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Effect of Analogy on the Understanding of the Concept of Osmosis among Secondary School Students in Minna, Niger State, Nigeria.

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Abstract

The study examined the "Effect of analogy on secondary school students understanding of the concept of Osmosis in biology". The increase in the inability of students to cope with and comprehend basic science concepts necessitated the search for a more effective teaching strategy to improve students' understanding and performance. A total of 160 students in senior secondary class two (SS II) randomly selected from four secondary schools in Minna metropolis made up the sample for the study. SS (II) students from two schools formed the experimental group. They were taught the concept of osmosis using Teaching With Analogy (TWA) model while students from the other two schools that formed the control group were taught the same concept using the traditional teaching method. The study instrument (TWA) was validated and its reliability determined as 0.91. Pretest-Posttest Experimental-Control Group design was used for the study. Analysis of data revealed that analogy was a more effective instructional strategy than the traditional teaching method. In enhancing students' understanding of the concept of Osmosis in biology as indicated by experimental group mean scores after the treatment. There was no gender difference observed. Based on these findings, recommendations were made for adoption of analogy as an instructional strategy at all levels of educational system.

Key Word: Analogy, Concept, Effect, Osmosis, Senior Secondary Students and Niger State.

Introduction

Biology is a branch of science dealing with living things. It seeks to explain the nature, structure, function as well as roles of living organisms in their environments. Abu (1998) and (2000) in discussing the usefulness of biology to man stated that the study of biology enables people to be aware of their changing environment and the need to contribute positively to national development. The knowledge of biology is also relevant in the study of medicine, dentistry, veterinary science, agriculture and biotechnology. Biology is one of the core and compulsory subjects for all students in Nigerian Senior Secondary Schools. The current biology curriculum used in secondary schools emphasized the need for biology to be taught sequentially from simple to complex concepts. It further emphasized that during biology instruction, the language should be simple and precise, biological terms clearly defined, concepts properly illustrated with local examples, diagrams, charts and tables clearly labeled and relevant activities used (Ndu, Edwards, Danquah and Ezenkwe, 1999).

Inspite of the (i) richly designed biology curriculum (ii) tremendous importance of biology to mankind and (iii) effort of biology teachers to help students perform well in biology, evidence continue to abound that little achievement has been made in terms of students' understanding and performance in biology especially at the Secondary School Certificate Examination (SSCE). The West African Examination

Council, Chief Examiners' report (1992, 1998 and 2000) revealed that biology students performed below average.

Many reasons have been adduced for these problems. Some of the identified causes of the problems include: abstractness of concepts (Nkadi, 2000); inadequate equipments (Fafunwa, 1990) and inefficient teaching method (Balogun, 1982; Okebukola, 1992 and Ajewole, 1997). Gana (1998) reported that many secondary school biology students exhibited a high level apathy towards ecology, plant systematic, genetics and evolution because they found these areas abstract, uninteresting or difficult to understand. All these lead to poor performance of students at the SSCE. Fafunwa (1990) pointed out that the scientific equipments have not been adequately provided to schools by government. Most public schools operate without standard scientific equipment, hence, rendering science instruction ineffective. Ogunniyi (1988) opined that teachers' method of teaching science hinder students' understanding of scientific concepts. Oyedokun (1983), Jegede (1996) and Akinyemi (1997) amongst others asserted that students' performance in science is on the decline due to teachers' poor method of teaching. Balogun (1982), Okebukola (1992) and Ajewole (1997) stated that science teachers still use mainly the traditional method of teaching. This method has not aided meaningful learning of science especially biology.

In search for a better way to improve biology learning, Okebukola (1998) listed various methods which seemed to bring about meaningful learning to include vee-mapping, concept mapping, analogy, co-operative learning and problem solving to mention just a few. However, the use of analogy seems to be gaining ground in the area of biology instruction (Allan, 1992; Lagoke, 1992; Lagoke, 1997; Susan, 2001 and Abimbola, 2001).

Analogy has been defined in many ways by various experts. It has been defined as similarities; as mapping of knowledge; as correspondence and as comparison. Glynn (1991) viewed analogy as a process of identifying similarities between two concepts, the familiar concept (analog) and the unfamiliar concept (target). Gentner (1983) defined analogy as mapping of knowledge from one domain (the base) to another as a correspondence between concepts, principles or formulas otherwise dissimilar. Treagust, Duit, Joslin and Lindauer (1992) described analogy as comparison of structure of two conceptual domains. They all agreed that analogy is a systematic method, which involves mapping of knowledge from the familiar concept (analog) to the unfamiliar concept (target).

