figure II can be used in solving problems in physics, chemistry and biology.

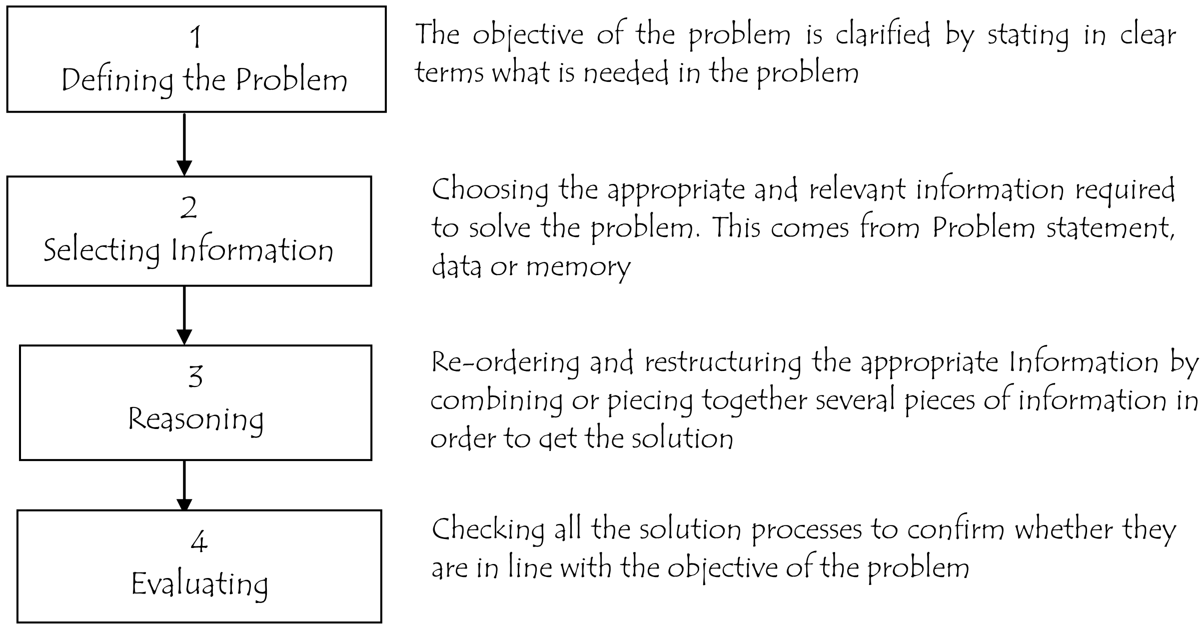

Figure 1: Ashmore, Frazer and Casey (1979)'s model of Problem Solving skills

Validation and Reliability of Problem Solving Skills Test on Ecological Concept (PSSTEC)

The initial 30 essay and matching type items were scrutinized by Biology experts in Colleges of Education, Teacher Education (Science Unit) for face construct and content validity, and those that were found to be inadequate were removed. Validation after trial testing reduced the items to sixteen. The reliability coefficient of the 16 items was determined using parallel/ alternate statistical tool and the value was 0.81.

Cognitive Style Test (CST)

This instrument was in line with that of Sigel's cognitive style Test (1967). The revised edition by Awolola (2009) and Ogundiwin (2013) was adapted in this study. The CST consists of twenty cards numbered 1 to 20. Each card contains three pictures in black and white, two of which could have one thing or the other in common or could go together in some ways. The CST was used to classify the students into 'analytic' and 'non-analytic' styles on the basis of their statements regarding the way they perceive the pictures. The students were asked to respond to each set of three pictures by noting how any two of the three pictures in the set go together or are related in any way. The statements made by the students regarding the way they perceived the pictures and classified any two together could be categorized into three thus:

- Analytic Descriptive (AD);
- Categorical Inferential (CI) and;
- Relational Contextual (RC)

Analytic Descriptive Responses

Students placed together objects based on their shared or common characteristics, which are directly discernible. Example, in a card containing a Wristwatch, a man and a ruler, participants here place together wristwatch and man because "they have leathered material on".

Categorical Inferential Responses

Participants placed together objects on the basis of super ordinate features, which are not directly discernible (abstract), but are inferred. Example, participants here placed a wristwatch and ruler together because "they are for measurement".

