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Influence Of Cognitive Styles On Senior Secondary Students' Achievement In Trigonometry In Yobe State, Nigeria

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Abstract: **This study investigated the influence of cognitive styles on senior secondary students' achievement in Trigonometry in Yobe State, Nigeria. The study adopted a descriptive survey research design. The population comprised 1,230 public senior secondary (SSII) students in co-educational schools in Damaturu education zone in Yobe state, Nigeria. The sample of the study constituted 100 students drawn from senior secondary schools using multi-stage random sampling technique. Two instruments were used for data collection namely; Group Embedded Figures Test (GEFT) with a reliability coefficient of 0.87 and Trigonometry Achievement Test (TAT) with a reliability coefficient of 0.94 established using Kuder Richardson (KR-20). Descriptive statistics of means and standard deviations were used to answer the research questions while z-test was used to test the hypotheses at 0.05 level of significance. The findings of this study showed that students in the Field-Independence (FI) category achieved better than their counterparts in the Field-Dependence (FD). The findings also showed that male students in Field-Dependence (FD) and Field-Independence (FI) category achieved better than female students in Field-Dependence (FD) and Field-Independence (FI) category. Based on the findings, it was recommended among others that Mathematics teachers should vary their structural strategies to suit both Field-Dependent and Independent cognitive style students.**

Keywords—Cognitive Styles, Secondary school, Students' achievement, Trigonometry

INTRODUCTION

In Nigeria and other parts of the world, Mathematics plays the vital role among the other school core subjects in the school curriculum. It has been considered as an essential and an important tool in the information of the learned or educated man in the society. Mathematics is also considered as the means of sharpening the individual's mind, sharpening his reasoning ability or capacity and developing his personality (Ukeje, 1997). The Federal Republic of Nigeria in the National Policy on Education (NPE, 2014) recognizes the importance of Mathematics and hence, the study of Mathematics is compulsory for all students right from primary to secondary school levels. Despite the fact that Mathematics is seen as a subject par excellence, in which reasoning power can be trained, the trend has revealed that in order to secure or gain admission to tertiary institutions of learning/higher levels of education, a credit-pass in Mathematics is required (Joint Admissions and Matriculation Board brochure (JAMB), 2010).

Despite the importance of Mathematics to the national growth and development, economy, manpower and concerted efforts by government at all levels to improve Mathematics teaching and learning in schools, students' achievement is still very poor and below average . This has become worrisome over the years for several Mathematicians and Mathematics educators in Nigeria and beyond. Many researchers such as Sanni (2012) and AMOO (2013) opined the poor achievement in Mathematics among primary and secondary school students could be ascribed to many factors such as ineffective instructional skills, poor teaching methods and instructional materials used by Mathematics teachers and unpreparedness on the part of the students, learning environment, psychological factors and location of schools among others. Due to the decline in Mathematics students' achievement, stakeholders in STM agree that the vast investment in Science, Technology and Mathematics Education is not yielding the anticipated dividend.

Cognitive style is a psychological construct which is concerned with how an individual learns, thinks, remembers, solves problems and relates to others. Cognitive style has therefore emerged as a new dimension within individual differences through cognitive psychology studies in the field of information processing. It has a particular importance as it determines the way of information processing when solving problems or making decisions. Every individual has his/her own style in the organization of perception and memory. Cognitive style is bipolar and exists along a continuum, ranging from one extreme

to another with each pole having adaptive value and judge positively when seen as necessary in relation to a particular circumstance (Mesick, 2010). Example at one end of the pole is clustered the competence articulation plus an impersonal orientation (Field-Independent) while at the other end is clustered a social orientation but less articulation competence (Field -Dependent). From these different orientations come the cognitive forces that provide individual personality with requirements to do specified tasks. The Field-Dependent (FD) and Field-Independent (FI) dimension is to be viewed as "bipolar" cognitive style because individuals at the two ends are different, not more or less of the same characteristics. The views of different researchers on cognitive styles are expressed differentially particularly in the field of education (Hudson, 2009). Cognitive style is the basis of discrimination between individuals during their interaction with the elements of the situation, and is an important approach to understanding a personal way of thinking (Sternberg & Willams, 2002).

