Cognitive Style as a Determinant of Academic Achievement of Secondary School Science Students in Onitsha Education Zone

Nwanze Azubuike Cornelius
Inyi secondary school, Inyi,
Delta State, Nigeria,

Konyefa Bridget Izondeme
Department of Chemistry, School of Science Education,
Isaac Jasper Boro College of Education,
Sagbama, Bayelsa State,

Ezeanya Maureen Chinyere
Department of Science Education,
Nnamdi Azikiwe University,
Awka,

Abstract
The study investigated cognitive style as a determinant of academic achievement of secondary school science students in Onitsha Education Zone of Anambra state. Four research questions guided the study and four hypotheses were tested at 0.05 level of significance. The study adopted the mixed method research design with correlational survey and ex-post-facto background. The study population comprised 8, 202 science students out of which a sample of 600 students were drawn for the study using a multi-staged sampling procedure. The instrument for data collection was Witkin's Embedded Figure Test (WEFT) validated by experts and a Kuder-Richardon-20 reliability coefficient of 0.62. The method of data collection involved administering the instrument to the students with the aid of research assistants and their achievement scores in chemistry, physics, biology and mathematics obtained from their teachers' diary. The data obtained were analyzed using descriptive statistics, analysis of variance, analysis of covariance and regressions. The results revealed that the predominant cognitive style among science students was the field dependent style and that field independent students achieved significantly higher than field dependent students. The study also revealed that cognitive style is a significant determinant of the secondary school students' achievement in science. The study recommended that field dependent and field neutral students who are already studying science or who hope to choose sciences later should be exposed to other science achievement determinants that can boost achievement and be trained to develop those personality structures and skills.

Keywords: *cognitive style, science, achievement, gender, determinant*

Introduction

The role of science in the development of a nation unanimously agreed to be indispensable. 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 secondary level of education, students study core science subjects such as chemistry, physics biology and mathematics. The government to achieve development through science however, must ensure that the objectives of science education match the intellectual capacity of the students who are the citizens of the nation.

This is because learning is primarily a cognitive activity and every child is unique in terms of his inherent nature and inborn potentialities and processes information in a manner unique to them (Vandana, 2017). Neurological research also established that the left hemisphere of the brain is responsible for logical/rational functions and the right hemisphere for intuitive/judgemental functions (Madhuri & Rani, 2016). The hemispheric dominance is also referred to as cognitive style.

Cognition according to Margret (2015) is generally taken to include such mental activities as thinking and conceptualization and deals with things like memory, mental imagery, perception and retention, reasoning and decision making and representation. The definition of cognitive by Neisser (1967) gave a more progressive conception of cognitive process to be:

> *The term "cognition" refers to all processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used. It is concerned with these processes even when they operate in the absence of relevant stimulation, as in images and hallucinations (Neisser, 1976, p.19)*

Style subsumes personal as well as cognitive characteristics. Thus, the term cognitive style was conceptualized in this study as the control process or style which is self-generated, transient, situationally determine conscious activity that a student uses to organise and to regulate, receive and transmit information and ultimate behaviours.

Earliest studies (Kagan, Rosman, Day, Albert & Phillips, 1964; Messick, 1970; Pask, 1976; Witkin, 1970, 1976) on how students' process information have resulted in different theories among which Herman Witkin's field dependence model was considered to be one of the most established and widely researched model in the field. In Witkin's study, the unique manner of processing information was termed cognitive style and the measure of the construct was the determination of cognitive perception. Cognitive style was defined in Witkin's theory as a measure of the extent to which an individual can overcome the effects of irrelevant background elements when consciously focusing on a learning task or activity. Cognitive style has been defined by Terrance, Susan and Leonhard (2001) as information processing habits representing the learner's typical mode of perceiving, thinking, problem-solving, and remembering.

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). Other research studies posit that from extensive evidence accumulated over the years, cognitive style play significant role in problem-solving and thinking as well. Cognitive style according to Witkin (1972) is a potent variable in students' academic choices and vocational preferences; in students' academic development through their school career; in how students learn and teachers teacher and in how students and teachers interact in the classroom. The necessity of the present study arose however, from Witkin's report that cognitive style is a factor in academic evolution and achievement.

