EFFECTS OF THE USE OF METAPHOR ON SENIOR SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN CELL STRUCTURE IN ILORIN, NIGERIA

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Abstract

This study examined the effects of the use of metaphor on senior secondary school students' achievement in cell structure in Ilorin, Nigeria. The study adopted the quasi-experimental design of the pre-test, post-test, non-randomized, control group. The 380 students that participated in the study were drawn from eight intact classes of two purposively selected co-educational senior secondary schools in Ilorin, Kwara State, Nigeria. The response instruments were Field-dependent/Field-independent Biology Figure Sorting Test and Cell Achievement Test with reliability indexes of 0.87 and 0.82 respectively. The research questions were answered using mean while the three corresponding null hypotheses were tested using t-test statistics. The findings revealed that Metaphor significantly improved students' achievement in cell structure. However, no significant difference was found in the achievement of male and female student taught cell structure using metaphor. A significant difference was observed in the achievement of students based on their cognitive styles in favour of the field independent students. The researchers recommend that biology teachers should employ metaphor in the teaching of cell structure and other concepts considered difficult to understand by the students.

Keywords: Metaphor, cell structure, achievement, gender, cognitive styles.

Introduction

Biology is a natural science subject that deals with the study of living organisms and life, including their structure, distribution, growth, function, taxonomy and evolution (Gorgeous, 2013). As a field of study, biology has remained a fundamental science subject taught at the senior secondary school level of education in Nigeria (Federal Republic of Nigeria, 2013). The importance of biology cannot be over-emphasized, because it constitute a core requirement in many fields of study such as medicines, pharmacy, nursing, agriculture, biotechnology, nanotech-nology, forestry, and many other areas that has contributed immensely to the scientific and technological growth of many nations (Ahmed & Abimbola, 2011).

Moreover, biology is undoubtedly an essential discipline because it does not stop at looking for solutions to the different environmental issues but also significant for the successful existence of

human on earth (Adeoye & Abimbola, 2016). The knowledge of biology has also aided the acquisition of problem-solving and decision-making skills that had enhanced the development of inquiry and critical thinking abilities of several individuals as reflected in the positive responses of several people to the widespread and radical changes in all ramification of life.

Nevertheless, biology education has faced lots of challenges for decades and this is evident in the West African Examinations Council Chief Examiners' Report (2015) which indicated that students' achievement has shown little improvement over the years despite the high level of enrollment relative to other science subjects such as chemistry and physics. The various factors and causable variables adduced for the unremarkable achievement of students in biology included learning barriers, students study habits and non-usage of appropriate and innovative instructional strategies by biology teachers (Adeoye & Abimbola, 2016; Ebele & Olofu, 2017; Tanner, 2013).

Adesoji and Olatunbosun (2008) specifically observed that, oftentimes, most science teachers in Nigeria senior secondary schools employ the lecture method over learner-centred and innovative instructional strategy. Piaget (1977) had earlier affirmed that the construction of knowledge by students and the overall mastery of subject matter is based on the adoption or adaptation of suitable instructional strategies that marches learners mental and chronological ages. This is because the success of classroom instruction begins and end with the deployment of appropriate instructional strategies by teachers. Meanwhile, the results of research studies on the level of awareness and trends of deployment of innovative instructional strategies during classroom activities have indicated a poor level of teachers awareness and utilisation of innovative instructional strategies such as choral response, field trip, models, study aids and metaphor (Achor, Samba & Ogbeba, 2010; Oyelekan, Igbokwe & Olorundare, 2018).

Metaphor is a figure of speech in which words or phrases that should ordinarily describe one thing are used to describe other things, and as such makes comparison more explicit (Your Dictionary, 2016). The use of metaphor is prevalent in everyday life including in thoughts and actions, and it goes beyond being a literary device used only in languages, as it is used by all categories of people including scientists, in explaining research findings to members of the scientific world (Lakoff & Johnson, 1980). Therefore, metaphors can be used to describe objects by creating mental images shared in common by such objects (Fredriksson & Pelger, 2016).

