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Cognitive styles as correlate of secondary school students' academic achievement in biology in Awka education zone, Anambra state

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Abstract
Biology is one of the important subjects taught in secondary schools in Nigeria, but has witnessed poor achievement by students. Teachers are faced with the need to look out for cognitive styles that could enhance learning, in order to improve students' academic achievement. This study investigated cognitive styles as correlate of secondary school students' academic achievement in Biology in Awka Education Zone, Anambra State. Two research questions guided the study and two null hypotheses were tested. The study adopted a correlational research design. Population of the study comprised 4175 senior secondary year two (SSII) biology students in the 193 public secondary schools in the zone. The sample comprised 519 SS2 biology students which were selected using a multi-stage, sampling procedure that involved stratified random sampling, simple random sampling and purposive sampling techniques. Biology Students' Cognitive Style Questionnaire' (BSCSQ) was used to collect data on students' cognitive styles in Biology, while data for academic achievement was collected from the annual result record sheets (SS1 annual cumulative result of 2022/2023 academic session) in each of the sampled school. The instrument for data collection was validated by three experts. Cronbach Alpha was employed for the reliability of the instrument and reliability coefficient of 0.81 was obtained for the cognitive styles instrument. Data were collected with the aid of research assistants who were biology teachers. Research questions were answered using Pearson Product Moment Correlation Coefficient while the hypotheses were tested also with multiple regression at 0.05 level of significance. Findings from the study among others revealed that there was a high positive relationship between senior secondary school students' cognitive styles and academic achievement in biology in Anambra State. Based on the findings, it was recommended among others that, biology teachers should be encouraged to consider cognitive styles in teaching of students so as to make them achieve better in the subject.

Keywords: Cognitive styles, Anambra state, Okoye and Onwuachu

Introduction

The overall sustainable development of any nation depends on the level of scientific and technological literacy of her citizens. The level of scientific and technological development of a nation depends on a qualitative and functional science, technology and mathematics (STM) education. This is because, it is through qualitative and functional STM education that appropriate scientific, technological and technical skills are transmitted to students. The importance of science in the development of a nation cannot be over-emphasized. Science education has therefore been introduced at different levels of education with the fundamentals of science learning studied in pre-basic and basic educational levels as basic science. At the senior secondary level, students study core science subjects such as chemistry, physics, biology and mathematics.

Biology deals with the study of living organisms and the interaction between them and their environment (Udegbe and Okoli, 2022) [20]. Okoye and Onwuachu (2018) [17] opined that, biology as one of the STM subjects which prepares students for future careers such as: nursing, pharmacy, medicine, dentistry, fisheries, among others. Biology is the fulcrum on which all sciences and technology disciplines and careers are hinged for national development. This is because, biology is a branch of science that deals with the study of life or of living things. Biology undoubtedly improved the quality of our lives. Some important achievements of applied biological research include: (a) Organ transplant, (b) Development of vaccines and drugs for preventing and curing many serious diseases. (c) *In-vitro* fertilizations (IVF) which helps infertile couple to have children and (d) Production of hybrid crop plants and farm animals with desirable qualities, (Nwanze, Konyefa and Ezeanya, 2021) [14].

Despite the several importance of biology to national development and careers available for people with qualifications in biology, Okoye and Onwuachu, (2018) [17] were of the view that students still perform poorly in biology at secondary school level. One of the most serious issues in science subject like biology is students' perceptions that many of their biology classes are boring, uninteresting, lack connection with reality and irrelevance. This is consistent with Okoli and Osuafor (2019) [16] who stated that, science subject like biology, is viewed as irrelevant by students and hence, becomes uninteresting to them as it affects their academic achievement. The impact of poor achievement among students who enroll for Biology at external examination such as West African Senior School Certificate Examination (WASSCE) has continued to deter students from the subject.

According to WAEC Chief Examiner's Report (2023) on students' performance of SSCE examination in Anambra State, only 31.33% to 37.16% passed at credit level among students who sat for Biology from 2013-2023 with a population range of 1,721,163 to 1,972,150, 53.73% of the students passed at credit level from 2013-2016, despite the increment in the (1, 648, 3631 in 2013, 1,365,384 in 2014, and 1,200,367 in 2016) number of those who enrolled for

biology. From 2013-2016 and from 2016 to 2019, there was a notable increase in the percentage of students (1,349,881) who passed at credit level but the difference between each year with particular focus on the population of the students who enrolled for the examination, was not significant. In 2020, 2021, 2022 and 2022, there were no notable changes in students' achievement as compared to the previous year in Anambra State.

