INTERACTION EFFECTS OF COGNITIVE STYLE AND INSTRUCTIONAL MODE ON STUDENTS' KNOWLEDGE OF INTEGRATED SCIENCE

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ABSTRACT

The study examines the interaction of cognitive style and instructional mode on students' knowledge of integrated science. The sample consists of 360 field-dependent-independent JSS III students drawn from six secondary schools. The study design was quasi-experimental 2 x 2 non-equivalent pretest - posttest control group design. The instruments used were the modified cognitive style test (CST) and test of knowledge in integrated science (TKIS). ANCOVA was used to analysis the data. This hypothesis were tested at .05 level of significance. MCA was performed where the main effects were significant. The analysis revealed that there is a significant interaction effect of cognitive style and instructional mode on students' knowledge of integrated science.

Keywords: Interaction Effects, Cognitive Style Instructional Mode, Students Knowledge, Field Dependent and Field Independent Students.

INTRODUCTION

Research in science education is directed towards identifying patterns and problems associated with content acquisition as related to differential levels of intellectual functioning amongst learners. Hence, the research evidence by Witkin (1978), who said, "all of us have characteristic mode of functioning that we reveal throughout perceptual and intellectual activities in a highly consistent and pervasive way. (p. 67)". Also in the same vein Messick (1978) stated, "stable attitude, preferences, or habitual strategies determine a persons personal mode of perceiving, remembering, thinking and problem-solving". This therefore shows that, human beings exhibits 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 students learning styles in the opinion of Thomson (1976) is one of the first steps to providing an effective education. Serache and Spodek (1981) opined that the cognitive style of a student could be identified early in his or her school career and appropriate curriculum and teaching methodology provided that is consistent with pupils cognitive style. Some of the common factors that greatly affect students' knowledge (hence their achievement in science) include shortage of equipment (Aigbomian, 1990), home conditions, peer groups behaviour, school conditions and emotional predisposition of students (Fobih, 1987), as well as other learner factors like cognitive style (Ehindero. 1982). Thus, students' knowledge of integrated science and the sciences in general may be attributed to these factors. Teaching method as a factor is closely associated with students' cognitive development. Studies like those of Dunn and Dunn (1979), Umeoduagu, (1994), Okobia (2000), Arisi (2002) and Agboghoroma (2005) are in

support of this. An experimental study of teaching behaviour and students' achievement in science by Akuezuilo (1984) shows that students activities are better than teacher activities in promoting authentic learning at least in junior secondary school integrated science classrooms. The implication of these findings is that students may have a better knowledge of science due to the teaching method adopted by teachers. The teacher factor in science teaching and learning has attracted the attention of some scholars over the years. Umeoduagu (1994) reported that students' poor achievement in science is as a result of the fact that most science 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 methods that is better in the teaching of integrated science for a group of learners with different cognitive styles.

Statement of Problem

The problem of the study is: which instructional mode would enhance students' knowledge of integrated science taking cognizance of their cognitive styles? In other words, this study investigates the interaction effect of two teaching methods: Guided-inquiry (activity mode) and expository method and cognitive style (field-independent and field dependent) on students' knowledge of integrated science.

Research Hypothesis

The following null hypotheses were formulated and tested at 0.05 significant level:

Ho_1: There is no significant main effect of cognitive style on students' knowledge of integrated science.

Ho_2: There is no significant interaction effect of cognitive style and instructional mode on students' knowledge of integrated science

Design of the Study

The study employed a quasi-experimental non-equivalent pretest-posttest control group design. This involved a 2x 2 factorial design comprising of three experimental and three control groups.

Population and Sample

The target population for this study were JSS III students in secondary schools in Delta State intact classes were used. The samples were drawn from six local government areas in Delta State. The six schools used were randomly selected through balloting. All schools used were mixed schools. A total of three hundred and sixty (360) students were used for the study comprising 180 each from urban and rural school setting.

Instrumentation

The two instruments used for the study were the modified cognitive style test (CST) by Siegal (1967) and the test of knowledge in integrated science (TKIS) designed by the researcher. CST was first revalidated by Onyejiaku (1980) and used in the Nigerian setting. This validated

instrument has been used at various times by researchers such as Mansaray (1985), Umeoduagu (1994), Onwuegbu (1998). Okobia (2000), Arisi (2002) and Agboghoroma (2005) in the Nigerian environment. TKIS consists of forty five statements which required a test of indepth knowledge of students in integrated science. The test rated students' knowledge acquisition such as their ability to recognize specific and universal elements, recall of facts, names, principles and terminologies in integrated science classroom. The instrument yielded a reliability estimate of 0.87 when the Cronbach Coefficient Alpha was applied to determine the internal consistency of the test instrument, This was adjudged adequate for the study.