Ates and Catalogu (2007) stated that there are many dimensions of cognitive styles that distinguish individuals in their dealings with the various situations to which they are exposed. The most important of these dimensions is Field-Dependent and Field-Independent cognitive styles. This dimension refers to relatively stable individual differences in the interaction with the elements of the situation. Individuals with field-independent cognitive style have ability to deal with the subject perceived separately from the surrounding elements, and consider those elements which appear as a background figure as a whole. Individuals with Field-Dependent cognitive style cannot deal with the subject perceived separately from the surrounding elements. Field-Independent (FI) individuals resolve a problem in absence of clear data and are not affected by criticism. They enjoy dealing with abstract ideas and theories, relatively tend to be concentrated on self, enjoying the isolation and have high ambition. Individuals with Field-Dependent (FD) cognitive style are friendly, tend to work with others and do not enjoy dealing with abstract ideas and theories. They are usually influenced by others, less centered on self and respond largely to outside stimuli.

Writing on the cognitive styles in relation to achievement, Witkin, Goodenough and Karp (2013) have indicated that FI individuals tended to do better in Sciences and Mathematics–fields requiring high analytic ability, whereas FD individuals tended to do better in Counseling, Social sciences, teaching and other people-oriented professions. Hansen and Stansfield (2010) have also observed that FI learners had slight advantages for communicative tasks, greater advantages for academic tasks, and greater for the combined tasks than Field-Dependent. In addition, Hansen (2014) noted that Field-Independent learners achieved better scores on cloze test than Field-Dependent students. Tinajero and Paramo (2017) reported that cognitive process styles affect how individual stores knowledge and retrieves it when the need arises. The students' cognitive styles may hamper or enhance the acquisition of knowledge in Science, Technology and Mathematics (Okwo & Otuba, 2017; Hooda & Devi, 2017). Studies by Okoye (2016), Owodummi, Sanni, Nwokolo and Igwe (2016), Idika (2017), Enyi and Eneja (2016) revealed that there is a difference between the mean achievement of Science and Mathematics students with analytical (FI) cognitive styles and with rational and inferential (FD) cognitive styles. Similarly, Sule and Musa (2018), Anidoh and Eze (2014), Amoo (2013), Awofala, Balogun and Olagunju (2012) in their different studies demonstrated that cognitive styles and gender have significance influence on students' academic achievement.

From the various review of literature on the influence of cognitive styles, academic achievement is not the same. While some researchers upheld that Field-Independent learners achieved better than Field-Dependent students, some disagreed to this view. In view of these inconclusive findings, it is appropriate to conduct further research to confirm or annul the otherwise protracted issue on the influence of cognitive styles (Field-Dependent(FD)/Field-Independent (FI) dichotomy) on academic achievement of senior secondary school students with particular preference to Damaturu Education Zone in Yobe State, Nigeria.

STATEMENT OF THE PROBLEM

Mathematics has been a compulsory secondary school subject. Students are not doing well in West African Examination Council (WAEC). An analysis of WAEC Chief Examiner's reports (2016) has identified Trigonometry as giving students more difficulties than other components of Mathematics. The persistent areas of difficulty which affects students' achievement in Trigonometry are as follows: inability to apply the knowledge of Trigonometry ratios in solving problems involving angles of elevation, depression and bearing, and to solve problems involving Trigonometry identities. Previous studies have identified factors responsible for students' poor understanding of this Mathematics concept-teacher factors such as inappropriate teaching methods and use of ineffective instructional materials have been well investigated (Agwagah, 2007). On this basis, there is need to turn to find out what could be the influence of other variable such as cognitive styles on students' achievement in Trigonometry. The aim is to gain a better understanding on finding solution to the problem of poor achievement. The problem of this study therefore is, what is the influence of cognitive styles on senior secondary students' achievement in Trigonometry in Damaturu Education Zone in Yobe State, Nigeria?

