

Effect of Cognitive Style on Students Achievement and Retention in Physics in Senior Secondary School in Gwer-West Local Government Area, Benue State, Nigeria

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Abstract

This study was undertaken to determine the effect of cognitive styles on students' achievement and retention in physics in senior secondary schools in Gwer-west local government area of Benue state. The study therefore looked at the achievement and retention of male and female students categorized under field independent and field dependent students in physics. Three research questions and three research hypotheses were set to obtain data for effective study. The study adopted the ex-post facto research design. The population of the study comprises 1015 SS1 physics students of 2016/2017 academic year in the twenty-nine co-educational schools of Gwer-west local government area of Benue state. The sample of the study was 150 physics students selected from five secondary schools out of 29 schools through judgmental sampling technique. The instruments for data collection were Group Embedded Figure Test (GEFT), Physics Achievement Test (PAT) and Physics Retention Test (PRT). Data collected was analyzed using descriptive analysis under parametric analysis to determine the mean and standard deviation. While the hypotheses were analyzed using statistical analysis of covariance (ANCOVA). The results of the findings therefore revealed that field independent students achieved better than the field dependent students in physics. It also showed that field independent students had a higher retention memory than field dependent students. Furthermore, it revealed that male students achieved better than female students under field dependent in physics. The analysis further explained that there was a significant difference in the entire three null hypotheses. Finally, summary, conclusion, recommendations were made and suggestions for the extension of the research to other levels of education were made.

1. Introduction

Education in the broad sense entails all those experiences of the individual through which knowledge is gained. Education can only be achieved when it involves the active participation of the learner upon whom the whole idea of teaching and learning lie upon. According to John (2012), education is a systematic process through which a child or an adult acquires knowledge, experience, skill and sound attitude. It makes an individual civilized, refined, cultured and educated. For a civilized and social used society, education is the only means. Denga (2005), in Rose (2014) defines education as the processes by which individuals acquired physical and social capabilities required by the society in which they are born for daily functioning.

Physics can be defined as the branch of science concerned with the nature and properties of matter and energy. The subject matter of physics includes mechanics, heat, light and other radiation sound, electricity, magnetism and structure of atoms. Physics is a science subject that deals with objects and their motion, matter, energies, heat, temperature and the fundamental relationship between space and time including their related specific basic or derived units as well as light, electricity and sound.

The present senior secondary school physics curriculum is built on the conception of students as both product and process (Onah and Ugwu, 2010). As a process, they asserted that the subject has to do with the skills that come into play by scientists in carrying out scientific investigation, which implies adopting an inquiry method in the teaching and learning of physics at the secondary school level. As a product, they argued that it consists of scientific facts, principles, laws and generalizations derived from scientific investigations.

According to Fasanya (2005) as (cited in Ayodele, 2016, p. 30) physics is a vital subject in the Nigerian school curriculum because of its potential to enhance the study and acquisition of relevant technology necessary for suitable human development and environmental management. He reported that despite the potent application of physics vis-à-vis technology for nation building,

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many students step aside from selecting it as one of their science subjects' combination for the Senior Secondary School Certificate Examination (SSCE). This is because most students feel that physics is a very difficult subject which cannot be handled by average students except the most intelligent ones. However, the technological advancement of various nations all over the world proved that physics is a vital discipline in every sphere of life.

Evidently, it can be seen as vital, where an x-ray machine or device built by technologists using the knowledge of physics is capable of photographing the human body to detect the internal sickness for medical treatment. The application of the knowledge of physics had led to the manufacture of aeronautics, nuclear devices, atomic bomb, electricity, satellites, space rockets and astronomical devices. Engineering uses the knowledge of physics in the application of its practical work to enhance technology. It also aims at equipping students with appropriate scientific skills, attitudes, competencies and ability to apply scientific knowledge to every challenges of life. The recent trends in education have to do with the changes in direction of Nigerian educational system. Adekola and Kumbe (2012) noted that education is one of the potent tools for human capital and societal development. The general consensus among the educationists and development practitioners is that no nation can develop beyond the level of her education.