According to Witkin, 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. He further established that:

> *'Underlying the connection between field-dependence-independence and academic and vocational choices is, first of all, 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 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. Finally, cognitive style has been implicated*

in the important phenomenon of shifts in major during the college years (Witkin, 1972, p.14)'

Students in the senior secondary level of education are present with the option of choosing to pursue a study in the sciences, arts or humanities. Quite often, the number of students opting for arts and humanities are enormous and has consistently been greater than the number of those going for sciences. The ratio of science students to other disciplines has been given a higher quota for admission by the Federal Government of Nigeria to ensure that more students are educated within the science orient. A number of incentives have also been put in place to incite students to choose sciences. State governments are making efforts to improve science learning and its application in their state through state science exhibitions and trade-fare, institution of ministries of science and technology and building of innovation hub for training and retraining in science careers. A lot of research has been going on also among educational researchers on how to develop innovative instructional strategies and implement them during instruction to help students improve achievement in science subjects. Despite these efforts, students' achievement in science subject has been greeted by appalling remarks from the Chief Examiners and the interest in science learning dwindles greatly.

The study of science seems to demand more of analytical skills which are possessed by the field independent students whereas majority of the students are field dependent as established in earliest studies mentioned. Also, female students who has been established in those earlier studies to be field dependent tend to shy away from science while male who are more field dependent embrace science. There is need to investigate which of these extremes of cognitive style determine science achievement and the extent of such determination. There is also the need to establish through empirical study the determination of science achievement by cognitive style in relation to gender. The researcher was therefore poised to examine the role of cognitive style in science achievement given its importance in academic achievement, educational evolution and development.

The concept of cognitive style can be clearly seen among three variant styles of cognition namely: field independent, field dependent and field neutral (Witkin & Goodenough, 1981). The field Independent (FI) students rely on more internal frame of refrence that is, they are less dominated by the more obvious or salient cues that a problem presents and are thus able to perceive analytically while the field dependent (FD) students rely more on external frames of reference, depending to a greater extent on their superior social skills to solve a problem and are non-analytical but perceive globally. Witkin, Moore, goodenough and Cox (1971) further elaborated that Field dependence/ field independence measures the degree to which a learner's perception or comprehension of information is affected by the surrounding environment, or fields." Field dependents may find it hard to find the information that they are looking for, given the noise and ill-defined problems that they are working on. Field independents can find ways to recognize relevant information, or make the problems they are working 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.

Several studies have shown that students differ in academic achievement relative to cognitive style. Margaret (2015) reported from her study 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) 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 (2001), 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.

In a study by Oludipe (2014), 69 percent of students were field independent and a significant difference was observed in the achievement scores of field dependent and independent secondary school students in physics in favour of the field dependent students. There was also a significant difference between the physics achievement of field dependent and field independent males as well as female field dependent and independent students in Ogun state. Yu-Shih, Gwo-Jen and Fan-Ray (2009) field-independent learners have superior learning achievement to field-dependent learners once a context-aware ubiquitous learning environment is introduced. A study by Ogan (2012) examined the influence of cognitive style and gender on students' achievement in selected areas of mathematics. Ogan's results showed that field independent students achieved better than the field dependent students in geometry, algebra and statistics. Ahmadzade and Shojae (2013) investigated the relationship between cognitive style and achievement of male and female students of Behbahan Islamic Azad University, Iran. They found that there is a significant positive relationship between male and female students' field dependence and field independence and their academic achievement. In addition, regression analysis revealed that cognitive style is a significant predictor of academic achievement accounting for 10 percent of the variance in students' achievement. Agboghoroma (2015) in his study established that there is a significant interaction effect of cognitive style and instructional mode on students' knowledge of integrated science.

In a study, Yu (2006) examined the effects of field dependent and independent cognitive styles and cueing strategies on recall and comprehension of undergraduate students of Virginia Polytechnic Institute and State University. The students were randomly assigned to one of three treatment groups that varied in their use of cueing strategy. The results of the study showed that field independents outperformed field dependents in all tests and a significant interaction was observed between cognitive style and cueing strategy. In another study, Mehmet (2003) showed that field independent science students in Abant Izzet Baysal University, outperformed the field dependent students. The study also revealed that there was a significant interaction between instructional method and 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.

It can be seen from all the studies reviewed that field-independent students significant 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 achievement difference among science students of different cognitive style and relative to their gender. This present study which sought to examine cognitive style as a determinant of academic achievement among science students is therefore a worthwhile quest.