PURPOSE OF THE STUDY

The purpose of this study was to investigate the influence of cognitive styles on senior secondary students' achievement in Trigonometry in Damaturu

Education Zone in Yobe State, Nigeria. Specifically, the study sought to find out the influence of:

1. Field-Dependent (FD) and field-Independent (FI)) cognitive styles on students' achievement in Trigonometry.
2. Field-Dependent (FD) cognitive style on male and female students' achievement in Trigonometry.
3. Field-Independent (FI) cognitive style on male and female students' achievement in Trigonometry.

RESEARCH QUESTIONS

The following research questions were stated and answered in the study:

1. What are the achievement mean scores of Field-Dependent (FD) and Field-Independent (FI) cognitive style students in Trigonometry?
2. What are the achievement mean scores of male and female students with Field-Dependent (FD) cognitive style in Trigonometry?
3. What are the achievement mean scores of male and female students with Field-Independent (FI) cognitive style in Trigonometry?

STATEMENT OF HYPOTHESES

The following null hypotheses (H_o) were formulated and tested at $\alpha = 0.05$ level of significance:

Ho_1: Field-Dependent (FD) and Field-Independent (FI) cognitive styles have no significant influence on the achievement mean scores of students in Trigonometry.

Ho_2: Field-Dependent (FD) cognitive style has no significant influence on the achievement mean scores of male and female students in Trigonometry.

Ho_3: Field-Independent (FI) cognitive style has no significant influence on the achievement mean scores of male and female students in Trigonometry.

SIGNIFICANCE OF THE STUDY

The findings of this study would be beneficial in the following ways:

1. It would help mathematics teachers to categorize their students and determine their students' cognitive style in Mathematics classroom. By emphasizing methods of reasoning, provide critical direction so that the learner can discover the concepts through investigation. In other words, teachers can identify strong style patterns in their classes and utilize relevant approaches to accommodate individual cognitive style preferences.
2. It would enhance students' learning power by being aware of their cognitive styles. By working on those cognitive style areas, students can be provided avenues to foster their intellectual growth.
3. It might help guidance and counselors to classify students into cognitive style for career choice according to their brain make-up regardless of their gender. This might be of importance to guidance and counselors, who from time to time have to guide and counsel the students in both academics and other areas of life.
4. It might enable Curriculum planners to design a curriculum for teaching institutions and teaching policies, by allotting more weights in the curriculum where students show evidence of poor achievement; and indicate instructional materials to be used, possible methods teachers can use in teaching the Mathematics concepts based on the information about cognitive styles
5. The findings of this study would be added to the existing literatures. The future researchers in the similar field of study who might be interested in conducting a research would find the results of this study very interesting and use as empirical studies when it is published in referred Journals and posted on Internet.

METHODOLOGY

The study adopted a descriptive survey research design and was carried out in Damaturu Education Zone in Yobe State, Nigeria. The population of the study comprised 1,230 all the public senior secondary two (SSII) students. Findings of the study can easily be generalized and constitute a good representation of the entire state. The sample of the study was 100 students comprised 49 dependent (25 males and 24 females) and 51 Independent (25 males and 26 females) using multi-stage sampling technique. Two instruments were used for the study namely: Group Embedded Figures Test (GEFT) and Trigonometry Achievement Test (TAT). The Group Embedded Figures Test was adapted since no instrument is validated forever (Witkin, Raskin & Oltman, 1971). GEFT consists of 21 test items from which the subjects in the research were required to locate/trace out-line of the simple form located in complex form. Their responses are scored as one "1" when students correctly locate the figure and as zero "0" when they failed to. Test score is the total number of figures correctly located, while the total mark is twenty-one. Thus, the cut-off mark for GEFT is nine which is the closest number to half of the total mark and served as a pass mark. Students who scores below nine are Field-Dependent while those who score above nine are Field-Independent. GEFT was administered to all students in the intact classes and used to classify the students into Dependent and Independent cognitive styles and Trigonometry Achievement Test (TAT) with a 30–item multiple choice questionnaire was constructed by the researchers and used to measure students' achievement in Trigonometry. Each item has 5-options A-E, the test items were adopted from Senior Secondary Certificate Examination (2021-2022) used for the study. Both the GEFT and TAT were faced validated by experts in Mathematics Education, measurement and evaluation in terms of their suitability in generating the anticipated type of data as well as to determine the research objectives. The reliability coefficients of 0.87 for GEFT and 0.94 for the TAT were established using Kuder Richardson (KR-20) formula respectively. The two instruments

