INTERACTION EFFECTS OF COGNITIVE STYLE AND INSTRUCTIONAL STATEGY ON STUDENT'S KNOWLEDGE OF PHYSICS IN AKWA IBOM STATE SECONDARY SCHOOLS

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ABSTRACT

The purpose of this study was to investigate the interaction effects of cognitive style and instructional strategy on student's knowledge of physics. The sample of the study consisted of 386 SS1 physics students drawn from eight (8) secondary schools. The design of the study was quasi-experimental 2× 2 non-equivalent pre-test – post-test control group design. Two instruments, Sigel's Cognitive Style Tests (GCST) and Test of Knowledge in Physics (TKIP) were used in generating data for the study. Two research hypotheses were formulated to guide the investigation. The reliability coefficient of the instrument determined by Kudar–Richardson formula 21 (KR-21) were 0.71 for GCST and 0.81 for TKIP. ANCOVA was used in testing the hypotheses at P < 0.05 level of significance. MCA was performed where the main effect were significant. The analysis showed that there is a significant interaction effect of cognitive style and instructional strategy on students' knowledge of physics. It was recommended that physics teachers strive to be aware of the type of cognitive style their students possess for proper choice of effective teaching strategies.

Keywords: cognitive style, instructional strategy, interaction effects, students' knowledge in physics, field-dependent and field-independent students.

INTRODUCTION

The essence of physics to nation building is not obscure, and the literature is awash of the importance of physics education to the upliftment of technology. Access to physics education is access to literacy, numeracy and acquisition of scientific skills which in turn transforms the lives of individuals, leading to better health, enhanced economy, social advancement, as well as contributing to national social economic development. One of the major goals of science education is to develop scientifically literate individuals that are concerned with high competency for rational thoughts and actions (Ndili, 2011). The national policy on education encourages all processes geared towards producing educators and scholars that will encourage the spirit of inquiry (FME, 2008). To be able to pursue this noble objective, physics was included as one of the core subjects in the national secondary school science and technology curriculum. The physic curriculum is spiral in nature with themes being repeated with greater complexity in subsequent years. This is aimed at sustaining the interest of learners and to promote meaningful learning of the subject, physics (FME, 2008). Based on these objectives, physics teachers are expected to adopt teaching strategies that emphasise active participation or role of the learner that will enable them construct their own understanding by interacting with their environment to meet the objectives offered by science and technology. Students are known to professionally take in and process information in different ways by seeing and hearing, reflecting and acting, researching logically and intuitively, analysing and visualising (Felder and Spurlin, 2005). Instructional strategies also vary, in the sense that some teachers lecture, others demonstrate or lead students to self-

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discovery; some focus on principles and others on applications; some emphasize memory and others understanding.

Messick (1994) stated, "Stable *attitude, preferences or habitual strategies determine a person's personal mode of perceiving, remembering, thinking and problem-solving*". This therefore shows that human beings exhibit different cognitive styles. Ausubel and Robinson (1969) are also of the view that every child has unique pattern of ability, interest and natural endowment. This uniqueness implied that different learners will adopt varying approaches to learning consistent with their qualities. Thus understanding student's learning styles in the opinion of Thompson (2008) is one of the first steps to providing an effective education. Some of the common factors that greatly affect students' knowledge and hence their achievement in physics include shortage of equipment (Aigbomian, 1990), home condition, peer group behaviour, as well as cognitive style (Ehindero, 2009). Thus students' knowledge of physics and the sciences in general may be attributed to these factors. Teaching method is closely associated with students' cognitive development. An experimental study of teaching behaviour and students' achievement in physics by Akuezuilo (2010) shows that students' activities are better than teachers activities in promoting authentic learning at least in secondary school physics classroom. The implication of these findings is that students may have a better knowledge of physics due to teaching method by teachers. The teacher factor in physic teaching and learning has attracted the attention of some scholars over the years. Umeoduagu (2011) reported that students' poor academic achievement in physic is as a result of the fact that most physics teachers lacked the requisite knowledge and skills in the teaching of the subject. It is against this background that the researcher intends to carry out this study with a view to finding out what instructional strategies that is better in the teaching of physics for a group of leaners with different cognitive styles.