Cognitive styles refer to the mental endowment acquired by an individual right from birth. In other words, it refers to an individual way of learning, perceiving, thinking, judging and reasoning, Ogan (2012). Katrina as in Oludipe (2014), sees it as the ability to carry out abstract thinking. Tella as cited in Oludipe (2014) was of the view that cognitive style is sine-qua-non to the elevation of students' achievement in learning and a significant predictor of future achievement. Cognitive psychologists such as Ausubel, Brunner, Gagne and educators (teachers) have been interested in understanding the individual differences in cognition and their impact on learning and instruction Altum and Cakan in Ogan (2012).

The nature of mental development exhibited by an individual is entirely different from one individual to another. This accounts for the difference in the level of achievement and retention of

information by an individual. Cognitive style is a psychological construct which is concerned with how an individual learns, thinks, remembers, solves problems and relates to others. Pitcher (2002) in Bruno (2015), defines cognitive style as the relatively stable strategies, preferences and attitude that determines an individual's typical modes of perceiving, remembering and problem solving. This implies that each student has a preferred cognitive style which is affected by such factors.

Over a decade a more serious attention has been paid to cognitive style by educational investigators. This is because it is a relevant factor that necessitates the process and results of learning in sciences. Besides, it is the paramount issue that has continued to be examined in the educational, psychological, and organizational research. The way an individual retrieves processes and utilizes information varies from other individuals. That is why the level individual's cognitive styles is never the same with other individuals' achievement in physics. The individual difference in cognitive styles of remembering, thinking, and judging are put together to come up with the view that individuals have different cognitive styles and are different in intelligence, ability, personality and achievement.

The knowledge of physics has been found to be vital to humanity and students' achievement over the years not really encouraging. Statistics from the West African Examination Council (WAEC, 2013; 2014; 2015) reported that students inability to achieve high scores in physics are attributed to a plethora of contributing factors among which are incompetent mode of teacher's mastery and delivery of concepts in the subject, inadequate use of instructional materials and ill-equipped physics laboratories. Thus, incompetence mode of teacher's instruction has led to inadequate development of intellectual and thinking skills among students. Looking at the relevant of physics to the national development and considering the state of poor academic achievement in the very subject at the secondary school level, incidentally, this serves as the foundation of advanced learning and professional courses in fields such as engineering, architecture and geology. The poor academic achievement noticed in physics results of students should be thing of serious and critical concern to any citizen of Nigeria.

Improvement of student's cognitive styles is a key issue in the teaching and learning process today. The cognitive styles of a learner have been identified as one of the major factors that have contributed to the massive poor achievement in physics at senior secondary schools in Nigeria. This has therefore led to the poor achievement and retention ability. More so, learning styles research have been applied at an ever increasing rate to the problems of education in order to provide solutions to the problems learners face in processing information. The ways students process and retrieve information have been found to determine their level of performance in physics.

According to Wang, (2008) as (cited in Changju, 2011), cognitive styles refer to individual's characteristics and preferred way of gathering, interpreting, organizing and thinking about information. Achievement in any learning process is solely dependent on a number of factors, prominent among which are the teacher's learner's cognitive pattern, environment and method of instruction. The cognitive style difference may affect the achievement of the learners. Achievement according to Abakpa (2011) is the measure of accomplishment in a specific field of study. He argued that achievement in physics test is the demonstration of a child's ability to attain certain level of instructional objectives out of his classroom experience. Therefore, the cognitive style of an individual is the basic determinant factor in student's achievement and retention in any sphere of life. It is also worthy to emphasize on the retention capacity of an individual. Retention (memory) in learning is the ability to keep or retain facts, figures and information in the student's memory.

Learning is said to have occurred when what is learnt remains relatively permanent in the mind of the learner. Hence, retention of

what is learnt by students is very important. The level of retention among students varies according to their abilities and skills. A typical investigation is that, students forget most of the specific facts taught, but remember the important concepts and principles. Hence, the study further attempts to inquire if there is a means of enhancing physics achievement and retention in students based on their various cognitive styles.

Another important factor that influences students' achievement and retention in physics has been realized to be gender. Many studies have shown that there exist sex differentials between cognitive styles and achievement. Most often, researchers refer sex as boys and girls when issues related to education are being discussed. Male and female basically seem to differ in their learning preferences. Amali (2013) described gender to reflect the cultural construct of male and female. In fact, Witkin's field-dependent cognitive style theory predicted that females are more likely to have a global or field dependent cognitive style, whereas males are more analytic or field-independent cognitive styled.

