The Influence of Dependent and Independent Cognitive Styles on Achievement in Mathematics among Senior Secondary School Students in Bida Educational Zone of Niger State, Nigeria

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ABSTRACT

This study employed ex-post-facto design. The study investigated the influence of dependent and independent cognitive styles on students' achievement in Mathematics. The study was guided by four research questions, two null hypotheses that were tested at 0.05 levels of significant. The population consisted of all the 40 senior secondary schools in Bida Education Zone of Niger State. One Hundred (49 dependent and 51 independent cognitive style) students, were drawn from the senior secondary schools, using multi-stage sampling technique, that constituted the sample of the study. Instruments adopted for data collection were the Student Group Embedded Figures Test (Witkin and Goodenough, 1984) used to determine the participants' Cognitive Styles Questionnaire (PCSQ) and Mathematics Achievement Test (MAT). Data collected were analyzed using mean, standard deviation and t-test. The findings of the study show that independent cognitive style students achieved significantly higher than their dependent cognitive style counterpart in Mathematics Achievement Test. It was also not consistent across gender levels. Recommendations among which include, that teachers should use independent strategies in integrating with students in the classroom, especially in mathematics, and other science related subjects.

Keywords: *Dependent cognitive style, independent cognitive style, students' achievement.*

INTRODUCTION

In the history of education, mathematics occupies a central place among the other school core subjects. It has been considered as an indispensable discipline and an essential tool in the formation of the educated man. Mathematics is also considered as the means of sharpening the individual's mind, shaping his reasoning ability, and developing his personality (Ukeje, 1997). Nigeria as a nation recognizes the importance of Mathematics and according to the National Policy on Education, which spelt out the details of the education system, the study of Mathematics is compulsory for all students at primary and secondary school levels. Apart from the fact that mathematics is a subject par excellence (Federal Republic of Nigeria, (FRN), 2004), in which reasoning power can be trained, the trend has also shown that in order to secure admission to higher levels of education, a credit-pass in mathematics is an advantage (Joint Admission and Matriculation Board (JAMB), 2006).

Therefore, the learning of Mathematics in Nigeria represents a basic preparation for adult life and a gateway into a vast array of career choices. Mathematics, which involves the study of qualities as expressed in numbers or symbols, comprises a variety of related branches. In elementary school, for example, mathematics is conceptualized in strands such as concepts, numeration, measurement, arithmetic, algorithmic, computation, and problem solving. In high school, curriculum offerings include algebra, geometry, trigonometry, and calculus. Little is understood, however, about how different aspect of Mathematical cognition relate to one another (i.e. which aspects of performance are shared or distinct, or how difficulty in one domain corresponds with difficulty in another). Such understanding would provide theoretical insight into the nature of Mathematics competence and practical guidance about the identification and treatment of Mathematics difficulties.

Ukeje (1997) lamented at the poor state of the teaching and learning of Mathematics at the secondary level in Nigeria. He stated that Mathematics has been a bugbear to many secondary school students, and this has led to the poor performance and under-achievement in Mathematics in schools have been a subject of thorough and intensive investigation over the years by many Nigerian Mathematicians and Mathematics educators. Most of their accusation fingers point to the inadequate teaching methods and materials used by Mathematics teachers in teaching Mathematics. Although, a lot of efforts have be made to address the problems of inadequate teaching methods and materials but the problems still persist. The world is currently expanding a new technological and information revolution that is having an on society at least as great as the Industrial Revolution.

Cognitive psychologist and educators have long been interested in understanding the individual differences in cognition and their impact on learning and instruction. Wikin, Moore, Goodenough and Cox (1977), undoubtedly, helped build the field dependency theory to better separate people with one factor from the total visual field. Lynch, Woelf, Hassen and Steele (1998) Cognitive styles are information processing habits which reflect the learner's typical mode of perceiving, thinking, problem-solving and remembering. In Messick's words (1984), cognitive styles are "stable attitudes, preferences, or habitual strategies determining a person's typical mode of perceiving, remembering, thinking, and problem-solving". Some of the elements of cognitive styles focus on whether a person is field-dependent or independent (Witkin and Goodenough 1981); global or analytic (Dwyer and Moore 2001); concrete or abstract (Jonassen and Grabowski, 1993), random or sequential (Summerville, 1999); risk-taking or cautions (Jonassen, 1988), and dependent or independent (Witkin *et al*, 1977, 1984). According to Lieu and Reed (1994), an individual's cognitive style is a basic intellectual determinant in his/her level of achievement.