Relational Contextual Responses

Participants here placed together objects or events on the basis of features establishing a relational link between them. The two stimuli or objects here are independent conceptionally; rather each derives meaning from the other. Hence, this style is sometimes called global or holistic or contextual mode of categorization. Example, participants here placed together "the man and the ruler" or "the man and the wristwatch" on the ground that, "the man can measure distances with ruler or "know the time with wristwatch". In this study, analytic style participants were those who scored above the median on Analytic Descriptive (AD) and Categorical Inferential (CI) responses and below the median on Relational Contextual (RC) responses. Non-analytic style participants were those who scored above the median on Relational Contextual (RC) responses and below the median on Analytic Descriptive (AD) and Categorical Inferential (CI) responses.

Table 1: Table of Specification for CST

S/N	Content Area	Responses	Number of Items
1.	Analytic Descriptive Responses	Placing objects of common characteristics together	7
2.	Categorical Inferential Responses	Placing objects together on the basis of super ordinate features which are not directly discernable but are inferred	6
3.	Relational Contextual Responses	Placing objects/events together on the basis of features establishing a relational link between them.	7
	TOTAL		20

Source: Awolola(2009)and Ogundiwin (2013)

Validation of Cognitive Style Test (CST)

The face validity of CST was done by showing the booklet of 20 cards which contain pictures of items to experts in educational psychology, educational technology and other technically untrained observers to determine their suitability. Pearson product moment coefficient for different responses showed stability coefficient obtained. Afuwape (2002) also trial tested the CST using 137 JS III students in four secondary schools in Lagos, Awolola (2009) and Ogundiwin (2013) also trial tested it, The trial test results showed no ambiguities in the instrument with test retest reliability value of 0.84 was obtained. For the present study the CST was trial tested twice (separated by two weeks) using 30 SS II students of the field-testing school (Adekile goodwill Grammar School Ibadan.) in order to further ensure its validity and reliability. A test-retest reliability value of 0.81 was obtained.

Teachers Instructional Guide

The researcher designed three instructional guides each based on the proposed strategy.

- Teacher's guide on Meaning focus strategy (TIGMFS)
- Teacher's Guide on practice and Invention (TIGPIS)

The Guides were prepared in line with UNESCO Curriculum (Esan 2000) with the following outline-topic, objectives, learning experience, integration of learning experience/content (attitude to develop, teacher activities, students activities) and materials. The units were reduced to lesson notes. The lesson note contain topic, objective of each lesson stated in a behavioural or instructional manner, assumed knowledge introduction procedure/presentation, instructional materials, references, Evaluation and assignments. The Guide also contain problem task within and at the end of each lesson period.

Experimental Group I: Meaning Focus Strategy (TIGMFS).

Procedure for Experimental Group 1 – Meaning focus strategy Steps Involved

- Teacher emphasises the meaning of ecological concepts
- Teacher emphasises, the implication of the concepts
- Students reflect on specific life situation e,g population,pollution
- Students connect new ideas and skills to past knowledge and experience.
- Students give feedback through corrections from teachers
- Teachers design new techniques of construction
- Students develop skills in problem solving.

Validation of teachers Instructional Guide on Meaning Focus Strategy (TIGMFS)

The instructional Guide was presented to science educators in higher institution of learning, more particularly biology teachers, to make necessary correction on the suitability of the content, coverage, language of presentation and the workability of the instructional guide. The recommendations given were used to reconstruct the guide and the inter-rater reliability estimated Scott Π obtained was 0.80.

Teacher's Instructional Guide on Practice and Invention Strategy (TIGPIS)

Procedure for Experimental group 2 practice and Invention strategy

- Teacher provides tasks that require reasoning
- Teacher introduces the lesson to rediscover necessary concepts

- Students are provided with opportunity for reflection
- Students give alternative approaches in solving situations
- Teacher stimulates students for further problem solving and instruction
- Students are given the opportunity to share experiences
- Teacher gives more problems and encourages student to solve it.

Validation of Teacher's Instructional guide on Practice and Invention Strategies (TIGPAIS)

The instructional guide was given to experts in Biology Education in higher institution, secondary school and also the researcher's supervisor for correction on the suitability of content, coverage, language of presentation and the workability of the guide. The corrections made were used to reconstruct the guide and the inter-rater estimated Scott II obtained was 0.83.