Purpose of the Study

The purpose of the study was to investigate cognitive style as a determinant of academic achievement of secondary school science students in Onitsha Education Zone of Anambra state. Specifically, the study sought to determine the:

1. Predominant cognitive style among secondary school science male and female students.
2. Mean achievement scores of secondary school science students based on their cognitive styles.
3. Extent to which cognitive style determine the achievement of secondary school science students in relation to gender.
4. Extent to which cognitive style determine the achievement of secondary school science students.

Research Questions

The following research questions guided the study:

1. What is the predominant cognitive style among secondary school male and female science students?
2. What are the mean achievement scores of secondary school science students based on their cognitive style and gender?
3. To what extent does cognitive style determine the academic achievement of secondary school science students?
4. What is the relative contribution of cognitive style to the academic achievement of secondary school science student?

Hypotheses

The following hypotheses were tested at 0.05 level of significance.

1. There is no significant between the mean achievement scores of secondary school science students based on their cognitive style.
2. There is no significant interaction effect of cognitive style and gender on the achievement of secondary school science students.
3. The extent to which cognitive style determines the achievement of secondary school science students is not significant.
4. The relative contribution of cognitive style to the academic achievement of secondary school science student

Method

The study is a mixed method research. The design adopted for the study was therefore correlational survey with an ex-post-facto background. The study was carried out in Onitsha Education Zone of Anambra state. The population of the study was 8,202 senior secondary two (SS2) science students in all the public secondary schools in Onitsha Education Zone out of which 600 students were involved in the study. A multi-stage sampling procedure was used compose the sample. First, twelve public senior secondary schools in Onitsha education zone were selected. Secondly, 50 SS2 science students were purposively selected in each school for the study. The reason for their selection is that their complete results on the science subjects namely: mathematics, biology, physics and chemistry were available as the time of the study and are registered in the respective science teachers' diaries.

The instrument for data collection was Witkin's Embedded Figure Test (WEFT) adopted from Witkin et al. (1971). The instrument measured students' levels of field independency through perceptual test which requires the subject to locate a previously seen figure within a larger complex figure. The test instrument consisted of 25 items for scoring. Generally, the WEFT manual (Witkin, et al., 1971) provides guidelines to identify different types of cognitive styles (Field Independent, FI, Field Neutral, Field Dependent, FD) by

displaying the norms. The instrument was validated by three experts from the Faulty of Education, Nnamdi Azikiwe University, Awka. A pilot test was conducted and the reliability of the instrument was established using Kuder-Richardson-20 to be 0.62.

The instrument was administered using 10 research assistants by following the exact procedures set out in the technical manual regarding time limits and the directions were closely followed. Students were given a maximum of 13 minutes. Each student was allowed up to 30 seconds per figure, scoring one point each time the correct figure was found during the time period. The points were added to find the total score for the student and compared against the mean scores for the students' age range from the standard data. According to the standard data, the mean range was calculated by adding the mean and standard deviation for each age to find the top end of the range while the standard deviation was subtracted from the mean to find the low end of the range. Students whose score were higher than the mean range are more field-independent, those lower than the mean range are more field-dependent while those whose score fell somewhere within the mean range has equal characteristics of field dependence and independence and were termed field neutral. Each students scores in the science subjects namely: mathematics, biology, physics and chemistry was immediately taken from the teachers' diary at the completion of the test and the mean score from the subject computed to determine the students' score in science.

Data relating to the research questions were analysed using descriptive statistics (frequency, Percentage, mean and standard deviation) and hypotheses were analyzed using Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA) and regressions. The interpretation of the correlation coefficient is as follows: $r = .00$, no relationship, $r = \mp.01\ to\ \mp 0.20$, low relationship; $r = \mp.20\ to\ \mp 0.50$, slight to fair relationship; $r = \mp.50\ to\ \mp 0.70$, substantial relationship; $r = \mp.70\ to\ \mp 0.99$, high relationship and $r = \mp 1.00$, perfect relationship. The decision rule for testing the hypothesis was reject null hypotheses when the significant value (P-value) is less than 0.05, otherwise the null hypotheses were not rejected.

Results

Research Question 1: What is the predominant cognitive style among secondary school male and female science students?