From the point of view of personality, the critical question is, how do Nigerian children learn best? What is their manner of preference of performance? An understanding of how our children process information will enable curriculum experts in the curriculum management plan for the learners. Ausburn and Ausburn (1998) defined cognitive styles as the "…psychological dimensions that represent the consistencies in an individual's manner of acquiring and processing information (p. 388)". According to Messick (1984) Cognitive style deals with the manner in which people prefer to make sense out of their world by

ISSN: 2141-6753

collecting, analyzing, evaluating, and interpreting data. These styles are thought to remain consistent preferences throughout life (Jonassen and Grabowski, 1993). Daniels (2009) summarizes the general tendencies of field dependent and independent learners as follows:
Field-dependents:

* Rely on the surrounding perception field.
* Have difficulty attending to, extracting, and using non salient cues.
* Have difficulty providing structure to ambiguous information.
* Have difficulty restructuring new information and forging links with prior knowledge.
* Have difficulty retrieving information from long-term memory.

Conversely, field-independents:

* Perceive objects as separate from the field.
* Can dissembled relevant items from non-relevant items within the field.
* Provide structure when it is not inherent in the presented information.
* Reorganize information to provide a context for prior knowledge.
* Tend to be more efficient at retrieving items from memory (p. 38)

Cognitive style has been reported to be one of the significant factors that may impact students' achievement on various school subjects (Murphy, Casey, Day and Young, 1997; Cakan, 2000). In a research study, Dwyer and Moore (2001) investigated the effect of cognitive styles on achievement with 179 students who enrolled in an introductory education course at two universities in the United States. They found the field independent learners to be superior to field dependent learners on tests measuring different educational objectives. The researchers concluded that cognitive style had a significant association with students' academic achievement.

Tinajero and Paramo (1997) investigated the relationship between cognitive styles and student achievement in several subject domains (English, Mathematics, Natural Science, Social Science, Spanish and Galician). With the sample of 408 middle school students, the researchers asserted that cognitive style was a significant source of variation in overall performance of students. That is, field independent subjects outperformed their field dependent counterparts. In another study, Murphy, Casey, Day and Young (1997) sought to determine the relationship between academic achievements and cognitive style 63 undergraduate Canadian students in information management program. They found that field independent cognitive style students perform better than field dependent cognitive style subjects only on one of the technical courses. For the other three courses the two groups performed similarly.

Although considerable research has been conducted on the impact of field dependence/independence and academic achievement, the relationship between FD/FI cognitive style and learning, including the ability to learn from social environments (Summerville, 1999), and the impact of cognitive styles on the use of learning strategies (Jonassen, 1988; Liu and Reed, 1994), few studies have considered affective variable and cognitive styles together in teacher training programs. Daniels (2009) examined cognitive style field dependence/independence based on the learner control of presentation mode within an educational hypermedia environment. Having problem-solving and recall rates

as independent variables, he also explored the causal relationship between field dependency and the provision of control (i.e., program or learner) over presentation mode in hypermedia environments. He found no correlation between field dependency and frequency of multimedia selections, nor a predictive relationship between field dependency and selection of presentation mode does not offer any significant benefit to users of hypermedia, nor does it accommodate the perceptive and cognitive differences associated with the cognitive style field dependence/independence. Daniels (2009) speculates that affective factors might have involved in the decision making process and confesses that examining the cognitive and affective variables that influence how learner interact in hypermedia environments may be more illuminating than post test measures of how much they learned. A correlation analysis was conducted to test the first hypothesis. Contrary to expectations, the results revealed insignificant correlation between participants' academic achievement and their cognitive styles ($r = .14$, $p = .15$). The results suggested that cognitive style had insignificant relationship with the participants' achievement scores. In other words, participants' cognitive styles did not depend on their achievement scores.