Teacher's Instruction Guide on Modified Conventional Method (TIGMCM)

The teacher

- Introduces the lesson
- Discusses the content of the lesson.
- Writes the note on the chalkboard.
- Asks students to copy in their note books.
- Gives an overview of the lesson
- Evaluates the lesson by asking questions from students
- Concludes the lesson by giving homework.

Validation of Teacher's Instructional Guide on Modified Conventional Method (TIGMCM)

The instructional guide was given to experts in Biology Education, for necessary corrections on the suitability of the content, coverage, language of presentation and the workability of the guide. The recommendations given and inter-rater reliability estimated scott Π obtained was 0.79.

Evaluation Sheet for Assessing Teachers Performance on the use of the strategies

This instrument was adopted and adapted for use in evaluating the teachers on the effective use of the instructional guides during the teaching process. The instrument shows presentation of concepts, mastery of the topics, use of materials and activities directed and how effective the presentation will be for the mastery of the concept by the students. The instruments would be used to evaluate the performance of the trained teachers on the effective use of the 4 strategies.

1. Meaning Focus Strategy
2. Practice and Invention Strategy
3. Modified Conventional Method

The Rating Scale Constitute 2 sections

SECTION A: This consists of the personal data of the trained teacher. The name, school, period, class taught, data and the summary of the concept discussed in the class.

SECTION B: This consists of items to be evaluated. The items are placed on 5 point, likert type rating scale, ranging from very good (5) Good (4) Average (3) Poor (2) Very poor (1)

Validation of (ESAT)

The instrument will be trial tested to ensure reliability and validation. Experts attention will be drawn to ascertain the appropriateness of the concepts and topics treated in Biology. The observation and comments of these experts were taken into consideration while preparing the final draft.

Procedure for Data Collection

Work Schedule

2 weeks	-	Training of Teachers
1 week	-	Pretest
8 weeks	-	Treatment
1 week	-	Post test

Training of Teachers

Teachers that participated in the study were adequately trained on the purpose, principles and procedures governing each group and the use of each treatment. The training material (instructional guide) was given to them. The teaching instrument for all groups has its content in the following areas of ecology: ecosystem, pollution, population and conservation of natural resources. The research assistants (teacher) were trained on how to administer the instruments. The pre-test materials were given to them shortly after the training. The first contact with the students in the classroom was to introduce the strategies and prepare the students mind towards the purpose, principle and procedures governing the research.

Administration of Pre-test

One week was used for the administration of the pre-test using the following instruments

i. . Problem Solving Skill Student Test on Ecological Concepts (PSSEC)

ii. Cognitive Style Test (CST)

Treatment

The study involved two treatments and one control group. Each of the groups consist of students of varying cognitive styles (Analytical & Non Analytical) Each group was exposed to one of the instructional strategies highlighted below.

i. Experimental group 1 Meaning focus Strategy
ii. Experimental group 2 Practice and Invention Strategy
iii. Control group-modified Conventional strategy

A. Procedure for Experimental Group 1 – Meaning focus strategy Steps Involved

- Teacher emphasises the meaning of ecological concepts
- Teacher emphasises, the implication of the concepts
- Students reflect on specific life situation e.g. population, pollution
- Students connect new ideas and skills to past knowledge and experience.
- Students give feedback through corrections from teachers
- Teachers design new techniques of construction
- Students develop skills in problem solving.

B. Procedure for Experimental group 2 practice and Invention strategy

- Teacher provides tasks that require reasoning
- Teacher introduces the lesson to rediscover necessary concepts necessary
- Students are provided with opportunity for reflection
- Students give alternative approaches in solving situations
- Teacher stimulates students for further problem solving and instruction
- Students are given the opportunity to share experiences
- Teacher gives more problems and encourages student to solve it.

C. Procedure for Control Group 4 Modified Conventional Teaching Method Steps Involved

The teacher

- Introduces the lesson
- Discusses the content of the lesson.
- Writes the note on the chalkboard.
- Asks students to copy in their note books.
- Gives an overview of the lesson
- Evaluates the lesson by asking questions from students
- Concludes the lesson by giving homework.

Administration of Post-test

Post test were administered on all the groups (i.e. both experimental groups and the control group) at the completion of treatments. The instruments used for the post-test was PSSTEC.