A number of cognitive styles have been designated in the learning of physics for over two decades. No effort seems to have been made towards investigating the effects of the two major cognitive styles which are the field-independent and field-dependent used by learners in schools on achievement and retention. To subdue this problem of poor achievement and retention in physics in relation to the cognitive styles of the learners, there is need to strive for a balance of effective learning strategies and the individual cognitive styles. It is hoped that the enhancement in balance will enable students with their various preferred cognitive styles to improve on achievement in physics, as well adopt strategies which will lead to an augmented comfort level to learn and acquire high retention achievement rate. It is against this background that the researcher seeks to make findings on the effect of cognitive styles on students' achievement and retention in physics in senior secondary school (sss1) in Gwer-West Local Government Area of Benue State.

Records of previous results announced by examination bodies like (WAEC) and (NECO) over a decade have shown that there have been public outcries from government, parents, teachers including students due to massive failure in performance of physics. This is evident from WAEC and NECO examination report in the number of years (2013, 2014-2015). The persistent poor trend in achievement score in physics among students in Nigeria may be attributed to the nature of cognitive styles of students. Bhavna and Mark, (2010) also highlighted that students who are aware of different learning styles find it easier to adapt to different learning situations and teaching strategies. The cognitive style of the learner can affect the learning strategies adopted by the learner. It may therefore affect the academic achievement of the learner.

2. Purpose of the Study

The main purpose of this study is to investigate the effect of cognitive styles/patterns on students' achievement and retention in physics in senior secondary schools in Gwer-West Local Government Area of Benue State. Specifically, the objectives are:

1. To determine the mean achievement scores of physics students that exhibit field dependent and field independent cognitive styles.
2. To determine the retention scores of students that exhibit field dependent and field independent cognitive styles in physics.
3. To determine the achievement scores among male and female students in field dependent cognitive styles in physics.

2.1 Research Questions

- i. What are the mean achievement scores of students with field dependent and field independent cognitive styles in physics among secondary schools?
- ii. What are the mean retention scores of physics students of field dependent and field independent cognitive styles in physics in secondary schools?
- iii. What are the mean achievement scores between male and female students with field dependent cognitive styles in

physics?

2.2 Research Hypotheses

The following hypotheses have been formulated for the purpose of this study;

- Ho: There is no significant difference in the mean achievement scores of students that exhibit field dependent and field independent cognitive styles in physics in senior secondary schools in Gwer-West.
- Ho: There is no significant difference in the mean retention scores of students that exhibit field dependent and field independent cognitive styles in physics in senior secondary schools in Gwer-West.
- Ho: There is no significant difference in the mean achievement scores of male and female students that exhibit field dependent cognitive styles in physics in senior secondary schools in Gwer-West.

3. Methodology

This chapter is concerned with the methodology of the study under the following sub-headings: Research design, area of the study, population of the study, sample and sampling techniques instrument for data collection, validation of the instrument, trials testing, reliability of the instrument, procedure of the study, method of data collection, and method of data analysis.

3.1 Research Design

This study will adopt an ex-post facto research design in which the independent variables have already occurred and no manipulation will be done on them to ascertain the level of cause and effect relationship of the dependent variables. Since it is aimed at establishing possible causes for behavior pattern by comparing subjects in whom it absents to a lesser degree (Emaikwu, 2013). The design is sometimes called casual-comparative research, since cases are studied after they have presumably exerted their effects on smaller variable which also seeks to establish its cause effect relationship.

3.2 Population of the Study

The population of the study covered all the twenty-nine secondary schools (SS1), sum up to the total of 1015 students as contained in the statistical data obtained from the Area Education Office in Gwer-West Local Government Area Naka. It is worthy of note that the secondary schools comprise co-educational schools and the choice of co-educational schools in that gender is a variable in the study.

3.3 Sample and Sampling Technique

The sample for this study was 150 students out of 1015 students drawn from five secondary schools out of 29 schools in Gwer-West Local Government Area Naka. Purposive or judgmental sampling technique was used to select the five schools. The schools to be selected are required to meet the following conditions (a) to be a co-educational (b) to be all private schools (c) to have physics laboratories. Simple random sampling was used in selecting the classes especially in schools where there are more than two streams of SS1 classes, the simple random sampling was employed in selecting two classes for the study and where there are only two streams of SS1, a coin was tossed to decide the class to be used.