were administered as a test on two separate days. On the first day, the GEFT was administered and on the second day, the TAT was administered with the help of research assistants (Mathematics teachers) in the sampled schools. Descriptive statistics of means and standard deviations were used to answers research questions while z-test was used to test the null hypotheses at 0.05 level of significance.

The analysis of the study was done based on the research questions with the corresponding hypotheses.

A Research Question One: What are the achievement mean scores of Field-Dependent (FD) and Field-Independent (FI) cognitive style students in Trigonometry? Data used to answer this research question is presented in Table 1.

FINDINGS

Table 1: Means and Standard deviations and Z-test of Students' FD and FI Cognitive Styles and Achievement in Trigonometry

Cognitive syles	N	Mean	SD	Df	z-cal	z-crit.	Decision
FD	49	2.65	0.605	98	2.68	1.96	S*
FI	51	2.89	0.643				

Table 1 indicates that field-dependent students had a mean score of 2.65 and a standard deviation of 0.605 while field-independent students recorded a mean score of 2.89 with a corresponding standard deviation of 0.643 in that order.

B ***Hypothesis One:*** *Field*-Dependent (FD) and Field-Independent (FI) cognitive styles have no significant influence on the achievement mean scores of students in Trigonometry.

From Table 1, z-calculated =2.68 with df = 98 at α = 0.05, z-critical = 1.96. From the fact that z-calculated > z-critical value, the null hypothesis was rejected. This shows that Field-Dependent (FD) and Field-Independent (FI) cognitive styles have significant influence on the achievement mean scores of students in Trigonometry. Hence, Field-Independent (FI) cognitive style students achieved significantly better than Field-Dependent (FD) cognitive style students in Trigonometry.

C Research Question Two: What are the achievement mean scores of male and female students with Field-Dependent (FD) cognitive style in Trigonometry? Data used to answer this research question is presented in Table 2.

Table 2: Means and Standard Deviations and Z-test of Male and Female Students' FD Achievement in Trigonometry

Cognitive style	Gender	N	Mean	SD	df	z-cal	z-crit.	Decision
FD	Male	25	3.17	0.298	98	3.500	1.96	NS
	Female	24	2.84	0.502				

Table 2 indicates that male dependent students had a mean score of 3.17 and a standard deviation of 0.298 while the female dependent students recorded a mean score of 2.84 with a corresponding standard deviation of 0.502 in that order.

D ***Hypothesis Two:*** Field-Dependent (FD) cognitive style has no significant influence on the achievement mean scores of male and female students in Trigonometry.

From Table 2, z-calculated = 3.500 and z- critical = 1.96.with df = 98 at α = 0.05 level of significance, From the fact that z-calculated > z-critical, the null hypothesis was rejected. This shows that Field-Dependent (FD)) cognitive style has significant influence on the achievement mean scores of male and female students in Trigonometry. Hence, Field-Dependent (FD) cognitive style male students achieved significantly better than Field-Dependent (FD) cognitive style female students in Trigonometry as measured by TAT.