Data Analysis

The data obtained from the study was analysed using the inferential statistics of Analysis of Covariance (ANCOVA). This determined the group differences using the pre-test scores as covariates. Estimated Marginal Mean (EMM) was used to find out the magnitude of the difference in the various groups. To determine the actual source of the significant difference, Scheffe post hoc Test was performed on the mean scores of the groups.

Results

HO1: There is no significant main effect of treatment on senior secondary students' problem solving skills in ecology.

Table 2 represents the summary of ANCOVA results on subjects' post test Problem solving skills scores.

Table 2: 3 x 3 x 2 ANCOVA of post-test Problem solving skills scores of students by treatment, Cognitive style and Gender in Ecology

Source	Sum of Squares	DF	Mean Square	F	Sig.	Eta Squared
Corrected Model	2757.224	12	229.769	25.374	.000	.646
Pre Problem solving	6.938	1	6.938	1.085	.299	.005
Main Effect:						
Treatment Group	704.604	2	352.302	55.116	.000	.318
Cognitive style	34.214	1	34.214	2.676	.071	.022
Gender	8.402	1	8.402	1.315	.253	.006
2-way Interactions:						
Treatment x Cognitive style	51.752	2	25.876	2.024	.092	.033
Treatment x Gender	21.720	2	10.860	1.699	.185	.014
Cognitive style x Gender	1.912	1	1.912	.150	.861	.001
3-way Interactions:						
Treatment x Cognitive style x Gender	21.704	2	10.852	1.132	.337	.014
Error	1508.508	242	6.107			
Total	4265.732	254				

The result shows that there was a significant main effect of Treatment groups on the students' posttest Problem solving skills scores ($F(2,242) = 55.116$, $P<.05$, $\eta^2 = .318$). The effect size of 31.8% was fair. Therefore null hypothesis is rejected. This means that there was a significant main effect of treatment on the mean problem solving skills scores of subjects exposed to treatment on the basis of these findings, hypothesis 1 was rejected. To find out the magnitude of the mean scores of the group's performance the table 3 is presented as follows:

Table 3: Estimated Marginal Means of Posttests Problem solving skills Scores by Treatment and Control Group.

Treatment Groups	N	Mean	Std Error
Meaning focus Strategy	83	13.893	.368
Practice and Invention Strategy	79	14.815	.300
Conventional Strategy	92	8.139	.439

From the above table 3, Practice and Invention Strategy had the highest Problem solving skills mean score of ($\bar{x}$ = 14.815) followed by Meaning focus Strategy by ($\bar{x}$ = 13.893) and lastly followed by Conventional Strategy ($\bar{x}$ = 8.139).
Further, the source of the significant difference obtained in Table 3. was traced using Scheffe post-hoc test in table 4.

Table 4: Scheffe Post-hoc tests analysis of Post-tests Problem solving skills Score according to Treatment Group.

Treatment	N	Mean	Meaning focus Strategy Strategy	Practice and Invention Strategy	Conventional strategy
Meaning focus Strategy	83	13.893		*	*
Practice and Invention Strategy	79	14.815	*		*
Conventional strategy	92	8.139	*	*	

Pairs of groups significantly different at P <0.05

The result form post-hoc analysis in Table 4 revealed that group 1 (Meaning focus Strategy) was significantly different from Practice and Invention Strategy and Conventional strategies in their Problem solving skills scores. Practice and Invention Strategy was significant different from Meaning focus Strategy and Conventional strategies in Problem solving skills scores, These reveals the direction of increasing effect of instructional strategies (treatment) on Ecology Problem solving skills , with Conventional strategy not performing better than Meaning focus Strategy, Meaning focus Strategy not performing better than Practice and Invention Strategy.

Ho2: There is no significant main effect of cognitive style on senior secondary students' problem solving skills in ecology.

The results in table 2 showed that there was no significant main effect of cognitive style on the Posttest Problem solving skills results of students in Ecology ($F(2,242)$ =2.676, $P>.05$, η^2 = .022). The effect size of 2.2% was negligible. Therefore, hypothesis 2 was not rejected.

Table 5 Estimated marginal means of posttest Problem solving skills by Cognitive style

Cognitive style at 2 Levels	N	Mean	Std Error
Non Analytical	137	11.884	.231
Analytical	117	14.005	.284

From the table 5, Analytical students had higher mean score of (14.005) followed by those with Non Analytical (11.884), but the differences in their mean values was not significant.