Pramling (2011) observed that the use of metaphor could enhance science teaching and learning; promote higher-level thinking; and yield new tools for interpreting science education researches. This is because metaphor provides detailed explanation of concepts, ideas or

events in an ordinary style of expression understood by students (Wikipedia, 2017). Several researchers in the field of science education have established the effectiveness of metaphor in the teaching and learning of different biology concepts.

For instance, Awofodu (2016) discovered that metaphor instructional strategy enhanced students' cognitive achievement and practical skills in ecology after a study on the differential effect of metaphors and problem-solving strategies on senior school students' achievement in ecology. In addition, findings from the study of Gregory and Campbell (2001) revealed that metaphor instructional strategy enhanced students' metacognition in chemistry. In contrast, the present study investigated the effects of the use of metaphor on senior school students' achievement in cell structure.

Cell structures are components adapted and/or specialized in carrying out specific functions necessary for normal cellular activities. The cell constitutes the basic unit of structure, physiology, and organization in living organisms. However, there are varieties of differentiated internal structures known as organelles that performs the functions of maintaining the cell. These organelles include Mitochondria, Cytoplasm, Cell membrane, Endoplasmic reticulum, Nucleus, Golgi bodies, Ribosomes, Vacuoles and many more (Wikipedia, 2017). As a topical content in the senior secondary school biology curriculum, cell structure, falls under the theme organization of life (Federal Ministry of Education, 2009). The content scope of the present study – cell structures, is borne out of the observed difficulty of cell structures and related biology topics by the West African Examinations Council Chief Examiners' Report (2016, 2018).

The influence of gender on the teaching and learning of biology has been of interest to researchers in the field of science education. This is partly due to the fact that there seem to be no consensus in the views of researchers on the achievement of male and female students in biology. In fact, there are studies (Badmus, Bello, Hamzat, & Sulaiman, 2019; Ibrahim, 2020; Kingdom-Aaron, Etokeren, & Okwelle, 2019) that have established that gender is not a significant factor in determining students' achievement in biology while others believed that gender greatly influences how well, or poorly students perform in biology (Anchor, Kurumeh & Orokpo, 2012; Otor, 2013). Since there is no agreement on the influence of gender on students' achievement in biology, the present researchers deem it an important independent variable to investigate in other to affirm the gaps emanating from previous studies.

Cognitive styles of learners as field dependent and field independent individuals is another variable whose influence on learners' achievements has been investigated in several studies. Cognitive style relates to the way each learner processes information (Williamson & Watson, 2006; Witkin, Oltman, Raskin & Karp, 2002). Studies have indicated that

cognitive style significantly influences students' achievement in different subject areas (Ashiru & Sadiq, 2016; Idika, 2017). Conversely, Okoye (2016) posited that cognitive style was not a significant factor in relation to the achievement of field-dependent and field-independent students in biology. In the present study, the field-dependent and field-independent categorization of learners was also adopted as obtained in many existing studies, however, it was based on students' achievement in cell structure.

Purpose of the Study

The main purpose of this study was to investigate the effects of the use of metaphor on senior secondary school biology students' achievement in cell structure in Ilorin, Nigeria. Specifically, the study determined the:

1. difference in the achievement of senior secondary school students taught cell structure using metaphor instructional strategy and those taught without metaphor instructional strategy.
2. influence of gender on biology students' achievement when taught cell structure using metaphor instructional strategy.
3. influence of cognitive style on biology students' achievement when taught cell structure using metaphor instructional strategy.

Research Hypotheses

The following hypotheses were generated from the research questions and tested in this study:

H_{01}: There is no significant difference in the achievement of senior secondary school students taught cell structure using metaphor instructional strategy and those taught without metaphor instructional strategy.

H_{02}: There is no significant difference in the achievement of male and female students when taught cell structure using metaphor instructional strategy.

H_{03}: There is no significant difference in the achievement of students based on their cognitive styles when taught cell structure using metaphor instructional strategy.