Many researchers reported that the use of analogy as an instructional strategy improved the learning and understanding of scientific concepts and led to better performance of the students (Gentner, 1983; Glynn, 1988; Duit, 1991; Lagoke, 1992; Brown, 1994; Lagoke, Jegede and Oyebanji, 1997; Lagoke, 1999; Nkadi, 2000; Esiobu, 2000 and Susan, 2001). The use of analogy in enriching the teaching of biology in Nigerian Secondary schools has been shown also to arouse students' interest and imagination which could lead to understanding and retention of concepts (Lagoke, 2000). The use of analogy in teaching has been shown to

help make the previously learned structural and organizational knowledge interact constructively with the new challenging experiences, hence misconceptions in learning could be avoided.

This research study therefore focused attention on effect of analogy on secondary school students' understanding of the concept of Osmosis in biology. Specifically, the study was designed to address the following research questions: Will the use of analogy in teaching the concept of Osmosis in biology:

(i) result to better understanding of the concept of osmosis in biology by secondary school students than when traditional method is used?

(ii) result in differential understanding by male and female students taught with analogy?

Based on the above research questions, the following null hypotheses were formulated and tested at the 0.05 significant level.

HO_1. There is no significant between the mean scores of students taught with analogy and the traditional methods.

HO_2. There is no significant difference between the mean scores of male and female students taught with analogy and the traditional methods.

Methodology

Design: The design for the study was the Pretest-Posttest Experimental – Control Group design. The experimental stimulus (analogy) was withheld from the control group and used on the experimental group. Bo groups were first pre-tested, thereafte the experimental group was taught th topic "Osmosis" using Teaching-Wi Analogy (TWA) model of Glynn (199 while the control group was taught th same topic using the traditional teachin method. After the treatment, a postte same as pretest consisting of fifty ite achievement test on Osmosis wa administered to both groups.

Sample and Sampling Techniques:

The subjects comprised of on hundred and sixty (160) students (8 boys and 80 girls) from four secondar schools randomly selected in Minna Niger State. The four schools used ar Niger State government owned co- educational schools. The students o two schools (Bosso Secondary School Bosso and Day Secondary Schools Tunga) were randomly assigned t experimental group while those of th other two schools (Government Da Secondary School, Minna and Government Day Secondary School Maikunkele) were assigned to control group. From each school, an intact class of 40 (20 boys and 20 girls) Senior Secondary II (SS II) students was used.

Instrumentation

The instrument used for the study was a 50-Multiple Choice Test Items on Osmosis (MCTIO) drawn from past question papers of Senior Secondary Certificate Examination (SSCE) O' Level conducted by West African Examinations Council (WAEC) and National Examinations Council (NECO). The instrument was validated by three experts in biology and the reliability coefficient was determined as 0.91 using the test-retest method.

Data Collection:

by three experts in biology and the reliability coefficient was determined as 0.91 using the test-retest method.

Data Collection:

Before the commencement of the study, a pretest was administered to both groups to determine whether they were equivalent with respect to their previous knowledge of the concept of Osmosis in biology. The researcher personally handled the teaching in all the classes for five weeks. The experimental group was taught the topic 'Osmosis' using Teaching-With-Analogy (TWA) model while the control group was taught the same topic using traditional teaching method. The Teaching With Analogy (TWA) model used consists of six sequential stages, which are:

i. introduce the target concept,
ii. recall of the analogy,
iii. identify the similar features of analog and target,
iv. map out the similarities between the analog and target,
v. identify where the analogy breaks down, and
vi. draw conclusion.

The teaching of the experimental group followed the six stages of the TWA model. A posttest same as pretest was given to both groups at the end of the treatment to determine whether there were differences in their mean scores. The scores from the test formed data for testing the study hypotheses, t-test statistics was used to analyze the data collected.

Result and Discussion

Table 1: Pretest Performance of Experimental and Control Groups.

Group	N	DF	$\bar{X}$	SD	t-value calculated	t-value critical	P
Experimental	80	79	23.58	5.11	0.81^{ns}	1.67	0.423
Control	80		24.38	6.57			

ns = Not significant at the 0.05 level.

Table 1 presents the t-test result of the pretest for the experimental and control groups. From the table, the calculated t-value (0.81) is less than the t-value critical (1.67). This indicates that there is no significant difference between the mean score of the experiment group (23.58) and that of the control group (24.38) at the 0.05 significant level ($P>0.05$). This therefore, meant that the students in both groups were found to be equivalent with respect tot heir prior knowledge of the concept of osmosis in biology before the teaching treatment.

Posttest Result for Experimental and Control Groups

HO_1. There is no significant difference between the mean scores of students taught with analogy and the traditional teaching methods.