Table 1: Cognitive Style of secondary school male and female science students

Cognitive Style	Gender		Total	Percentage
	Male	Females		
Field-independent	102	65	167	27.83%
Field-dependent	85	141	226	37.67%
Field-neutral	79	128	207	34.5%
Total	266	334	600	100

Table 1 show that males (102) are more field independent than the females (65). Female on the other hand are more field dependent (141) than males (85). There are more female field neutral female science students (128) than male field neutral science students (79). 37.67% of the science students are field-dependent, with 27.83% being field-independent where 34.5% are field-neutral. The predominant cognitive style was therefore the field-dependent style. The predominant cognitive style among male science students was the field independent style while among the female science students, field-dependent cognitive style was predominant.

Research Question 2: What are the mean achievement scores of secondary school science students based on their cognitive style and gender?

Table 2: Mean achievement score of secondary school science students based on their cognitive style and gender

Cognitive Style	Gender	N	Mean	SD
Field-independent (FI)	Male	102	76.94	3.86
	Female	65	76.25	3.97
	Total	167	76.67	3.90
Field-dependent (FD)	Male	85	69.31	14.41
	Female	141	67.59	16.03
	Total	226	68.23	15.43
Field-neutral (FN)	Male	79	70.54	16.81
	Female	128	64.11	15.42
	Total	207	66.57	16.23
Total	Male	266	72.60	12.91
	Female	334	67.94	14.86
	Total	600	70.01	14.21

Table 2 shows that FI male science students achieved slight higher (76.94) than the females (76.25), with FD male student achieving slightly higher (69.31) than the females (67.59) where FN male science students also achieved higher (70.54) than the females (64.11). FI male students achieved higher (76.94) than FD male science students (69.31) and FN male science students. FN male students also achieved higher than FD male science students. FI female students achieved higher (76.25) than FD female science students (67.59) and FN female science students (64.11). FD female students also achieved higher than FN female science students. FI science students has a higher mean achievement score of 76.67 than FD science students with a mean achievement score of 68.23 and FN science students with mean achievement score of 66.57. The FI science students have a more homogeneous mean science achievement score (3.903) than FD students (15.43) and FN students (16.23).

Research Question 3: To what extent does cognitive style determine the academic achievement of secondary school science students?

Table 3: Extent to which cognitive style determine academic achievement of secondary school science students

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.253[a]	.064	.062	13.759

a. Predictors: (Constant), Cognitive Style

Table 3 shows that there exist a low positive relationship between cognitive style and academic achievement of secondary school science students. Table 3 also shows that cognitive style determined 6.4% of science students' achievement.

Research Question 4: What is the relative contribution of cognitive style to the academic achievement of secondary school science student?

Table 4: Relative contribution of cognitive style to the academic achievement of secondary school science student

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	59.337	1.762		33.672	.000
	Cognitive Style	.727	.114	.253	6.388	.000

a. Dependent Variable: Achievement

Table 4 shows that every unit rise in the cognitive style of science students among other factors increases academic achievement by 0.727.

Hypothesis 1: There is no significant difference between the mean achievement scores of secondary school science students based on their cognitive style.

Table 5: 3X2 ANCOVA on significant of difference between the mean achievement scores of secondary school science students based on their cognitive style and gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	12776.012[a]	5	2555.202	14.034	.000
Intercept	2796202.632	1	2796202.632	15357.222	.000
Cognitive Style	8744.475	2	4372.237	24.013	.000
Gender	1213.225	1	1213.225	6.663	.010
Cognitive Style * Gender	874.078	2	437.039	2.400	.092
Error	108153.961	594	182.077		
Total	3061490.000	600			
Corrected Total	120929.973	599			

Table 5 shows that at 0.05 level of significance, 2df numerator and 599 df denominator, the calculated F was 24.013 with Pvalue of .000 which is less than 0.05. Thus, the null hypothesis was rejected. Therefore, there is a significant difference between the mean achievement scores of secondary school science students based on their cognitive style.

Table 6: Scheffe PostHoc Test of direction of significance on difference in science students' achievement by cognitive style

(I) Cognitive Style	(J) Cognitive Style	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
FI	FD	8.146*	1.416	.000	5.366	10.927
	FN	9.267*	1.442	.000	6.435	12.098
FD	FI	-8.146*	1.416	.000	-10.927	-5.366
	FN	1.120	1.338	.403	-1.507	3.748
FN	FI	-9.267*	1.442	.000	-12.098	-6.435
	FD	-1.120	1.338	.403	-3.748	1.507

Table 6 reveals that a significant difference exists between the mean achievement scores of FI and FD science students in favour of FI. Table 6 also reveals that a significant difference exists between the mean achievement scores of FI and FN science students in favour of FI science students. Table 6 further shows that there is no significant difference between the mean achievement scores of FD and FN science students.