Methods

This study adopted the quasi-experimental research design. Particularly, the pre-test, post-test, control group, non-equivalent and non-randomized design was adopted for the study. The population consisted of all senior secondary school students offering biology in Ilorin, Kwara State Nigeria. However, the target population comprised of eight intact classes of senior secondary school biology students in first year in Ilorin, Nigeria. Two co-educational senior schools in Ilorin were randomly selected for the study while the sample consisted of 380 Senior Secondary School one students (SSS 1). The response instruments used for data collection were Field dependent/Field independent Biology Figure Sorting Test (FDIBFST) and Cell Achievement Test (CAT). The CAT comprised of 20 questions on cell structure while the FDIBFST (used to categories students into the Field

dependent and Field independent groups) was adapted from Witkin, Oltman, Raskin, and Karp (2002), and Adamu (2010).

The content, construct and face validity of the instruments were determined by two senior secondary school biology teachers, two biology education experts and a plant Biologist from the University of Ilorin. A reliability index of 0.87 and 0.84 were obtained for the FDIBFST and CAT, respectively using the test-retest method and Pearson product-moment correlation statistical tool. At the commencement of treatment administration, the researchers sought the consent of the students' and their biology teachers (who were trained and involved as research Assistants) through informed consent forms. The study lasted for five weeks out of which the pre and posttest were administered in the first and fifth weeks while treatment administration took place in second, third and fourth weeks. The research questions were answered using descriptive statistics of the mean and standard deviation, while the hypotheses were tested using *t*-test statistics at 0.05 level of significance.

Results

Hypothesis One: There is no significant difference in the achievement of senior school students taught cell structure using metaphor instructional strategy and those taught without metaphor instructional strategy.

Table 1: *Mean gain difference for the Experimental and Control group*

Groups	*N*	Pre-test (*M*)	Pre-test SD	Post-test (*M*)	Post-test SD	Mean gain
Experimental	193	29.14	15.10	43.18	14.21	14.04
Control	187	40.00	10.87	42.46	12.02	2.46

Table 1 revealed that students in the experimental group exposed to metaphor instructional strategy had a higher mean gain score (14.04) than students in the control group (2.46). This was deduced from the pre-test and post-test mean scores of (29.14 and 43.18) and (40.00 and 42.46) obtained for the experimental and control groups, respectively. This shows that the mean gain score of the experimental group was higher than that of the control group with a difference of 11.58, in favour of the experimental group exposed to metaphor instructional strategy.

Table 2: *t-test Analysis of the Control and Experimental Groups*

Group	N	*M*	SD	*df*	*t*	Sig.
Experimental	193	43.18	14.21			
				382	0.50	.00
Control	187	42.46	12.02			

p < 0.05

Table 2 indicated that when $t_{(382)} = .50$, $p < .05$. Hence, hypothesis 1 was rejected since $p < .05$. This implies that there was a significant difference in the achievement of senior school students taught cell structure using metaphor instructional strategy and those taught without metaphor instructional strategy.

Hypothesis Two: There is no significant difference in the achievement of male and female students when taught cell structure using metaphor instructional strategy

Table 3: *Mean and Standard Deviation Distribution of Students Achievement Based on Gender*

Gender	*N*	*M*	SD	Mean Difference
Male	106	42.22	11.11	0.94
Female	87	43.16	13.97	

Table 3 showed that the mean score of the male ($M = 42.22$) and female ($M = 24.16$) students taught cell structure using metaphor instructional strategy was homogeneous. This suggest that there was no disparity in biology students' achievement taught cell structure using metaphor instructional strategy based on gender.

Table 4: *t-test showing the Achievement of Students Base on Gender*

Gender	*N*	*M*	SD	*df*	*t*	Sig.	Decision
Male	106	42.22	11.11				
				191	0.89	.38	NS
Female	87	43.18	13.97				

p > 0.05

Table 4 revealed that the calculated *t*-value was not significant at 0.05 alpha level of significance ($t_{(191)}$ = .89, p = .38). This indicates that there was no significant difference in the achievements of male and female students taught cell structure using metaphor instructional strategy. Hence, hypothesis two was not rejected.