Treatment

The study made use of two treatment groups. These were the experimental and control groups. The experiment group was made up of the guided-inquiry (activity method) instructional mode and the control group made up of the conventional expository mode of instruction.. To avoid contamination of the groups, intact classes were used to avoid effect like Hawthorne by not informing the students that they are involved in an experiment. Also the use of control group, controlled for maturation, testing and history. Experimental bias was controlled for by ensuring that interaction with subjects was considerably reduced. The instruments were administered as pretest and later as posttest. In between the two tests, the treatment was applied by the researcher personally. The study lasted for six weeks.

Data Analysis

The hypotheses formulated were tested using Analysis of Covariance (ANCOVA) at 0.05 significant level. ANCOVA was opted for because it is a statistical technique for controlling for an extraneous variable indirectly. This is accomplished by partialling out of the dependent variable, the variable or variance, one wishes to control for. In a quasi-experiment design like this were one or more manipulated variables are used with non-equivalent groups, ANCOVA is resorted to in an attempt to "equate" or "adjust" for initial differences among the groups on relevant variables. In this study, it was not possible to assign randomly subject to treatment groups: intact groups field-dependence and field-independence students in urban and rural school setting were used, but with the random assignment of such groups as either experiment or control.

Testing Hypothesis One

Ho_1: There is no significant main effect of cognitive style on students' knowledge of integrated science.

Table 1: ANCOVA summary table of main and interaction effects of cognitive style on students' knowledge of integrated science

Sources of variation	Sum of square	Df	Mean square	F	P
Covariates	74373.203	1	74373.203	1452.288	0.000
Pretest	74373.203	1	74373.203	1452.288	0.000

Main effects	4758.025	2	2379.013	44.500	0.000*
Cognitive style (CS)	3909.328	1	3909.328	73.125	0.000*
Instructional Treatment (IT)	1399.691	1	1399.691	26.182	0.000*
2-way interaction	3088.586	1	3088.586	57.773	0.000*
CS x IT	3088.586	1	3088.586	57.773	0.000*
Explained	82219.814	4	20554.954	384.486	0.000*
Residual	18978.586	355	53.461		
Total	101198.400	359	281.890		

* Significance at $P < 0.05$

The Table 1 reveal a significant main effect of cognitive style on students' knowledge of integrated science (f_1, 359 = 73.125, $p < 0.05$). Based on the result, hypothesis one was rejected. This therefore mean that cognitive style has a role to play on students knowledge of integrated science. To check for the amount of variance, that is measure of change attributed to cognitive style and instructional mode variable, the multiple classification analysis (MCA) is presented below:

Table 2: Multiple classification analysis of effects of cognitive style and instructional mode N = 360, Grand Mean – 123.60

Variable + Category	**N**	**Unadjusted deviation ETA**	**Adjusted for independent + Covariance BETA**
Instrument treatment 1. Guided-Inquiry 2. Expository	 180 180	 -11.02 11.02	 -4.12 4.12
		0.66	0.25 (6.25%)
School Setting 1. Urban 2. Rural	 180 180	 4.12 -4.12	 2.33 -2.33
		0.25	0.14 (1.96%)
Multiple R Squared Multiple R			0.785 0.886

Table 2 shows relevant result as regards the main effect of cognitive style on students knowledge of integrated science. The field-independent students displayed a better knowledge than the field-dependent students. The adjusted post-test mean score of field-independent student was 127-72 (i.e. Grand mean of 123.60 + 4.12) as against the field -dependent students with adjusted mean score of 119.48 (i.e. Grand mean of 123.60 4.12). The table also show that cognitive style accounted for 6.25%, that is $(0.25)^2$ of the variation in the posttest scores.

Testing Hypothesis Two

Ho_2: There is no significant interaction effect of cognitive style and instructional mode on students' knowledge of integrated science The Table 1 reveal a significant interaction effect of instructional treatment and cognitive style on students' knowledge of integrated science (f_1 359 = 26.182, $p<0.05$). Based on this, hypothesis two was rejected. It therefore means that there is a significant interaction effect of instructional treatment and cognitive style on students' knowledge of integrated science. This implies that instructional mode significantly depend on cognitive style to determine students' knowledge of integrated science. Also a close looks at the multiple classification analysis in Table 2 above indicates that the guided- inquiry (activity-oriented) instructional treatment had an adjusted post-test mean score of 125.93 (i.e. 123.60 + 2.33) while expository mode had an adjusted post-test mean score of 121.27 (i.e. 123.60 - 2.33). It equally shows that the guided-inquiry instructional treatment accounted for (1.96%) that is $(0.14)^2$ in the variation on the post-test scores. From the result of the study, the instructional treatment, made a difference in the students' knowledge of integrated science.