3.4 Method of Data Collection

The questionnaires were presented to the respondents in accordance with the aid of the two research assistants. The method of administering the instruments was on the spot administration with the help of the two research assistants to ensure 100% return. The GEFT instrument was administered first to the students to enhance the classification of the students with their various cognitive styles and the students were made to comprehend the instructions very well prior to working through the items on the instrument. The instrument was collected and given to the researcher. PAT was administered after the four weeks of lesson which was followed lastly by the administration of PRT after two weeks of administering the PAT. The scripts from each student were retrieved, marked and the scores used for analysis.

3.5 Method of Data Analysis

The mean (\bar{x}) and standard deviation (SD) were employed to answer the research questions while analysis of covariance (ANCOVA) was used to test the hypotheses formulated at 0.05 level of significance, the analysis of covariance is suitable because it is a powerful tool which provides method of statistical control of the differential in the criterion scores attributable to the covariate and uses pre-test mean score as covariate to control initial difference between the subjects on a number of independent variables. Emaikwu (2010), ANCOVA was used to analyze scores obtained from GEFT and PAT tests.

4. Results and Discussions

In this chapter, the researcher presents the results obtained from the data collected in the study. The presented results are based on the research questions and hypotheses. Mean and standard deviation was used to answer the research questions while ANCOVA was used to answer the hypotheses at 0.05 level of significant.

4.1 Research Question One

Table 1: Mean and standard deviation of field dependent and field independent students in geometry

Cognitive style	N	Mean	Standard deviation
Field dependent	90	26.87	11.77
Field independent	60	68.33	11.47
Total	150		

The result presented in the table 1 above shows the mean achievement scores of field dependent and field independent students in physics. Field dependent students had a mean score of 25.87 with the standard deviation of 14.77 while field independent students recorded a mean score of 68.33 and standard deviation of 11.47 comparatively; field independent students had a higher mean score than field dependent students in physics. This clearly shows that the cognitive style of students had an effect on their academic achievement in physics.

4.2 Research Question Two

What are the mean retention scores among students of field dependent and field independent cognitive styles in physics?

Table 2: Mean and standard deviation of field dependent and field independent students in physics

Cognitive style	N	Mean	Standard deviation
Field dependent	90	25.96	11.79
Field independent	60	63.93	9.08
Total	150		

Table 2 shows the mean retention scores of field dependent and field independent students in physics. The field dependent students obtained a mean score of 25.96 and a standard deviation of 11.79 while the field independent students had a mean score of 63.93 and a standard deviation of 9.08. Therefore, the field independent students had a higher mean score than the field dependent students in physics. This clearly indicates that the cognitive styles of students had an effect on their academic memory retention in physics.

4.3 Research Question Three

What are the mean achievement scores between male and female students with field dependent cognitive styles in physics?

Table 3: Mean and standard deviation of male and female students with field dependent cognitive styles in physics

Field Dependent	N	Mean	Standard deviation
Male	70	28.20	11.55
Female	20	19.70	7.22
Total	90		

Table 3, shows the mean achievement scores of male and female students exhibiting field dependent cognitive style in Physics. The male students had a mean achievement score of 28.20 with a

standard deviation of 11.55 while the female students obtained a mean achievement score of 19.70 with a standard deviation of 7.22. In this analysis, the high mean score favored the male students while the female students scored less than the male student. This clearly indicates that even under the field dependent category, male students out-scored the female students owing to the fact that very few number of female students participated in the exercise and there is a likelihood that the male students would perform better than the female students.

4.4 Hypothesis One

There is no significant difference in the mean achievement scores of students that exhibit field dependent and field independent cognitive style in Physics in Secondary schools in Gwer- West.

Table 4: Analysis of covariance on posttest students mean achievement scores based on field independent and field dependent cognitive style.