Discussion

There was a significant main effect of treatment on the mean problem solving skills scores of subjects exposed to Meaning focus Strategy and Practice and Invention Strategy. Teachers that want adeptness in problem solving, must allow students to practice problem solving activities. Using Practice and Invention, students work must include tasks that require such reasoning, and the competence in procedures that is stated in the objective and the curriculum include attention to such procedure in which the Science teacher grasp the interest of science students when problem solving skills is developed by the students. This research corroborates the work of Lucas and Dooley,(2006) that revealed concentrated efforts on fostering desirable problem solving skills in science and the teaching of science in the learner makes the teacher to get relevant information on what to teach? When a Biology teacher is sufficiently prepared in terms of his problem solving skills, quality, materials and methods, there is tendency for learners to develop problem solving skills in his or her subject (science). Problem solving skills in science is closely related to achievement in science (George, 2000). Problem solving skills science predicts achievement in science (Kan and Akbas, 2006).. The problem solving skills of the teachers, to a large extent, affects achievement of students in science (Adetunji, 2000; Abram, 2004).

The findings from okurumeh (2009) shows that, when students discover ideas and invent procedures, they have a stronger conceptual understanding of connections between the ideas. Dorothy and Louisa (2003) also revealed that using. Teachers that are undertaking research-based study tended to be more positive about research (80.6% positive). Those who had undertaken action research at some time also tended to be more positive (66.4% positive). Teachers disposition to research work opens them to practice and invention phenomenon in their profession. Meaning focus strategy performed better than Conventional strategy. Typical way of processing information and creating meaningful association is to think about how the information can be personally meaningful. According to Prabhu (2007) students learn best when classroom time is spent on doing meaning focused activities such as information, reasoning and opinion gap task. Investigations have consistently shown that emphasis on teaching for meaning has positive effects on students learning, including better initial learning, greater retention and increased likelihood that the ideas will be used in new situations (Grows and Cebulla., 2000). According to Ige, (2001),Student's cognitive styles have been found to mediate learning, most of the differences encountered in students' learning could be described in terms of different manners in which students perceive and analyze a stimulus configuration (i.e. their cognitive styles). Each individual responds differently when exposed to a stimulus world. Some act on first impulse, some examine isolated components of what is presented to them before responding while others respond on the basis of contextual or holistic manner (Awolola, 2009). This calls for its better understanding by the teacher in his/her choice and usage of teaching strategies.

Conclusion

The results of this study showed that Meaning focus, Practice and Invention strategies enhanced students 'problem solving skills in ecology. The increase in the problem solving skills might be attributed to the fact that the instructional strategies encouraged student-to-student interaction thus enhancing learning through group cooperation. In addition, the students' interest in the subject was enhanced and left a positive effect on their problem solving skills. The results also showed that Cognitive style of the students though not significant effect should be considered when selecting strategies for teaching students. The teachers should devote more time to students from Non analytical background whenever Meaning focus, Practice and Invention strategies are used for teaching.

Implications of Findings

The following are the implications of the findings of this study based on the research results.

- The concepts of Ecology in Biology are better taught using Meaning focus, Practice and Invention strategies Instructional Strategies which encourage active involvement of students than the conventional strategy.
- The study also showed that Practice and Invention strategy serves as the best teaching guide followed by Meaning focus strategy while conventional strategy is least advised for teaching Ecology concepts in secondary schools.
- Irrespective of the Cognitive style of the students, if Meaning focus, Practice and Invention strategies are employed in teaching, they (students) would benefit equally in the learning process.

Recommendations

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

- The two instructional strategies, Meaning focus, Practice and Invention, have been shown to be more effective in imparting Problem. Therefore, these teaching strategies are recommended for teachers of secondary school students.
- Practice and Invention strategy is recommended for teachers' use when it comes to imparting skills that are meant to be functional, skills that are needed to be applied in the day-to-day activities of students. Meaning focus, Practice is better used when the teacher is interested in developing the less achievers in the class because each student in a team is made to give his/her point in the discussion. The strategies are advantageous to teachers in that the teacher talk less while the students participate actively in the lesson.
- It is recommended that workshops or seminars should be organized for teachers regularly on the use of Meaning focus, Practice and Invention strategies in teaching learning process

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