E Research Question Three: What are the achievement mean scores of male and female students with Field-Independent (FI) cognitive style in Trigonometry? Data used to answer this research question is presented in Table 3

Table 3: Means and Standard Deviations and Z-test of Male and Female Students' FI Achievement in Trigonometry

Cognitive style	Gender	N	Mean	SD	df	z-cal	z-crit.	Decision
FI	Male	25	3.22	0.257	98	5.505	1.96	S*
	Female	24	3.19	0.268				
	Total	49						

Table 3 indicates that male Independent (FI) students had a mean score of 3.22 and a standard deviation of 0.257 while the female Independent (FI) students recorded a mean score of 3.19 with a corresponding standard deviation of 0.268 respectively.

F Hypothesis Three: Field-Independent (FI) cognitive style has no significant influence on the achievement mean scores of male and female students in Trigonometry.

From Table 3, the calculated z-value = 5.505 and z-critical = 1.96 with df of 98 at 0.05 level of significance. Since the z-calculated > z-critical, the null hypothesis was rejected. This signifies that Field-Independent (FI) cognitive style has significant influence on the achievement mean scores of male and female students in Trigonometry. Thus, male students in Field-Independent (FI) category achieved significantly better than their counterparts.

DISCUSSION OF FINDINGS

The findings of this study showed that students in the Field-Independence (FI) category achieved significantly better than their counterparts in the Field-Dependence (FD). This finding is in line with the ealier findings of Sule and Musa (2018), Anidoh and Eze (2014), Amoo (2013), Awofala, Balogun and Olagunju (2012) Witkin, Goodenough and Karp (2013), Okoye (2016), Owodummi, Sanni, Nwokolo and Igwe (2016), Idika (2017), Enyi and Eneja (2016), Mandana (2011), Bassey, Umoren and Udida (2011), Tinajero and Paramo (2017), Dwyer and More (2015) in their separate studies found that there is significant difference between the achievement mean scores of students with Field-Independent (FI) or analytical cognitive styles and those with Field-Dependent (FD) or relational and inferential cognitive styles in Mathematics and other related science subjects, in favour of students with Field-Independent (FI) cognitive style. The implication of this finding is that, if Field Independent and Field Dependent students are exposed to equal classroom instructions, there might not be much difference in the achievement of students. On the other hand, the finding disagrees with that of Tukur (2013) who reported that significant difference does not exist in mean scores of Field-Dependent (FD) and Field-Independent (FI) cognitive style students.

The findings of this study also showed that male students in Field-Dependence (FD) and Field-Independence (FI) category achieved significantly better than female students in Field-Dependence (FD) and Field-Independence (FI) category. This finding is not entirely surprising as it confirms the findings of Amoo (2013) and Ndirika (2013) who reported that cognitive styles and gender have significant influence on students' Mathematics achievement and other related subjects in the schools. The possible reason for the high achievement of male students with Field Independence and Field-Dependence level of cognitive styles could be from the fact that; Field Independence and Field-Dependence individuals are excellent analytical thinkers who view things from serialistic and detailed manner. The more Field Independence/Field-Dependence students are; the more likelihood for them to achieve meaningful learning.

CONCLUSIONS

Based on the findings of this study and the discussions that followed, the study concluded that students in the Field-Independence (FI) category achieved significantly better than their counterparts in the Field-Dependence (FD). The findings equally showed male students in Field-Dependence (FD) and Field-Independence (FI) category achieved significantly higher than female students in Field-Dependence (FD) and Field-Independence (FI) category. According to this research results, the study showed that cognitive styles could have significant influence on secondary school students' achievement in Trigonometry and that there could be a difference in the type of cognitive style between students, males and females, depending on the cognitive style one has, this could have an influence on academic achievement in a particular discipline.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made and deemed imperative by the researchers.

1. Mathematics teachers should vary their structural strategies to suit both Field-Dependent and Field-Independent cognitive style students.
2. Mathematics teachers should identify strong style patterns in their classes and utilize relevant

approaches to accommodate individual cognitive style preferences.

3. To meet differences in students' cognitive styles among males and females, Mathematics teachers should pair male and female students in Field-Dependence (FD) and Field-Independence (FI) category in solving Trigonometry problems/tasks.

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