Source	Type III sum of squares	df	Mean square	F	Sig
Corrected model	65009.092 ^a	2	32504.546	276.801	.000
Intercept	30698.019	1	30698.019	261.417	.000
Pretest	3107.652	1	3107.652	26.464	.000
Methods	64522.799	1	64522.799	549.462	.000
Error	17262.081	147	117.429		
Total	365500.000	150			
Corrected total	82271.173	149			

a. R square d = 790 (Adjusted R squared = .787)

From table 4, it shows that $F(1, 147) = 549.462$, the sig. value for the methods (field dependent and field independent) is 0.000. Hence $P=0.000 < 0.05$, therefore, the null hypothesis is not accepted. This implies that there was a significant difference in the mean achievement scores of secondary school students taught in the field dependent and field independent groups in physics in Gwer-West. This entails that the students in the field independent group achieved higher than those in the field dependent group.

4.5 Hypothesis Two

There is no significant difference in the mean retention scores of students that exhibit field dependent and field independent cognitive styles in physics in secondary schools in Gwer-West.

Table 5: Analysis of covariance on posttest students mean retention scores based on field independent and field dependent cognitive style.

Source	Type III sum of squares	df	Mean square	F	Sig
Corrected model	67950.868 ^a	2	33975.434	8210.334	.000
Intercept	86.754	1	86.754	20.964	.000
Pretest	15723.384	1	15723.384	3799.635	.000
Groups	24.478	1	24.478	5.915	.016
Error	608.305	147	4.138		
Total	323340.000	150			
Corrected total	68559.173	149			

a. R Squared = .991 (Adjusted R squared = .991)

Table 5, shows that $F(1, 147) = 5.915$, the sig. value for the groups (field dependent and field independent) is 0.016. Thus, $P = 0.016 < 0.05$, therefore, the null hypothesis is rejected. This implies that there was a significant difference in the mean retention scores of secondary school students taught in the field dependent and field independent groups in physics in Gwer-West. This clearly indicates that students in the field independent group retained higher than those in the field dependent group.

4.6 Hypothesis Three

There is no significant difference in the mean achievement scores of male and female students that exhibit field dependent cognitive styles in physics in secondary school in Gwer –West.

Table 6: Analysis of Covariance on posttest students mean achievement scores of male and female students of field dependent cognitive style.

Source	Type III sum of squares	df	Mean square	F	Sig
Corrected model	1134.252 ^a	2	567.126	4.755	.011
Intercept	6698.707	1	6698.707	56.161	.000
Pretest	10.363	1	10.363	.087	.769
Gender	1134.084	1	1134.084	9.508	.003
Error	10377.037	87	119.276		
Total	73816.000	90			
Corrected total	11511.289	89			

a. R Squared = .099 (Adjusted R squared = .078)

Table 6, indicates that $F(1, 87) = 9.508$, the sig. value for the gender (male and female) is 0.003. Hence, $P = 0.003 < 0.05$, therefore, the null hypothesis is not accepted. This implies that there was a significant difference in the mean achievement scores of secondary school students of male and female students in the field dependent gender based in physics in Gwer-West. This shows that the male students out-performed the female students in field dependent gender classification.

4.7 Cognitive style and achievement of field independent and field dependent students in physics

The findings of this study revealed that field independent students performed better than the field dependent students in their mean achievement scores in physics. The field dependent students had a mean score of 25.87 and standard deviation of 14.77. Whereas the field independent students obtained a mean of 68.33 and a standard deviation of 11.47 respectively. Further analysis was done using the analysis of covariance test on hypothesis (ANCOVA TEST). This is also indicated from table 3.1.1 where $F(1, 147) = 549.462$ and the significance value for the methods (field dependent and field independent) is 0.000. Hence, $P = 0.000 < 0.05$, therefore, the null hypothesis was not accepted. This implies that there was a significant difference in the mean achievement scores of secondary school students taught in the field dependent and field independent groups in physics in Gwer-West. This entails that the students in the field independent group achieved higher than those in the field dependent group. The finding of this study agrees with Mandana (2011) who investigated the relationship between field independent/dependent cognitive styles in Iran and found out that the field independent students achieved higher in physics than the field dependent students.