Hypothesis 2: There is no significant interaction effect of cognitive style and gender on the achievement of secondary school science students.

Data relating to hypothesis 2 is contained in table 5. Table 5 shows that there was no significant interaction effect of cognitive style on science students' achievement, F (2, 599) = 2.400, P (0.092) > 0.05. The null hypothesis was not rejected. Therefore, there is no significant interaction effect of cognitive style and gender on the achievement of secondary school science students. The interaction between cognitive style and gender is shown in Figure 1.

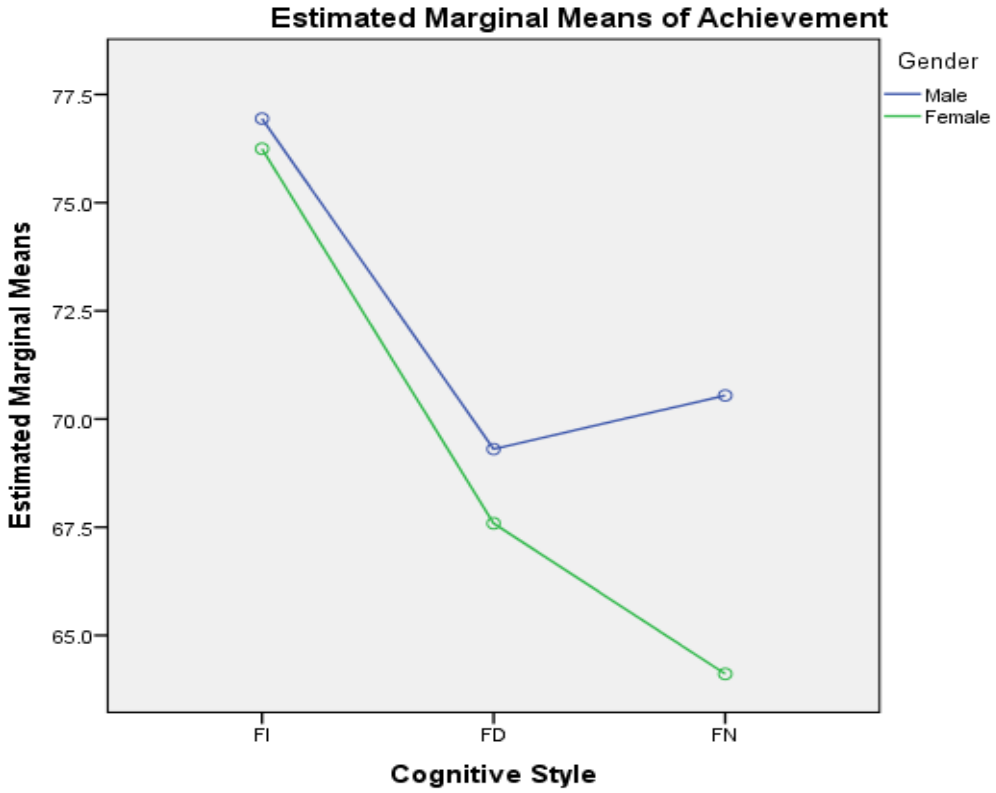

Figure 1: Interaction effect of cognitive style and gender on science achievement

The plot of interaction effect between cognitive style and gender shows that there existed a non-significant ordinal interaction between cognitive style and gender on science achievement. This implies that the main effect of cognitive style on the achievement of science students did not change when gender was put into consideration. It also implies that the effect of cognitive style on achievement of science students is not gender sensitive but gender biased. Thus, male science students whether FI, FD or FN achieve significantly higher than female FI, FD or FN respectively. This is shown in Table 5, that there was significant difference between the mean achievement of male and female science students, F (1, 599) = 6.663, P < 0.05.

Hypothesis 3: The extent to which cognitive style determine the academic achievement of secondary school science students is not significant.

Table 7: Test of significance on the extent of determination of science students' achievement by cognitive style

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7725.572	1	7725.572	40.810	.000
	Residual	113204.401	598	189.305		
	Total	120929.973	599			

Table 7 shows that at 0.05 level of significance, 1df numerator and 599 df denominator, the calculated F was 40.810 with Pvalue of .000 which is less than 0.05. Thus, the null hypothesis was rejected. Therefore, the extent to which cognitive style determines the academic achievement of secondary school science students is significant.

