Influence of Cognitive Styles and Gender on Upper Basic III Mathematics Students' Achievement in Keffi, Nasarawa State, Nigeria

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Abstract

This study investigated the influence of cognitive styles and gender on upper basic III Mathematics students' achievement in Keffi, Nasarawa State, Nigeria. The study was a descriptive survey research design. The population consisted of 1,890 upper basic III Mathematics students in 25 coeducational schools in the zone. The sample of the study comprised 245 upper basic III Mathematics students drawn from six intact classes of six coeducational schools in Keffi Education zone. The schools were randomly selected using disproportionate stratified random sampling techniques from the schools that satisfied the condition that their students were taught by qualified teachers over the years. Two instruments were employed for data collection namely; Cognitive Style Checklist (CSC) with a reliability coefficient of 0.79 and Mathematics Achievement Test (MAT) with a reliability coefficient of 0.81. 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 revealed that Basic Mathematics students in the Field Independence (FI) group achieved significantly better than the those in the Field Dependence (FD). The findings also revealed that male students in both the Field Independence (FI) and Field Dependence (FD) groups achieved better than the female students significantly. Based on the findings of this study, it was recommendation that seminars and workshops should be organized to adequately equip teachers with the needed skills to create an environment where students with different cognitive styles can experience meaningful learning of Mathematics.

Keywords: Achievement, Cognitive Styles, Gender and Mathematics.

INTRODUCTION

The selection of Mathematics as one of the core subjects offered in Basic and Secondary schools in Nigeria, as well as its status as part of mandatory requirement for admission into post-secondary Institution in the country are clear indication of the relevance of the subject in Nigeria education (FRN, 2014). At national and global levels, there is a general consensus that economic development, viability and stability are solely, in the 21 century, scientific and technological based. This means that, economic prosperity of a nation depends largely on the scientific and technological development, which cannot be possibly attained without sound, effective and strong Mathematics Education (Sanni, 2012). Alechenu (2012), described Mathematics as the "queen" of the sciences without which it would be difficult for people to study other sciences like physics, chemistry, biology

and computer science/information technology. Underscoring the importance of Science, Technology and Mathematics Education to national development, he said. "We hope our government will properly address the issue of scientific transformation of our grown dynamics and processes as a nation". As important as the subject is, there is tremendous and persistent failures of the Nigerian Students in it.

Despite the relevance of Mathematics to national development, security, economy, manpower and government's efforts to improve Mathematics instruction in schools, students' achievement is below average. This has become a great concern for Mathematics educators especially at the foundational level. Researchers such as (Amoo, 2013; Sanni 2012; Alechenu, 2012) opined that underachievement in Mathematics among basic school students could be attributed to several factors such as poor teaching, psychological factors, unpreparedness on the part of the students, poor learning environment, school locations, gender stereotyping, dearth of qualified teachers among others. As a result of the decline in Mathematics students' achievement, stakeholders in STM agree that the huge investment in Science, Technology and Mathematics education is not yielding the desired dividend.

Gender remains an important factor to be considered in the determination of students' academic achievement. Gender has been identified as a major factor that affects students' achievement in science examinations and Science, Technology and Mathematics endeavor (Omiko, 2017). Oni (2014) posited that in Nigeria, women are marginalized while men are given greater opportunities to advance based on their science background. In the Nigerian setting, this factor has been found to offer males an unfair advantage over their female counterparts. Alabi (2014) reported that women are hindered from progressing through discrimination on the basis of gender, early marriage and child bearing and as a result, they are deprived sound education, job opportunities and incapacitated and rendered passive generally in the society. Researchers (Oludipe, 2012; Kola & Taiwo, 2013) in their various studies observed that there is no significant difference between male and female achievement; on the other hand, (Onuekusi & Ogomaka, 2013; Igoegwu & Okonkwo, 2012; Amoo, 2013) found out that a significant difference did exist between the achievement of male and female students in favour of the male students. Nevertheless, there is no specific study on the influence of cognitive style and gender on upper basic III Mathematics students' achievement and Nasarawa State; hence the need for this study.