A lot of factors as detailed by Mbaegbu and Osuafor (2021) have been implicated for the poor and unstable academic achievement of students in Biology which among others includes poor and unimpressive teaching method used by the teacher, lack of innovative instructional materials, students' interest and attitude towards biology, as well as how students reason or judge things or process information (cognition). As discussed by Okoye and Onwuachu (2018) [17], the factor that could cause poor academic achievement and lack of interest of students in biology may be their styles of processing biology information. To achieve development and positive academic achievement of students through science however, government must ensure that the objectives of biology education match the intellectual capacity of the students who are the citizens of the nation (Mbaegbu and Osuafor, 2021). This is because, learning is primarily a cognitive activity and every student is unique in terms of his inherent nature and inborn potentialities and processes information in a manner unique to them (Vandana, 2017) [21]. Neurological research also established that the left hemisphere of the brain is responsible for logical/rational/artistic functions and the right hemisphere for intuitive/judgmental functions (Madhuri and Rani, 2016) [8]. The hemispheric dominance is also referred to as cognitive style.

Cognitive style is a psychological construct which describes individuals' mode of information perception, organization and representation. As viewed by Sara, Maruta and Olarinoye (2016), cognitive styles are strategies determining a person's typical modes of perceiving, remembering, thinking and problem-solving skills. Saracho, (2019) explained that cognitive styles are dimensions integrated in the individuals' psychological differentiation, which determine a person's response and functioning in all situations. An individual's cognitive style refers to his or her preferred method for acquiring and processing information and this is regarded as relatively stable over time. Cognitive styles as opined by Hamann, Pilotti, and Wilson (2021) [5] are the way people perceive stimuli and how they use this information to guide their behavior (that is, thinking, feeling, and actions). Cognitive style is the manner by which individuals perceive information in the environment and the patterns of thought that they use to develop knowledge base about the world around them, (Martens, 2022). Cognitive styles can encompass attitudes, preferences or strategies used by individuals that influence functions such as perceiving, remembering, thinking, and problem solving (Mealor, Simner, Rothen, Carmichae, and Ward, 2016) [12].

According to Witkin, in Nwanze, Konyefa and Ezeanya (2021) [14], cognitive style is an important variable in the preference students express and in the choices they actually make at various points in their academic development when options are available to them. There are several different dimensions of cognitive styles which among others includes field-dependence-independence,

impulsiveness-reflectiveness, breadth of categorization, and leveling-sharpening. The authors further established the underlying connection between field-dependence-independence and academic and vocational choices which are the degree to which a given academic or vocational area calls for the particular cognitive skills involved in a more field-dependent or field-independent style. Contributing to the connection as well are the personal characteristics associated with students possessing these cognitive styles. The frequently found sex differences in field dependence also seem to enter into the differences that have been observed between men and women in academic choices and vocational preferences. The importance of cognitive style and its role in students' learning arose from the very fact that students of different cognitive style learn differently (Vandana, 2017) [21]. Other research studies posit that from extensive evidence accumulated over the years, cognitive style play significant role in problem-solving and thinking as well. One characteristic of a person's cognitive style as discussed by Roberts (2020) [19] is that it is an inbuilt, relatively fixed preference, and it is a consistent individual difference in how people process and organize information. Cognitive style is one approach to characterize individual differences. It includes stable attitudes, preference, or habitual strategies distinguishing individual styles of perceiving, remembering, thinking and solving problems. According to Saracho (2019), individuals also differ in the characteristics of these dimensions. However, the findings of Martens (2022) showed that, there are three very important cognitive styles: leveling-sharpening, field-dependence/field-independence, and reflectivity-impulsivity.

Two cognitive styles of field-dependence (FD) and field-independence (FI) will be studied in this work. These styles will be studied because they are the commonest and frequently used styles for categorizing students' mental ability into FD and FI with the use of Group Embedded Figure Test which is a timed psychological assessment consisting of 18 items pertaining to field dependence and field independence that requires the subject to locate a previously seen figure within a larger complex figure.. Okoye and Onwuachu (2018) [17] reported that, students who are field-dependent (FD) learners tends to be global in the analysis of learning situations and have difficulty in breaking information into isolated parts; perceive an item as discrete from its background; neither can they impose structure when it is lacking in content. Field-dependent (FD) learners may prefer more direct instruction or definition of the material in situations that involve restructuring abilities. They also seem to be incidental learners in social contexts and have difficulty using initiation.