Hypothesis 4: The relative contribution of cognitive style to the academic achievement of secondary school science student

Data relating to hypothesis three is contained in Table 4. It shows that with a t-value of 6.388 and Pvalue of 0.000, the relative contribution of cognitive style to the academic achievement of science students was significant.

Discussion

The findings of the study showed that the predominant cognitive style among science students was the field-dependent style. Male students were predominantly of field independent cognitive style whereas females were more predominantly field dependent. It was also revealed in the results that in field independent cognitive style, males were more than female while females where more than males in field dependent and field neutral styles. The findings of the study also showed a significant difference in achievement score of science students based on cognitive style in favour of FI followed by FD and FN. These observations in the result explains why there are more male dominance in science disciplines that require more field independent cognitive style than females. Field independent students tend to be more analytical and perceive problems in their unit details resulting in better science achievement.

The results of the study also explain the preferential choice made by male students towards science when presented with the options including arts and humanities. This fact is validated by the result of this study that shows that Field independent males achieved significantly higher than field independent females and the same observation is seen among field dependent and field neutral male and female students. It is no wonder there was a gender-based interaction effect of cognitive style and gender on the achievement of science students favouring the males. The findings of the study are at contrast to the finding of Margaret (2015) that more males were found to be field dependent while more female were found to be field independent. The findings of the study are at contrast also with the findings of Terrance, Susan and Leonhard (2001) and Oludipe that a vast majority of the students are field independent as against the predominant field dependent science students found in the present study. The finding of predominant cognitive style was supported by the finding of Ramlah (2014) the predominant cognitive style was field dependence. The findings of the study contravened the findings of Agboghoroma (2015) and Mehmet (2003) that there is a significant interaction effect cognitive style and gender on students' achievement. The findings however supported the finding of Margaret (2015) that field independent students scored higher than field dependent students and the findings of other researcher namely: Oludipe (2014), Yu-Shih, Gwo-Jen and Fan-Ray (2009), by Ogan (2012), Yu (2006) and Mehmet (2003).

The study also revealed that there exist a significant positive relationship between cognitive style and academic achievement of secondary school science students, significantly

determining 6.4 percent of the variance in their science achievement. Every unit rise in cognitive style also improved science achievement by approximately 1 percent. Depending on the cognitive style of the students, problems can be perceived without distraction from the surrounding fields or cues resulting in improved achievement. As students cognitive style proceed from field dependence through to field independence, the global and social perception of science problems reduces and the student tend to focus more accurately on the objective of instruction. The findings of the study are supported by Vandana (2017), Margaret (2015), Lusweti, Kwena and Mondah (2018), and Ahmadzade and Shojae (2013).

Conclusion

The conclusion drawn from the present study is that although secondary school science students in Onitsha Education Zone are predominantly field dependent, field independence tend to favour science achievement more than field dependence. The study also establishes that male science students irrespective of their cognitive style attain better science achievement than their female counterparts. Finally, cognitive style is a significant determinant of academic achievement of secondary school science students.

Recommendations

In the light of the findings of the study, it is recommended that:

1. Secondary school students should be guided and counselled based on their cognitive style at the point of selection of the discipline which they hope pursue throughout their academic endeavour.
2. Field dependent and field neutral students who are already studying science or who hope to choose sciences later should be exposed to other science achievement determinants that can boost achievement and be trained to develop those personality structures and skills.
3. Although cognitive style may be genetically inherent, acquired, developed due to environmental factors and upbringing, effort should be made to train field dependent and field neutral science students to develop more analytical skills and modify their cognitive style.

Suggestion for Further Studies

The following are suggested for further research consideration.

1. A study of predominant cognitive style among male and female students across different disciplines, age, academic level, family background and upbringing using a wider population sample.
2. A meta-analytic study of interactions of instructional approaches and cognitive style to determine the more effective instructional approach for FI, FD and FN science students.

References

Agboghoroma, T. E. (2015). Interaction effects of cognitive style and instructional mode on students' knowledge of integrated science. *European Journal of Research and Reflection in Educational Science, 3*(1), 47- 54.

Ahmadzade, L. & Shojae, M. (2013). Investigating the relationship between cognitive style (filed dependence/independence) and academic achievement in male and female students of Behbahan Islamic Azad University. *Journal of Life Science and Biomedicine, 3*(3), 245-249.