Cognitive style is a psychological construct which is concerned with how an individual learns, thinks, solve problems, remembers and relates to others. It represents the individual differences in the various subcomponents of an information-processing model of three main cognitive processes: perception, memory and thought. Cognitive style is considered to be personality dimension that influences attitudes, values and social interaction. It is an individual characteristic mode of perceiving and processing information in the environment (Hall, 2000). An individual is either Field-independent (FI) or Field-dependent (FD). A Field-independent (FI) cognitive style learner is described as analytic, competitive, individualistic, task-oriented, internally referent, intrinsically motivated (self-study), self-structuring, detail oriented and visually perceptive, prefers individual project work and has poor social skills; while Field-dependent (FD) cognitive learner is described as global (wholistic), group-oriented, sensitive to social interactions and criticisms, externally motivated, externally referential, not visually perceptive, a non-verbal and passive learner who prefers external information and group projects (Hall, 2000; Calcaterra, Antonetti & Underwood, 2005; Guisande, Paramo, Tinajero & Almedida,

2007). A summary of the differences between the two dimensions of cognitive styles (Field Dependence and Field Independence) is shown in Table 1.

Table 1

Differences Between Field Dependence and Field Independence Cognitive Styles

FIELD DEPENDENCE (FD) (non-analytic)	FIELD INDEPENDENCE (FI) (analytic)
Have comprehensive perception	Excellent at analytical thinking
Perceive objects as a whole and approach a task more wholistically	Focus on individual parts of the object and tend to be more serialistic in their approach to learning
Rely on external references	Rely more on internal references
More influenced by format-structure	Less affected by format structure
More reliant on salient cues in learning	Tend to sample more cues inherent in the field and are able to extract the relevant cues necessary for the completion of a task
Likely to use active cognitive strategies	Likely to use passive cognitive strategies
Adopt a hypothesis-testing role in learning	Adopt a spectator role in learning
Likely to benefit from a self-directed emphasis	Tend to prefer more structured learning environments
Self-view is derived from others	Has sense of separate identity
Not well-skilled in social/interpersonal relationships	Highly skilled in interpersonal/social relationships

Source: Wyss (2002), Chen and McCredie, (2004)

Cognitive process styles affect how one stores knowledge and retrieves it when the need arises (Tinajero & Paramo, 2000). The students' cognitive styles may hinder or facilitate the acquisition of knowledge in Science, Technology and Mathematics (Hooda & Devi, 2017; Okwo & Otuba, 2007). Studies (Hooda & Devi, 2017; Idika, 2017; Okoye, 2016; Agboghoroma, 2015; Owoduni, Sanni, Nwokolo & Igwe, 2016; Ezeugwu, Nji, Anyaugbunam, Enyi & Eneja, 2016; Bassey, Umoren & Udida, 2013) reveal that there is a difference between the mean achievement of Science and Mathematics of students with analytical (FI) cognitive styles and those with relational and inferential (FD) cognitive styles while Ndirika (2013) opined that ability levels have no significant effect on the achievement of students. Also, Okereke (2011), Amoo (2013) Anidoh and Eze (2014) reported that cognitive styles and gender have influence on students' achievement. Nevertheless, there is no specific study on the influence of cognitive styles and gender on upper basic III Mathematics students in Nasarawa State, hence, there is a need to investigate how upper basic III students' cognitive styles and gender influence their achievement in Mathematics.

Statement of the Problem

Mathematics is the chief corner stone of all sciences without which there will be no technology and without technology, there will be no modern society. This implies that a strong background in mathematics is critical for the nation's scientific and technological development. Despite its importance, underachievement in this

subject has become a thing of concern to stakeholders in Education. This persistent underachievement in Mathematics especially at the basic level is linked to factors of teaching and learning. Based on these, effort is geared towards improving teaching and learning strategies and yet students' achievement is still below expectation. On this note, there is need to turn to find out what could be the influence of other variables such as cognitive styles on students' achievement in Mathematics. The problem of this study therefore is, what is the influence of cognitive styles and gender on upper basic III Mathematics students in Keffi, Nasarawa State, Nigeria?