Conversely, students that are field independent learners tend to be more analytic, solve complex problem and isolated facts. They can separate relevant elements from a distracting or confusing background and prefer working alone, flexible in learning situations and self-reliant, reflective, task-oriented and concerned with mastery of concepts. Field independents recognizes relevant information, or make the problems they are working with more concrete. The field neutral are those students who manifest equal characteristics of field dependency and independency and whose score fall between the continuum in the upper and low extreme of the group embedded figure test (Nwanze, Konyefa and Ezeanya, 2021) [14]. Cognitive styles are students' preferred

ways of thinking about learning tasks which affects their academic achievement either positively or negatively.

Academic achievement according to Berkley and Chang (2022) refer to the extent to which a student, teacher or institution has attained the short or long-term educational goals. Academic achievement describes academic outcomes that indicate the extent to which a student has achieved their learning objectives (Inyang, 2022) [7]. Achievement is often measured through a standardized or teacher made test and often denote a students' grade in an examination or test. Academic achievement as viewed by Mbaegbu (2023) [10, 11] represents performance outcomes that indicate the extent to which a person has accomplished specific goals that were the focus of activities in instructional environments, specifically in school, college, and university. Academic achievement as viewed by (Mbaegbu, Ikeanumba, and Anazodo, 2023) [10, 11] referred to be the observed and measured aspects of students' mastery of skills and subject contents as measured with valid and reliable test. The researchers continued that, in any school system, academic achievement is a priority to the students as well as the teacher. The teacher, students and the school administration must put effort to see that high academic achievement is attained by students irrespective of gender.

Gender is defined as the behavoural, cultural, or psychological traits typically associated with one sex (Galle and Galle, 2018). Gender is a socially constructed term depicting the system of relations between males and females, and designates behaviours, attitudes, roles, status and other processes that govern relationship among sexes in a given educational, socio-economic and political context (Esomonu and Ikeanumba, 2021) [4]. Several studies have shown that students differ in academic achievement relative to cognitive style. Ramlah (2014) in a study of the relationship between cognitive style and achievement of primary school mathematics students showed that the predominant cognitive style was field dependence. The study revealed that greater percentage of male and female students were field dependent than field-independent and that male and females differed significantly in their cognitive styles. This was supported by the findings of Margaret (2015) who reported that more males were found to be field dependent while more female were found to be field independent and that field independent students scored higher than field dependent students in chemistry. Margret also established that cognitive style has a significant relationship with achievement in chemistry. In the study conducted by Vandana (2017) [21] on the relationship between cognitive styles and learning style with achievement, a link was established between cognitive style and learning style which also determine achievement. Lusweti, Kwena and Mondah (2018) established that cognitive style determined 62.8 percent of variance in science subject like chemistry. In a study by Terrance, Susan and Leonhard in Nwanze, *et al* (2021) [14], analysis of cognitive styles of 130 students of 214 engineering mechanic-statics in North Carolina revealed a highly skewed distribution on cognitive style scale, with vast majority being highly field independent. Their study also revealed that students who manifested field independent cognitive style achieved significantly higher grades in the course than those with a field dependent cognitive style.

There has been poor performances in biology by secondary school students in Awka Education Zone as compared to previous years as evident among students given their resultant poor achievement as reported by the WAEC Chief Examiner from 2017-2023 in Anambra State. The situation is worsened given the fact that biology teachers often do not consider the way students' reason, think and process information during classroom activities. The poor achievement in biology concepts have been linked to some factors which among others includes inability of teachers to understand students' mental activities as thinking and conceptualization and deals with things like memory, mental imagery, perception, retention and reasoning and decision (Mbaegbu, *et al*, 2023) [10, 11]. It can be seen from all the studies reviewed that field-independent students significantly achieve more than field independent students in science subjects such as mathematics, chemistry and physics. Male and female students differed significantly in their cognitive styles and therefore academic achievement. There are barely any studies however that examined secondary school students' cognitive styles as a correlate of their academic achievement in biology in Anambra State. This present study was therefore a worthwhile quest.

Statement of the Problem

Biology as a science subject is beginning to lose its popularity among science students as the number of students enrolling for the subject has continued to decline when compared to other science subjects. There has been poor performance in the subject as compared to previous year as evident among students given their resultant poor achievement as reported by the WAEC Chief Examiner from 2017-2021in Anambra state. The situation is worsened by the fact that Biology teachers often do not consider the way students reason, think and process information during classroom activities. The poor achievement of biology concepts have been linked to some factors which among others includes inability of teachers to understand students' mental activities as thinking and conceptualization and deals with things like memory, mental imagery, perception and retention, reasoning and decision making and representation. Many teachers simply assess 'how much' rather than 'how' the student has learnt. Thus, not many learners are aware of how they acquire and process new information. Furthermore, teachers are also unaware of their own thought processing and that of their students. It follows then that in an effort to get learners to understand, teachers tend to impose their own cognitive styles on learners. Such imposition results in a blockage in knowledge transfer which results in teaching of concepts repeatedly instead of moving to subsequent content. Delayed delivery of content has direct bearing on any future learning considering that when concepts in the syllabus are not adequately covered, some important building blocks are skipped. Learners then enter the next level of learning with a shortfall on academic achievement in biology. Hence, there was the need to investigate how cognitive styles correlate to secondary school students' academic achievement in biology in Awka Education Zone of Anambra State.