Hypothesis Three: There is no significant difference in the achievement of students based on their cognitive styles when taught cell structure using metaphor instructional strategy

Table 5: *Mean and Standard Deviation Distribution of Students Achievement Based on Cognitive Styles*

Cognitive styles	*N*	*M*	SD	Mean Difference
Field Dependent	100	36.13	9.50	26.81
Field Independent	93	62.94	9.80	

Table 5 indicated that the mean score of the field-dependent (M = 36.13) students taught cell structure using metaphor instructional strategy was less than those of the field-independent (M = 62.94) students. This result suggests that metaphor instructional strategy favoured the field-independent students more than the field-dependent students.

Table 6: *t-test showing the Achievement of Students Base on Cognitive Style*

Cognitive styles	*N*	*M*	SD	*df*	*t*	Sig.	Decision
Field Dependent	100	36.13	9.50				
				191	-19.72	.00	S
Field Independent	93	62.94	9.80				

p < 0.05

Table 6 revealed that there was a significant difference in the achievement of field-dependent and field-independent students taught cell structure using metaphor instructional strategy in favour of the field independent students ($t_{(191)}$ = -19.72; p < .05). Hence, hypothesis 3 was rejected.

Discussion

The first finding of this study revealed that a significant difference existed in the achievement of students in the experimental and control groups in favour of students in the experimental group that were exposed to metaphor instructional strategy. Although, the pre-test score of the control group was higher (due to their pre-exposure to the content before the research), the mean gain score, however, indicated a low rate of achievement. The experimental group, on the other hand, had not been taught the content before the period of the study. Hence, they had a low pre-test achievement but a significantly high post-test mean score after exposure to metaphor instructional strategy. The implication of this is that the exposure of students to instruction using metaphor instructional strategy assisted them to learn cell structure meaningfully and thus, resulting in a better achievement. This finding is in agreement with those of Pramling (2011), Awofodu (2016) and Aboyeji (2019) who concluded in their various study that metaphor is an effective tool for facilitating and enhancing students' achievement.

The second finding of this study indicated that there is no significant difference in the achievement of male and female students' taught cell structure using metaphor instructional strategy. This finding may be attributed to the active involvement of both male and female students in the class sessions without any form of discrimination from the research assistants. The result implies that metaphor is gender friendly; thus, it can be used in coeducational institutions or mixed-gender classroom. This result tallies with the findings of Badmus, Bello, Hamzat, and Sulaiman, (2019); and Ibrahim, (2020) that students' achievement in biology is not affected by students' gender. However, the finding is contrary to those of Anchor, Kurumeh and Orokpo (2012); and Otor (2013) who identified gender as a significant factor affecting students' achievement in biology.

The third finding of this study revealed that there was a significant difference in the achievement of field-dependent and field-independent students taught cell structure using metaphor instructional strategy in favour of the field independent students. This finding may be due to the ease in information processing skills of the field-independent students which might have enhanced their achievement over the field-dependent students. This finding implies that metaphor instructional strategy alone cannot facilitate the achievement of field-dependent learners. This finding is in consonance with the findings of Ashiru and Sadiq (2016); and Idika (2017) but contrary to Okoye (2016) who identified cognitive style as a non-significant factor in determining students' achievement in biology.

Conclusion

The study concluded that metaphor enhanced students' achievement in cell structure. In addition, there was improvement in students' achievement irrespective of their gender when taught cell structure using metaphor instructional strategy. Furthermore, a significant difference was observed in the

achievement of students based on cognitive styles in favour of students belonging to field-independent cognitive style. Thus, metaphor can be used to facilitate students' achievement and understanding of cell structure and by extension other biology concepts.

Recommendations

The following recommendations are put forward based on the findings of the study:

i. Biology teachers should employ the use of metaphor in the teaching of cell structure and other hard to teach or difficult to learn biology concepts.
ii. Metaphor should be used in presenting instructions to students' irrespective of their gender because it is gender friendly.
iii. Metaphor instructional strategy alone cannot facilitate the achievement of field-dependent learners. Thus, other innovative teaching and learning strategies should be used in conjunction with metaphor to cater effectively for the field-dependent learners.

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