Purpose of the Study

The purpose of this study is to investigate the influence of cognitive styles and gender on upper basic III Mathematics students in Nasarawa State. Specifically, this study sought to find out the influence of;

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

Research Questions

The following research questions guided the study;

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

Hypotheses

The following hypotheses were tested at 0.05 α level.

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

Ho_2: Field-Independent (FI) cognitive style have no significant influence on mean achievement scores of male and female students in Mathematics.

Ho_3: Field-Dependent (FD) cognitive style have no significant influence on mean achievement scores of male and female students in Mathematics.

Methodology

The study was a descriptive survey research design. The study was carried out in Keffi Education Zone of Nasarawa State. The population consisted of 1,890 (987 males and 903 females) upper basic III Mathematics students in 25 coeducational schools in the zone. The sample of the study comprised 245 upper basic III Mathematics students (139 males and 106 females) drawn from six intact classes of six coeducational schools in the zone. The schools were randomly selected using disproportionate stratified random sampling techniques from the schools that satisfied the condition that their students were taught by qualified teachers over the years. Two instruments were employed for data collection; they are: CSC and MAT. The Cognitive Style Checklist (CSC) was adapted Robert Wyss (2002) CSC, it consists of 10 simple statements from which subjects in the research were to indicate the ones applicable to them. The checklist was used to categorize students based on their cognitive styles. It was divided into two sub-statements. Sub-statement A represents the characteristics of the Field Independent (FI) while sub-statement B represents those of Field Dependent (FD). The instrument was subjected to construct and face validity by expert in Measurement and Evaluation from Nasarawa State University, Keffi. It reliability was determined through test-retest and the reliability coefficient of 0.79 was obtained. The Mathematics Achievement Test (MAT) is a 20 multiple choice achievement test designed to measure students' achievement in Mathematics. Each item has 5-options A-E. the test was based on the units of study (Ratio, Indices and Logic) in upper basic III Mathematics curriculum used for the study. The instrument was subjected to content and face validity by expert in Science Education from Nasarawa State University, Keffi. It reliability was determined using Kuder-Richardson formula 20 (KR_{20}) and the reliability coefficient of 0.81 was obtained. The two instruments were administered on two separate days. On the first day, the CSC was administered and on the second day, MAT was administered with the help of research assistants who were seasoned teachers in the sampled schools. 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.

Results

Research Question One

What are the mean achievement scores of students with Field-Independent (FI) and Field-Dependent (FD) cognitive styles in Mathematics?

The data used to answer this research question is presented in Table 2.

Table 2

Means, Standard Deviations and Z-test of Students' FI and FD Cognitive Styles and Achievement in Mathematics.

Cognitive Styles	N	Mean	SD	Df	Z-cal	Z-crit.	Decision
FI	136	41.81	12.40				Reject H_o
				243	28.40	1.96	
FD	109	37.12	12.98				
Total	**245**						

Table 2 shows that the mean achievement scores of Mathematics students in the FI group stood at 41.81 with SD of 12.40. It also shows that the mean achievement scores of Mathematics students in the FD group stood at 37.12 with SD of 12.98.

Hypothesis One

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

From Table 2, Z-calculated = 28.40 and with df = 243 at $\alpha = 0.05$, Z-critical = 1.96. Since Z-calculated > Z-critical, the null hypothesis is rejected. This indicates that there is significant difference in the mean achievement scores of Mathematics students with FI and FD Cognitive styles. Hence, Mathematics students in FI group achieved higher than those in the FD group.

Research Question Two

What are the mean achievement scores of male and female students with Field-Independent (FI) cognitive styles in Mathematics?

The data used to answer this research question is presented in Table 3.

Table 3

Means, Standard Deviations and Z-test of male and Female Science Students' FI Cognitive Style and Achievement in Mathematics.