4.8 Cognitive style and retention of field independent and field dependent students in physics

Here, the finding of this study indicated that field independent students had a higher retention scores than the field dependent students in physics. This is reflected from the result presented in table 3.2 where the field dependent students obtained a mean score of 25.96 and a standard deviation of 11.79. The field independent students on the other hand, had a mean score of 63.93 and a standard deviation of 9.08 respectively. Further analysis was carried out using the analysis of covariance test on hypothesis (ANCOVA TEST). This is also shown from table 3.2.2 where $F(1, 147) = 5.915$ and the significance value for the groups (field dependent and field independent) is 0.016. Thus $P = 0.016 < 0.05$, therefore, the null hypothesis was rejected. This implies that there was a significant difference in the mean retention scores of secondary school students taught in the field dependent and field independent groups in physics in Gwer-West. This clearly indicates that students in the field independent group retained higher than those in the field dependent group. The finding of this study seems to be unique since

it does not relate to any similar previous study carried out by other researchers.

4.9 Cognitive style and achievement of male and female students under field dependent (FD) category in physics

The finding of this study showed that male students achieved better than the female students of field dependent group in physics. This can also be seen from table 3.3 where male students had a mean achievement score of 28.20 and a standard deviation of 11.55 while the female students obtained a mean achievement score of 19.70 with a standard deviation of 7.22. In this analysis, the high mean score favored the male students while the female students scored less than the male students. Further analysis was done using analysis of covariance test on hypothesis (ANCOVA TEST). This is indicated from table 3.3.3 where $F(1, 87) = 9.508$ and the significance value for the gender (male and female) is 0.003. Hence, $P = 0.003 < 0.05$, therefore, the null hypothesis was not accepted. This implies that there was a significant difference in the mean achievement scores of secondary school students of male and female students in the field dependent gender based in physics in Gwer-West. This clearly shows that the male students outperformed the female students in field dependent gender classification. The possible cause of this finding could be that female students see physics as a male subject. This is why Olaguaju in Ogan (2012) observed that boys choose science courses in high schools than girls, especially mathematics, chemistry and physics. The result of this study is not in conformity with the finding of Jabor, Machtmes, Kingu and Bunat (2011) who pointed out that female had higher mathematics GPA scores than their male counterpart

5. Conclusions

On the basis of the data analyzed, the researcher made the following conclusion:

1. Field independent students achieved more than the field dependent students in physics which explains that cognitive style determined students' achievement in physics.
2. Field independent students had a higher mean retention scores in physics than their counterpart field dependent students.
3. Male students achieved more than the female students in physics under the field dependent students.
4. There is a significant difference in mean achievement scores of field independent and field dependent students in physics.
5. There is a significant difference in mean retention scores of field independent and field dependent students in physics.
6. There is a significant difference in mean achievement of male and female students of field dependent group in physics.

5.1 Recommendations

In line with the research findings, the following recommendations are made:

1. Teacher should adopt instructional materials and techniques that are not gender sensitive. This will eliminate gender inequality in the classroom and achievement. The fact remains that the objective of teaching is to make student learn or achieve higher not in favour of male or female.
2. Seminars and workshop should be properly organized at state levels, educational zone and ministries of education where teachers, textbook, authors and curriculum planners will be taught different ways and methods of teaching physics to ensure that achievement of students regardless of ensure that achievement of students regardless of gender or cognitive style in different areas of physics is enhanced.
3. Teacher should encourage peer teaching among the students. The field independent students should co-operate with the field dependent students by teaching the field dependent students in areas where they encounter difficulties in physics class.
4. The school administrators should give prizes and rewards to the best physics student every end of section so as to stimulate their interest and zeal in the study of physics.

5.2 Limitations

1. There were no randomizations of the subjects into gender. Instead intact classes were used. This may also have effect on the results of this study.
2. The researcher also suffered a set-back in moving round repeatedly in the course of administration of instruments because same students were driven out of school due to non-payment of their school fees which may slow the process of data collection as well as the analysis of the data.
3. The physics teachers who taught the students were their regular teachers in the different schools of which classes of the school, factors such as academic qualification, gender, attitude and personality, teaching methods were not put into cognizance. Therefore, these may have affected the result of the study.
4. The physics teachers of each school may not have covered the topics in the theme where the topics were lifted and there could be variations in their lessons delivery. The reason is that the study does not ensure that teachers strictly used the same method of teaching in lesson delivery.

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