Table 2: t-test Result of Experimental and Control Groups on Posttest Scores

Group	N	DF	$\bar{X}$	SD	t-value calculated	t-value critical	P
Experimental	80	79	71.23	8.46	18.98*	1.67	0.001
Control	80		47.75	8.90			

* = Significant at the 0.05 level.

From table 2, the mean score for the experimental group was 71.23 and that of control group, 47.75. The calculated t-value of 18.98 is greater than the t-value critical (1.67). This indicates that there is statistical significant difference between the mean scores of the experimental group (71.23) and control group (47.75) at the 0.05 level ($P<0.05$). The experimental group exposed to analogy teaching performed significantly better than the control group that was taught without analogy. This result is in consonance with the findings of Solomon (1987) and Glynn (1989) that students taught with analogy performed better than those not taught with analogy. Therefore, the research hypothesis that there is no significant difference between the mean scores of students taught with analogy and the traditional teaching method was rejected.

Performance According to Gender

HO_2. There is no significant difference between the mean scores of male and female students taught with analogy and the traditional teaching methods.

Table 3: t-test Result of Posttest Scores of Male and Female Students in the Control Group.

Group	N	DF	$\bar{X}$	SD	t-value calculated	t-value critical	P
Male	40	39	47.60	9.30	0.13^{ns}	1.68	0.897
Female	40		47.90	8.60			

ns = Not significant at the 0.05 level.

From table 3, the calculated t-value of 0.13 is less than the t-value critical of 1.68. This indicates that there is no statistical significant difference between the mean score of the male students (47.60) and female students (47.90) at the 0.05 level, ($P>0.05$).

Table 4: t-test Result of Posttest Scores of Male and Female Students in the Experimental Group.

Group	N	DF	$\bar{X}$	SD	t-value calculated	t-value critical	P
Male	40	39	71.80	9.43	0.98^{ns}	1.68	0.335
Female	40		70.40	7.28			

ns = Not significant at the 0.05 level.

Table 4 revealed that the calculated t-value of 0.98 is less than the t-value critical of 1.68. This indicates that there is no statistical significant difference between the mean scores of the male students (71.80) and that of the female students (70.40) at the 0.05 level (P>0.05). Therefore, the research hypothesis that there is no significant difference between the mean scores of male and female students taught with analogy and the traditional teaching method was not rejected. This result is not in consonance with the findings of Jegede, et al., (1989) and Lagoke (1992) who found differences in the performance of boys and girls. The difference could be attributed to the class of students used. The results in table 3 and 4 therefore show that there is no significant difference in the understanding of the concept of osmosis by boys and girls in the control and experimental groups. In other words, the teaching method used (analogy) did not affect boys and girls differently.

Findings and Conclusions

The major findings of the study were that:

(i) exposure of secondary school students to teaching with analogy model significantly improved their understanding of the concept of osmosis in biology as the mean score of the experimental group on posttest scores (71.23) was more than that of the control group (47.75).

(ii) There was no significant difference in the performance of boys and girls exposed to the teaching with analogy model.

In the light of the above major findings, if the exposure to analogy of the students used for the study and in such a limited period of time could result in such a striking performance, it stands to reason that under normal classroom setting, analogy as an instructional teaching method would prove to be very efficient and effective in improving students' understanding and performance.

Recommendations

To ensure effective use of analogy, it is therefore recommended that:

(i) The use of analogy as a teaching strategy be adopted by science teachers in Nigerian secondary schools.

(ii) Government should organize and sponsor teachers to attend training courses on the use of analogy as an instructional strategy.

(iii) Science teachers should study and harness appropriate and familiar analogies in their teaching to enhance better understanding of science concepts. This will reduce misconceptions by students.

(iv) Teachers should be conversant with previous knowledge of students and make efforts to build on them.

(v) Teachers should plan properly their lessons before teaching to avoid mix up of the operational stages involved in the use of analogy.

(vi) In the lesson plan, teachers should cue in the analogy at

appropriate points and provide opportunity for students to identify the shared attributes between the analogy and the target.

(vii) Teachers should encourage students to identify where analogy breaks down (unshared attributes between the analogy and the target) so that they can discover the limitations of analogy by themselves.

(viii) Teachers should evolve an effective procedure of evaluating students' understanding of their teaching in order to find out the effectiveness of the analogies used in classroom instruction.

(ix) Government should motivate teachers by raising their status and increasing their monthly payment. This will encourage them to stay in the teaching profession and discharge their duties effectively.

(x) Authors should use relevant and familiar analogies for presenting specific concepts and principles in science textbooks. This will make students' learning more meaningful as the familiar analogy in the book will encourage them to read on their own.

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