STATEMENT OF PROBLEM

The problem of this study is to investigate the interaction effect of two instructional strategies (Guided-inquiry and Expository method) and cognitive styles (Field-independent and Field-dependent) on students' knowledge of physics.

RESEARCH METHDOLOGY

Research Hypotheses

The following hypotheses were raised to guide the investigation;

1. There is no significant main effect of cognitive styles on students' knowledge of physics.
2. There is no significant interaction effect of cognitive styles and instructional strategy on students' knowledge of physics.

Design of the Study

The design involved a 2×2 factorial design. That is, the study employed a quasi-experimental non-equivalent pre-test – post-test central design.

Population of the Sample

The population for this study comprised all Senior Secondary One (SS1) Physics students in AkwaIbom State Secondary Schools. This gave a population size of 3860 SS1 students. Random sampling technique was used in selecting ten secondary schools and this gave a sample size of 386 SS1 physics students. Intact classes were used. Half of this sample size each was from urban and rural school setting.

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Instrumentation

Two research instruments, Sigel's Cognitive Style Test (GCST) and Test of Knowledge in Physics (TKIP) were used in collecting data for the study. GCST which measured field-dependent and field-independent dimension of subjects' cognitive style was the version of Keyan Moses Sigel's (1963) cognitive style test that was modified and validated by Agboghoroma (2005). The test consisted of twenty trials of similar pictures, three in each set. Subjects were asked to match any two pictures in a set that could go together, and give reason for their choice. A subject was classified as field-dependent or field-independent on the basis of the reason given. TKIP consisted of fifty statements which required in-depth knowledge of subjects in physics. The test rated subjects' knowledge acquisition such as their ability to recall facts, names, principles, recognise specific and universal elements, calculate mathematics applicable to physics and terminologies in physics classroom. The two instruments had reliability coefficients of 0.71 for GCST and 0.81 for TKIP. These were determined using Kudar Richardson formula 21 (KR-21).

TREATMENT

The two groups, experimental and control were treated accordingly. The guided-inquiry (activity method) instructional strategy was used on experimental group while conventional expository strategy of instruction was used on the control group. The instruments were administered on the subjects as pre-test and later as post-test. The treatments were administered in between the two tests by the researcher. The study lasted for eight weeks.

Analysis of Data

The data that accrued for the study were analysed using Analysis of Covariance (ANCOVA) at 0.05 significant level.

Testing of Hypotheses One

Hypotheses one states that there is no significant main effect of cognitive style on students' knowledge of physics.

Table 1. ANCOVA Summary Table of Main and Interactive Effects of Cognitive Style on Students' Knowledge of Physics

Source of Variation	*Sum of Squares*	*DF*	*Mean Squares*	*F*	*P*
Covariates	64373.203	1	64373.203	1352.288	0.000
Pretest	64373.203	1	64373.203	1352.288	0.000
Main Effects	3758.250	1	1379.013	34.500	0.000*
Cognitive Styles (CS)	2909.328	1	2909.328	63.125	0.000*
Instructional Treatment (IT)	399.691	1	399.691	16.182	0.000*
2-Way Interaction	2088.586	1	2088.586	47.773	0.000*
CS×IT	2088.586	1	2088.586	47.773	0.000*
Explained	72219.814	4	10554.954	284.436	0.000*
Residual	8978.586	381	43.461		
Total	101198.400	385	181.890		

* = Significance atP<0.05

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Table 1 showed a significant main effect of cognitive style on students' knowledge of physics (f_1, 385 = 63.125, P <0.05). Based on this result, hypothesis one was rejected. This implies that cognitive style haspart to play on students' knowledge of physics. To know the amount of variance, that is, measure of change attributed to cognitive style and instrumental strategy variables, the Multiple Classification Analysis (MCA) is presented below:

Table 2. Multiple Classification Analysis of Effects of Cognitive Style and Instrumental Strategy N = 386, Grand mean = 118.40

Variation	*N*	*Unadjusted Deviation ETA*	*Adjusted for Independents + Covariate Beta*
Instructional Treatment			-5.27
(1) Guided-Inquiry	193	-12.16	5.27
(2) Expository	193	12.16	0.35
		0.77	(12.25%)
School Setting			3.21
(1) Urban	193	5.27	-3.21
(2) Rural	193	-5.27	0.26
		0.35	(6.8%)
Multiple R			0.712
Multiple R^2			0.507

The results in table 2 showed the main effect of cognitive style on students' knowledge of physics. The field-independent students showed a better knowledge of physics than the field-dependent students. The adjusted post-test mean score of field-independent students was 130.56 (i.e. grand mean of 118.40 + 12.16) as against the field-dependent students with adjusted mean score of 105.24 (i.e. grand mean of 118.40 – 12.16). The results in the table showed that 12.25% $(0.35)^2$of variation in the post-test scores are attributable to cognitive style.

Testing of Hypothesis Two

Hypotheses two states that there is no significant interaction effect of cognitive style and instructional strategy on students' knowledge of physics. Results in Table one showed a significant interaction effects of instructional strategy and cognitive style on students' knowledge of physics (f_1, 385 = 16.182 at $p < 0.05$). Hypotheses two, therefore, was rejected and the conclusion is that there is a significant interaction effect of instructional strategy and cognitive style on students' knowledge of physics. The implication of this finding is that instructional strategy significantly depends on cognitive style to determine students' knowledge of physics. The multiple analysis in Table 2 shows that the activity-oriented instructional treatment (Guided-Inquiry) had an adjusted post-test mean score of 121.61 (i.e. 118.40 + 3.21) while expository method had an adjusted post-test mean score of 115.19 (i.e. 118.40-3.21). The results in Table 2 further showed that the guided-inquiry instructional treatment accounted for 6.8% in the variation on the post-test scores. The conclusion from this result is that instructional strategy made a difference in the students' knowledge of physics.

DISCUSSION

The results in Table 1 provided the answer to research hypothesis one which sought to know if there was no significant effect of cognitive style on students' knowledge of physics. The result of the data from this table respecting hypothesis one shows significant effect of

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cognitive style on students' knowledge of physics and in favour of field-independent over field-dependent. The reason for this higher performance of field-independent over field-dependent subjects in acquisition of knowledge of physics is because field-independent subjects are known to have analytic skill, can perceive objects as separate from the field and solve problems that are presented and reorganized in different contexts. This finding agrees with Okobia (2000), Arisi (2002) and Agboghoroma (2005). The data analysis also showed that a significant interaction effect existed between cognitive style and instructional strategy on students' knowledge of physics. The F-calculated was 16.182 and this was significant at $P < 0.05$ significant level. These were the findings to hypotheses two which sought to know whether there is no significant interaction between cognitive style and instructional strategy on students' knowledge of physics. The observed significant interaction between cognitive style and instructional strategy is because of the effect of enhanced performance in physics knowledge by field-independent students over their field-dependent counterparts. This finding supports the finding of Okobia (2000).

RECOMMENDATION

The recommendations are made as follows for improvement of physics instruction in particular and science in general.

Since this study has proved the effectiveness of guided-inquiry, the choice of it as a method of teaching physics for improved academic performance should not be overlooked by physics teachers in particular and science teachers in general.

Physics teachers should strive to be aware of the type of cognitive styles their students possess. This will guide in the choice of effective teaching strategies.

CONCLUSION

The conclusion from the study is that the cognitive style and instructional strategy significantly interact to influence students' knowledge in physics as field-independent students showed a better knowledge of physics than the field-dependent students irrespective of the instructional strategy used. The study has also established significant main effects of cognitive style on students' knowledge of physics.

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