Cognitive Styles	Gender	N	Mean	SD	Df	Z-cal	Z-crit.	Decision
FI	Male	82	45.34	12.02				Reject H_o
					243	22.73	1.96	
	Female	54	31.14	12.41				
Total		**136**						

Table 3 shows that the mean achievement scores of male Mathematics students in the FI group stood at 45.34 with SD of 12.02. The mean achievement scores of their female counterparts is 31.14 with SD 12.41.

Hypothesis Two

Field-Independent (FI) cognitive style have no significant influence on mean achievement scores of male and female students in Mathematics.

From Table 3, Z-calculated = 22.73 and with df = 243 at $\alpha = 0.05$, Z-critical = 1.96. Since Z-calculated > Z-critical, the null hypothesis is rejected. This indicates that there is significant difference in the mean

achievement scores of male and female Mathematics students with FI Cognitive style. Hence, male students in both FI achieved higher in Mathematics than their female counterparts.

Research Question Three

What are the mean achievement scores of male and female students with Field-Dependent (FD) cognitive styles in Mathematics?

The data used to answer this research question is presented in Table 4.

Table 4

Means, Standard Deviations and Z-test of male and Female Science Students' FD Cognitive Styles and Achievement in Mathematics.

Cognitive Styles	Gender	N	Mean	SD	Df	Z-cal	Z-crit.	Decision
FD	Male	64	41.72	12.55				Reject H_o
					243	24.41	1.96	
	Female	45	33.11	12.27				
Total		**109**						

Table 4 shows that the mean achievement scores of male Mathematics students in the FD group stood at 41.72 with SD of 12.55. The mean achievement scores of their female counterparts is 33.11 with SD 12.27.

Hypothesis Three

Field-Dependent (FD) cognitive style have no significant influence on mean achievement scores of male and female students in Mathematics.

From Table 4, Z-calculated = 24.41 and with df = 243 at $\alpha = 0.05$, Z-critical = 1.96. Since Z-calculated > Z-critical, the null hypothesis is rejected. This indicates that there is significant difference in the mean achievement scores of male and female Mathematics students with FD Cognitive style. Hence, male students in both FD group achieved higher in Mathematics than their female counterparts.

Discussion

The findings of this study revealed that Mathematics students in the Field Independence (FI) group achieved significantly better than the those in the Field Dependence (FD). This finding is in agreement with the findings of (Hooda & Devi, 2017; Idika, 2017; Okoye, 2016; Agboghoroma, 2015; Owoduni, Sanni, Nwokolo & Igwe, 2016; Ezeugwu, Nji, Anyaugbunam, Enyi & Eneja, 2016; Bassey, Umoren & Udida, 2013; Okereke, 2011) in their various researches reported that there is a difference between the mean achievement of students with analytical (FI) cognitive styles and those with relational and inferential (FD) cognitive styles in Mathematics and other related subjects. But in contrast with the findings of Maghsudi (2007), Guisande, Paramo, Tinajero and Almeida (2007) who in their different researches reported that cognitive styles are not affected by intelligence and that Field Dependence/Independence focuses on the process of learning rather than ability.

The findings of this study revealed that male Mathematics students in both Field Independence (FI) and Field Dependence (FD) groups achieved significantly better than their female counterparts. This finding agrees with the findings of Ndirika (2013), Amoo (2013) and Aniodoh and Eze (2014) who reported that cognitive styles and gender have influence of students' achievement in Mathematics, and other related subjects. Learning Mathematics involves critical and deep thinking as well as display of initiatives. The reason for the high

achievement of students with Field Independence level of cognitive style could be because, Field Independence individuals are excellent analytical thinkers who view things from serialistic and detailed manner. The more Field Independence a students are, the more likelihood for them to achieve meaningful learning.

Conclusion

The findings of this study revealed that Mathematics students in the Field Independence (FI) group achieved significantly better than the those in the Field Dependence (FD). The findings also revealed that male students in both the Field Independence (FI) and Field Dependence (FD) groups achieved better than the female students significantly in Mathematics.

Recommendations

Based on the findings of this study, the following recommendations were made;

1. Seminars and workshops should be organized to adequately equip Mathematics teachers with the needed skills to create an environment where students with different cognitive styles can experience meaningful learning of Basic Science.

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