Kagan, J., Rosman, B. L., Day, D., Albert, J. & Phillips, W. (1964). Information processing in the child: Significance of analytic and reflective attitudes. *Psychological Monographs: General and Applied, 78*(1), 1–37. Doi.org/10.1037/h0093830

Kagan, J., Rosman, B. L., Gellel, A. (2005). *Can cognitive style predict scholastic performance? A study of 13 year olds.* A paper presented at the 11th biennial conference of the European Association for Research on Learning and Instruction, Nicosia, Cyprus.

Lusweti, S., Kwena, J. & Mondah, H. (2018). Predictive power of cognitive style on academic performance of students in selected national secondary schools in Kenya. *Cogent Psychology, 5*, 1-9.

Madhuri, H. & Rani, D. (2016). Significance of cognitive style for academic achievement in mathematics. *Scholarly Research Journal for Humanity Science & English language, 4*(22), 5521-5527.

Margaret, N.M. (2015). Cogntive styls and academic achievement among secondary school learners in Kenya. (Unpublished mater's thesis) Department of measurement and evalution, University of Nairobi.

Mehmet, B. (2003). *The effect of instructional methods on the performance of the students having different cognitive styles*. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 24*, 26-32.

Messick, S. (1970). The criterion problem in the evaluation of instruction: Assessing possible, not just intended, outcome. In W.C. Wittrock & D.E. Wiley (eds.), *The evaluation of instruction: Issues and problems* (pp. 183-202). New York, NY: Holt, Rinehart Winston.

Ogan, R. (2012). *Influence of cognitive style and gender on students' achievement in selected areas of mathematics*. (Unpublished Master's thesis), University of Nigeria, Nsukka.

Oludipe (2014). Cognitive style profile and physics achievement of senior secondary school students in Ogun state, Nigeria. *Journal of Education and Practice, 5*(8), 69-75.

Pask, G. (1976). Styles and strategies of learning. *British Journal of Educational Psychology, 46*, 128–148. Doi.Org/10.1111/Bjep.1976.46.Issue-2

Ramlah, B.J. (2014). Relationship between students' cognitive style (field-dependent and field-independent cognitive styles) with their mathematics achievement in primary school. *International Journal of Humanities, Social Sciences and Education (IJHSSE), 1*(10), 88-93.

Terrance, P.O, Susan, M.B. & Leonhard, E.B. (2001). Group embedded figures test and academic achievement in engineering education. *International Journal of Engineering Education, 17*(1), 89-92.

Vandana, S. (2017). Exploring the relationship between cognitive style and learning style with academic achievement of elementary school learners. *Educational Quest: An International Journal of Education and Applied Social Science, 8*(special issue), 413-419.

Witkin, H., Moore, C. A., Goodenough, D., & Cox, P. W. (1977). Field-Dependent and field-independent cognitive style and their educational implications. *Review of Educational Research, 47*, 1-64

Witkin, H.A. & Goodenough, D.R. (1981). Cognitive styles: essence and origins, field dependence and field independence, *Psychological Issues, 14* (Whole issue), No. 51.

Witkin, H.A. (1972). *The role of cognitive style in academic performance and in teacher-student relations.* Paper presented at a symposium on cognitive styles, creativity and higher education sponsored by the Graduate Record Examination Board, Montreal, Canada.

Witkin, H.A. (1976). Cognitive style in academic performance and in teacher-students relations. In S. Messick, et al. (eds.), *Individuality in learning* (pp. 38-72). Sam-Francisco, CA: Jossey-Bass.

Yu, C (2006). *Effects of field dependent and independent cognitive styles and cueing strategies on students' recall and comprehension*. (Unpublished Dissertation), Virginia polytechnic Institute and State University.

Yu-Shih, L., Gwo-Jen. H. & Fan-Ray, K. (2009). Effects on cognitive styles in students achievement for context-aware ubiquitous learning. In S.C. Kong, H. Ogata, H.C. Arnseth, C.K.K. Chan, T. Hirashima, F. Klett, J.H.M. Lee, C.C. Liu, C.K. Looi, M. Milrad, A. Mitrovic, K. Nakabayashi, S.L. Wong, S.J.H. Yang, (eds.) (2009). *Proceedings of the 17th International Conference on Computers in Education [CDROM]*. Hong Kong: Asia-Pacific Society for Computers in Education.