DISCUSSION

Research question one sought to know if there was no significant main effect of cognitive style on students' knowledge of integrated science. In this regard. the result of the data analysis in Table I shows that a significant difference existed between cognitive style and students' knowledge in integrated science. The F- ratio calculated was 73.125 and this was significant at 0.05 significant level. This again, shows that cognitive style significantly influenced students' knowledge of integrated science. This higher performance in knowledge rating of field-independent students over field-dependent students is in line with the findings of Start (1977), Babalola (1979), Mansaray (1985), Ughamadu (1990), Umeoduagu (1994) Okobia (2000), Arisi (2002) and Agboghoroma (2005). Field-independent students are known to perform better than field- dependent students on a variety of learning tasks (Ughamadu, 1990). As pointed out by Seracho and Spodek (1981) apart from having analytic skills, they can perceive objects as separate from the field and solve problems that are presented and reorganized in different contexts. Integrated science is a subject that demands a variety of tasks from students. Thus analytic or field-independent students are at advantage over the global or field-dependent students in their ability to perceive objects separately and able to handle a variety of problem solving tasks. The possible reason for the superiority of field-independent students over field-dependent students is that the field-independent students possess higher restructuring skills than the field-dependent students. The finding of this study however, contrast those of Douglas and Whale (1978), Adeyemi (1990) and Onwuegbu (1998). Research question two sought to know if there was interaction effect of cognitive style and instructional mode on students' knowledge of integrated science. In this regard, the result of the data analysis in Table 1 shows that a significant interaction effect existed between cognitive style and instructional mode on students' knowledge of integrated science. The f-ratio obtained was 26.182 and this was significant at 0.05 significant level. From the result of hypothesis two, it does appear that the teaching method made a difference in the students' knowledge of integrated science. This finding is in line with Arisi (2002) and Agboghoroma (2005). However, the finding of significant interaction of instructional

treatment and other variables other than knowledge in scientific studies is not conclusive. For instance, Onyejiaku (1980) established a non-significant interaction effect between cognitive style and teaching methods in transfer of mathematical tasks. In the same vein Ughamadu (1990) established no significant interaction effect of instructional strategy and cognitive style in thinking level of achievement in chemistry and Okobia (2000) also established a no significant interaction effect of cognitive style and instructional treatment in social studies. The implication therefore is that in light of this conflicting findings more empirical studies need to be carried out in Nigeria to find out more facts about the effect of interaction between cognitive style and instructional mode on students' knowledge and other variables in integrated science teaching and learning.

RECOMMENDATIONS

The following recommendations are made for the improvement of science teaching and particularly integrated science in secondary schools:

- Teachers in integrated science should strive to be aware of the type of cognitive styles their students possess. Since students perceive and process information according to the way they are being taught, it is necessary that teachers understand the various learning characteristics their students posses. In this regard in-service education programmes are required where practicing teachers should update certain psychological constructs that mediate pupils learning styles. Since the in-service training of most integrated science teachers do not give adequate attention to students learning styles, it is recommended that courses in these institutions should incorporate the concept of cognitive styles and its application in science teaching.
- The efficacy of the guided-inquiry (activity method) has been proved in this study. And to this end its choice as a method of teaching science can not be overemphasized in an attempt to promote science teaching and learning. So far, the use of expository method is mostly used in our science classrooms and this has not encouraged pupils much in scientific endeavour. Practicing science teachers should therefore be encouraged to combine the expository method with the guided-inquiry activity method as well as other methods to produce a balance in the choice of methods in teaching science at the secondary school level.

CONCLUSION

From this study it has been established that cognitive style and school setting has significant main effects on students' knowledge of integrated science. In the same vein, cognitive style and instructional mode significantly interact to influence students' knowledge as field-independent students display a better knowledge of integrated science then field-dependent students irrespective of the instructional mode used. The implication is that the integrated science teacher should consider the instructional mode of teaching in relation to the cognitive style. The integrated science teacher should therefore consider these variable when selecting and presenting integrated science learning materials in the classroom.

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