Research Questions

The following research questions guided the study.

1. What is the correlation between secondary school students' cognitive styles and their academic achievement in biology?

2. What is the correlation between secondary school male and female students' cognitive styles and their academic achievement in biology?

Hypotheses

The following hypotheses were tested at 0.05 level of significance.

1. There is no significant correlation between secondary school students' cognitive styles and academic achievement in biology.
2. There is no significant correlation between secondary school male and female students' cognitive styles and academic achievement in biology.

Materials and Methods

The study adopted a correlational research design. Population of the study comprised 4175 senior secondary year two (SSII) biology students in the 193 public secondary schools in the zone. The sample comprised 519 SS2 biology students which were selected using a multi-stage, sampling procedure that involved stratified random sampling, simple random sampling and purposive sampling techniques. Biology Students' Cognitive Style Questionnaire' (BSCSQ) was used to collect data on students' cognitive styles in Biology, while data for academic achievement was collected from the annual result record sheets (SS1 annual cumulative result of 2022/2023 academic session) in each of the sampled school. The instrument for data collection was validated by three experts. Cronbach Alpha was employed for the reliability of the instrument and reliability coefficient of 0.81 was obtained for the cognitive styles instrument. Data were collected with the aid of research assistants who were biology teachers. Research questions were answered using Pearson Product Moment Correlation Coefficient while the hypotheses were tested also with multiple regression at 0.05 level of significance.

Results

Research Question 1: What is the correlation between secondary school students' cognitive styles and their academic achievement in biology?

Table 1: Relationship between Students' Cognitive Styles and Academic Achievement in Biology

Variables	N	Cognitive Styles	Achievement	Remark
Cognitive Styles	519	1	0.81	High Positive Correlation
Achievement	519	0.81	1	

Table 1 reveals that the correlation coefficient (r) between the students' cognitive styles based on field-dependent and field-independent cognitive styles, and academic achievement in biology is 0.81. This shows that there is a high positive relationship between senior secondary school students' cognitive styles and academic achievement in biology.

Research Question 2: What is the correlation between secondary school male and female students' cognitive styles and their academic achievement in biology?

Table 2: Relationship between Male and Female Students' Cognitive Styles and Academic Achievement in Biology

Variables (Gender)	N	Cognitive Styles	Achievement	Remark
Male	168	1	.857	High Positive Correlation
Female	351	.822	1	High Positive Correlation

Table 2 reveals that the correlation coefficient (r) between the male and female students' cognitive styles and their academic achievement in biology is 0.857 and 0.822 respectively. This shows that there is a high positive relationship between senior secondary school male and female students' cognitive styles based on field-dependent and field-independent cognitive styles, and their academic achievement in biology with the male students having a higher index than their female counterpart.

Hypothesis 1: There is no significant correlation between secondary school students' cognitive styles and academic achievement in biology.

Table 3: Test of Significance of Pearson Correlation between Secondary School Students Cognitive Styles and their Academic Achievement in Biology

Sources of Variation	N	R	P-value	Remark
Cognitive Styles	519	0.81	0.00	Significant
Academic Achievement				

Table 3 shows that the calculated value of r is 0.81 and had P-value (P .00 <0.05). Table 3 also shows that based on the P-value (.00), there is a significant relationship between cognitive styles and academic achievement of secondary school students in biology in Anambra State. Therefore, the null hypothesis was rejected.

Hypothesis 2: There is no significant correlation between secondary school male and female students' cognitive styles and academic achievement in biology.

Table 4: Test of Significance of Pearson Correlation between Male and Female Secondary School Students Cognitive Styles and their Academic Achievement in Biology

Gender	Sources of Variation	N	R	P-value	Remark
Female	Cognitive Styles		0.822		Significant

	Academic Achievement	351		0.00	
Male	Cognitive Styles		0.857		Significant
	Academic Achievement	168		0.00	
Total		519			

Table 4 shows that the correlation of female students' cognitive styles and their academic achievement was 0.822 with Pvalue of 0.00 while their male counterparts had a correlation of 0.857 with Pvalue of 0.00. This shows that the null hypothesis was rejected. Therefore, there is a significant relationship between male and female secondary school students' cognitive styles and their academic achievement in biology.