There result did not support the previous studies which emphasized an association between the type of cognitive style and academic achievement (Dwyer and Moore, 2001). This may be due to the variation in the course subjects that students had taken from the first year through the fourth year and/or instructors' teaching preferences in those classes. It was against this background that this study attempt to investigate the influence of dependent/independent cognitive styles on Mathematics among Secondary School Students in Bida Educational Zone. The following research questions were formulated to guide this study.

1. How does the dependent cognitive style influence students' achievement in mathematics as measured by their mean scores?
2. What influence has the independent cognitive style on students' achievement in mathematics as measured by their mean scores?
3. To what extent is gender a factor of dependent students' achievement in mathematics as measured by their mean scores?
4. To what extent is gender a factor of independent students' achievement in mathematics as measured by their mean scores?

Two null hypotheses were formulated and tested at 0.05 level of significant in order to make decisions on the issues investigated in the study

1. There is no significant difference between the mean scores of dependent and independent students cognitive styles as measured by PCSQ.
2. There is no significant difference between male and female students mean scores of dependent and independent students cognitive styles as measured by MAT.

METHOD

The study employed ex-post-facto designed to determine the influence of dependent and independent cognitive styles on students' achievement in mathematics among public secondary schools in Bida Educational Zone of Niger State, The population of this study

ISSN: 2141-6753

comprises 1000 senior secondary school students. The sample of the study was 100 students consisting of 49 dependent (25 male and 24 female) students as well as 51 independent (25 male and 26 female) students. This was drawn through multi stage sampling technique. The Group Embedded Figures Test (Witkin et al. 1984) was use to determine the participants' cognitive styles. All students in selected classes were administered with the instrument of the study. The Participants' Cognitive Styles Questionnaire (PCSQ) was then used to classify the student into dependent and independent cognitive styles. Only students whose scores in the (PCSQ) clearly indicated that they belonged to either of the extremes of the dependent/independent cognition styles were selected.

The Participants' Cognitive Style Questionnaire (PCSQ) with 10 items was adopted and use for the study and Mathematics Achievement Test (MAT) objective test with 30 items questionnaire constructed by the researcher with the help of SSII Mathematics teachers. Both the PCSQ and MAT were face validated by experts in educational psychology, measurement and evaluation, and mathematics education in terms of their suitability in generating the designed data for the study. The reliability coefficient of 0.86 and 0.81 for the PCSQ and 0.92 for the MAT respectively were established.

RESULTS AND DISCUSSION

Table 1 shows that independent students had mathematics Mean Achievement scores of 2.89 with a corresponding standard deviation of 0.643. Their dependent cognitive style counterparts on the other hand scored a mean of 2.68 and standard deviation of 0.608 in mathematics. Table 2 shows that independent male students had a mean achievement score of 3.27 and standard deviation 0.197. The dependent cognitive style female students on the other hand had a mean score of 2.84 in Mathematics and a corresponding standard deviation score of 0.501. For independent cognitive style male students, a mean achievement score of 3.22 and standard deviation of 0.297 were recorded. Dependent males on their own part had a mean score of 3.19 and standard deviation of 0.298.

Table 3 shows that the calculated t value of 1.68 is less than the critical t value of 1.96 at $p< 0.05$ level of significant and df of 98. The null hypothesis one is therefore accepted. This implies that significant difference does not exists in the mean scores of dependent and independent cognitive styles as measured by PCSQ. This is in favour of the independent students. On table 4, it is observed that the calculated t value of 5.606 of the independent students is greater than the critical t value 1.96 at 98 df and $P<0.05$ level of significant. The null hypotheses two of the independent cognitive style students is therefore rejected. This means that significant difference exists between Mathematics Achievement of independent cognitive style male and female students as measured by MAT in favour of the independent male students. Furthermore, it is also observed that the calculated t value of 0.50 of the dependent students is less than the critical t value 1.96 at 98 df and $P<0.05$ level of significant. The null hypotheses two of the dependent students is therefore accepted. This means that significant difference does not exists between Mathematics Achievement of dependent cognitive style male and female students as measured by MAT in favour of the dependent cognitive style male students.