Discussion of Findings

Research question 1 in Table 1 reveals that the correlation coefficient (r) between the students' cognitive styles based on field-dependent and field-independent cognitive styles, and academic achievement in biology is 0.81. This shows that there is a high positive relationship between senior secondary school students' cognitive styles and academic achievement in biology. This is in line with Behera (2022) who examined the role of cognitive style on the academic achievement of university students of the Mayurbhanj district and found out that cognitive styles influence students' academic achievement. This is also in consonant with the findings of Nwanze, Konyefa and Ezeanya (2021) [14] whose result revealed that the predominant cognitive style among science students was that the field dependent style and that field independent students achieved significantly higher than field dependent students. The study of Ahmed, Nadeem and Basu (2019) [1] was not left out in the agreement with the findings of the work as their findings showed that academic achievement is positively correlated with the cognitive styles. The finding is also in agreement with the findings of Hussin, Razali and Agussalim (2021) who revealed that the correlation coefficient had a positive relation. The findings of the study is in consonance with the findings of Okoye and Onwuachu (2018) [17] who investigated the influence of cognitive styles and school location on academic achievement of students' in Biology and found that cognitive styles and school location had a significant influence on students' academic achievement in Biology. Hypothesis 1 in Table 3 shows that the calculated value of r is 0.81 and had P-value (P .00 <0.05). Table 3 also shows that based on the P-value (.00), there is a significant relationship between cognitive styles and academic achievement of secondary school students in biology in Anambra State. Therefore, the null hypothesis was rejected. This is in consonance with the findings of Nwanze, et al. (2021) [13] who revealed that cognitive style was a significant determinant of the secondary school students' achievement in science. This was supported by the findings of Sharma and Pooja (2018) who revealed that there is a significant positive relationship between cognitive styles (Field Independent and Field Dependent) and academic achievement.

Research question 2 in Table 2 reveals that the correlation coefficient (r) between the male and female students' cognitive styles and their academic achievement in biology is 0.857 and 0.822 respectively. This shows that there is a high positive relationship between senior secondary school male and female students' cognitive styles based on field-dependent and field-independent cognitive styles, and their academic achievement in biology with the male students having a higher index than their female counterpart. This is in consonant with the findings of Ahmed, Nadeem and Basu (2019) [1] who examined cognitive styles, academic achievement and gender: A study of higher education. The findings revealed that the cognitive styles of secondary school male and female students were highly correlated. The findings was supported by the findings of Atsuwe, and Mtoh (2019) [2] who revealed that male students achieved better than female students under field dependent in physics. Hypothesis 2 in Table 4 shows that the correlation of female students' cognitive styles and their academic achievement was 0.822 with Pvalue of 0.00 while their male counterparts had a correlation of 0.857 with Pvalue of 0.00. This shows that the null hypothesis was rejected. Therefore, there is a significant relationship between male and female secondary school students' cognitive styles and their academic achievement in biology. This was supported by the findings of Ahmad (2019) who revealed that whereas there were no significant gender differences in cognitive style and academic qualification of students.

Conclusion

Based on the findings of this research, it was concluded that cognitive styles influence secondary school students' academic achievement in biology. It was also observed that cognitive styles had influence on secondary school students' academic achievement in biology based on gender as the male students were more favoured than their female counterparts. This means that the cognitive styles of students may not depend on gender. It was also revealed that there were significant relationship between students' cognitive styles and their academic achievement in biology. This shows that secondary school students' cognitive styles should be considered in teaching and learning as it enhances their academic achievement in biology.

Recommendations

On the basis of findings from this study, it is recommended that:

1. Biology teachers should be encouraged to consider cognitive styles in teaching of students so as to make them achieve better in the subject.
2. Schools should train biology teachers on the use need to understand the different cognitive styles of students and work according to their pace.
3. Biology teachers should be encouraged to attend workshops, seminars, conferences and on the job trainings on the efficacies of students' different cognitive styles.
4. Appropriate methods of instruction would not be based on an objective approach on one's natural ways of thinking and learning.

Suggestions for Further Studies

There is a need for further studies on the cognitive styles of students as it relates to their academic achievement and interest. The following suggestions were proposed for other researchers:

1. Another study should be carried out on cognitive styles of students as a correlate of their academic achievement, retention and attitude in biology.
2. A study should also be carried out on cognitive styles considering study location and subject matter.

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