ISSN: 2141-6753

The findings of this study reveal that significant difference does not exist in the mean scores of dependent and independent cognitive styles students as measured by PCSQ. This is in favour of the independent students. This finding is line with the early findings of some of the elements of cognitive styles focus on whether a person is field-dependent or independent (Witkin *et al*. 1981; global or analytic (Dwyer and Moore, 2001). Concrete or abstract (Jonassen and Grabowski, 1993), random or sequential (Summerville, 1999); risk-taking or cautions (Jonassen, 1988); and dependent or independent (Witkin *et al.* 1977, 1984). According to Lieu and Reed (1994), an individual's cognitive style is a basic intellectual determinant in his/her level of achievement. From the point of view of personality,

Further more, the finding of this study reveals that, the null hypotheses two of independent students is therefore rejected. This means that significant difference exists between Mathematics Achievement of dependent and independent cognitive styles male and female students as measured by MAT in favour of the males independent students. Conversely, the finding of this study reveals that, the null hypotheses two of dependent students is therefore accepted. This means that significant difference does not exists between the mathematics achievement of dependent and independent cognitive styles male and female students as measured by MAT in favour of the males dependent students. Earlier research suggested a significant association between cognitive styles and academic achievement (Dwyer and Moore, 2001). Yet, unlike previous studies, this study revealed no significant association between mathematics achievement of dependent and independent cognitive styles. Prior studies (Witkin, Moore, Goodenough & Cox, 1997; Cakan, 2001) have shown that field-independent and field-dependent studies do not differ in learning ability but may respond differently to the content being presented as well as the learning environment.

Table 1: Mean and Standard Deviation for Dependent and Independent Students Achievement in Mathematics

Cognitive Styles	**Mean**	**Standard Deviation**
Independent	2.89	0.643
Dependent	2.68	0.608

Table 2: Mean and standard Deviation of Dependent and Independent Male and Female Students Achievement in Mathematics

Cognitive Styles	**Gender**			
	Male		**Female**	
	Mean	SD	**Mean**	SD
Independent	3.27	0.197	3.22	0.297
Dependent	2.84	0.501	3.19	0.298

Table 3: t-test Analysis of the differences between the mean scores of Dependent and Independent cognitive styles as measured by PCSQ

Groups	X	SD	Df	T-cal	t-crit	
Decision						
Independent	2.89	0.643	98	1.68	1.96	NS
Dependent	2.68	0.608				
P< 0.05						

ISSN: 2141-6753

Table 4: t-test of the Difference in Mathematics Achievement of Dependent and Independent Male and Female students as measured by MAT

Cognitive Style	Gender				Df	t-cal	t-crit	Decision
	Male		Female		98		1.96	
	X	SD	X	SD				
Independent	3.27	0.197	3.22	0.297		5.606		S
Dependent	2.84	0.501	3.19	0.298		0.500		NS

P< 0,05

CONCLUSION AND RECOMMENDATIONS

To conclude, the construct of cognitive style has been treated as a promising variable which may explain differences observed among students' mathematics achievements on various topics and provide us a better understanding of students' achievement by investigating the interactional and casual effect of affective variables. The current findings would help instructional designers and practitioners develop better quality instructional delivery methods to help field-dependent learners to become independent as such they can process information, mode of perceiving, thinking, problem-solving and remembering and so on. Based on the finding of this study, the following recommendations were made to help the dependent cognitive style students to become independent cognitive style students, these include:

1. Model the dependent cognitive style student as a teacher
2. Help dependent cognitive style students set higher standard for performance
3. Encourage the dependent cognitive style students to label new information as they work on a given task.
4. Talk with the dependent cognitive style students about taking time to think through an answer before responding.

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