Effect of computer-based instruction on performance in numeracy of field-dependent and field-independent primary school pupils in Ile-Ife, Osun state, Nigeria.

Taiwo O. Gbenga-Akanmu,[a]Philip O. Jegede[b]
[a]Institute of Education,ObafemiAwolowo University, Ile-Ife, Nigeria.
taoakanmu@yahoo..com
[b] Institute of Education,ObafemiAwolowo University, Ile-Ife, Nigeria.
pojegede@yahoo.co.uk

Abstract. The study examined the effect of computer-based instruction (CBI) on field-dependent and field-independent primary school pupils' knowledge of Arithmetic concepts.It also assessed the effect of Computer-based Numeracy instruction on their retention of learned Arithmetic concepts and investigated the moderating effects of sex on knowledge and retention of learned Arithmetic concepts by the two categories of learners. The study adopted the one-group pre-test post-test research design. The sample comprised 95 pupils of primary three in their contact classes in four primary schools purposively selected in Ile-Ife,Nigeria. The selection was based on availability of computer systems. The Group Embedded Figure Test (GEFT) was used to divide the pupils into group of field-dependent and field-independent after which 5the Computer Software Numeracy Instructional Package for Children (CSNIPC) was used to teach Arithmetic concepts. Achievement Test on Numeracy (ATN) was used for pre-test, post-test and retention test. The data collected were analyzed using Analysis of Covariance (ANCOVA) and 2-way repeated measure (ANOVA) respectively. Significant difference was found between pupils' mean score in Arithmetic concepts based on their cognitive styles of learning ($F_{1,92}$ = 0.02, p<0.05). Also Computer-based Numeracy Instruction (CBNI) has no significant effect on the retention of learned Arithmetic concepts of field-dependent and field-independent pupils ($F_{(2,92)}$ = 0.370, p >0.05). In addition, sex has no significant effect on the knowledge of learned Arithmetic concepts ($F_{(1, 90)}$ = 2.865; p>0.05) and retention ($F_{(2, 90)}$ = 0.292, p>0.05) of field dependent and field independent pupils.

Keywords:cognitive styles, computer-based numeracy instruction, arithmetic concepts.

INTRODUCTION

Mathematics performance has not been impressive over the years in Nigeria (Kurumah and Iji, 2009). This trend is irrespective of educational level. For example Abakporo (2005) indicated that the trend in students' academic performance in mathematics at the Secondary Schools level is terribly declining. Various reasons have been adduced for this which include poor cognitive competence of the mathematics teachers (Igbokwe, 1995), Students negative attitude (Bolaji, 2005), lack of qualified teachers (Anozie, 2005), Phobia (Faleye, 2005 and Aduroja 2004). Others include teaching strategies (Alebiosu, 1998) and language of instruction (Moore, 2002). To apprehend the problem associated with mathematics teaching and learning, some researchers have investigated cognitive styles of mathematics learners with respect to their mathematics performance and obtained that field independent learners do perform better than field dependent learners. But recent advances in teaching have employed Computer-aided instructions in the classroom and in mathematics learning in particular. The use of computer in education is expected to benefit all groups of learners (whether field-dependent or field-independent. It is therefore necessary to investigate whether Computer-Based Mathematics Institution (CBMI) can be used to bridge the gap in learning style exhibited by field-dependent and field-independent mathematics learners with primary school pupils as participants of the study. This is with a view to advancing appropriate intervention strategy at foundational level towards better performance of elementary mathematics. The following objectives will guide the study.

(a) Examine the effect of computer-based numeracy instruction CBNI on field-dependent and field-independent primary school pupils' knowledge of Arithmetic concepts;

(b) Assess the effect of CBNI on their retention of learned Arithmetic concepts; and

(c) Investigate the moderating effects of sex on knowledge and retention of learned arithmetic concepts by the two categories of learners.

The following research hypotheses were formulated.

(a) There is no significant effect of computer-based numeracy instruction on field-dependent and field-independent primary school pupils' knowledge of Arithmetic Concepts.

(b) There is no significant effect of computer-based numeracy instruction (CNBI) on the retention of learned Arithmetic concepts between field-dependent and field-independent group of pupils.

(c) There is no significant moderating effect of gender on knowledge and retention of learned Arithmetic concepts by the two categories of learners.

METHOD

The study adopted the one-group pre-test post-test quasi experimental research design. This design did not use a control group but subjected all the participants to the same treatment. The population for the study consisted of all pupils in the lower primary schools. Four schools were purposively selected based on availability of computer facilities in the schools. Intact classes of primary III pupils from each of the four schools were selected as participants in the study using the simple random sampling technique. The sample consisted of Ninety Five primary III pupils. The instruments used for the collection of data in the study were Group Embedded Figures Test (GEFT), a psychological test developed by Witkin*et al* (1971), was used to divide the participants into groups of field-dependent and field-independent. This GEFT is a timed test that requires each pupil to locate the simple figures embedded in a complex one. The pupils are categorized to be field-independent if they located half of the required figures correctly within the limited time, and those that could not locate more than half of the required figure within the time given were considered to be field-dependent. The GEFT in all comprised of 10 geometrical simple figures embedded in more complex figures.

The Achievement Test on Numeracy (ATN) was designed to measure the pupils understanding and knowledge of numeracy concepts. The test measures the contribution of logical-mathematical, visual-spatial and verbal-linguistic intelligence in their knowledge of numeracy concepts. The ATN is thus divided into three sections namely, word problems, mental sums and quantitative reasoning. The first section contains 10 word problems, the second section 5 mental sums and the third section, 5 quantitative reasoning questions. Each question gotten correctly was awarded 1 mark, thus making the total score obtainable to be 20. The treatment instrument was an adapted computer instruction program "Computer Software Numeracy Instructional Package for Children (CSNIPC)" was developed with the help of a software developer. The pupils were exposed to the CSNIPC for lessons on numeracy concepts – addition, subtraction, multiplication and division. The CSNIPC presented series of exercises which the pupils demonstrated their understanding of basic numeracy concepts. The researcher served as the teacher/facilitator to the pupils in using the software package for teaching Arithmetic concepts with them.

The three instruments used in the study GEFT, ATN and CSNIPC were examined by the supervisor and experts in relevant field to ensure suitability of the objectives of the measurement. The Cronbach's Alpha reliability test coefficient of the GEFT for the study was 0.82 while the result correlation ratio using Pearson's Correlation formula was 0.75 for ATN.This indicates that the instruments used in the study were suitable and reliable for the study. The researcher categorized the pupils into field-dependent and field-independent based on their GEFT scores.

RESULTS

Table 1. Sex distribution of pupils showing cognitive learning styles

		Cognitive Style		
		Field Dependent	Field-Independent	Total
Sex	Male	23	15	38
	Female	27	30	57
	Total	50	45	95

Table 2. ANCOVA table showing the effect of CBNI on Arithmetic knowledge of Field- Dependent/Independent pupils

Source	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	32.775[a]	2	16.388	.828	.013
Intercept	771.242	1	771.242	38.961	.000
Pre-test	32.382	1	32.382	1.636	.204
GEFT	.031	1	.031	.002	.021
Error	1821.183	92	19.795		
Total	9585.000	95			
Corrected Total	1853.958	94			

R squared = .018 (Adjusted R Squared = - 0.004)

Table 3.Repeated Measures Analysis of Variance Showing the Effect of Computer-Based Numeracy Instruction (CBNI) on Retention of Learned Arithmetic Concepts by Cognitive Styles

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
CBNI	Pillai's Trace	.154	8.352[b]	2.000	92.000	.000	.154
	Wilks' Lambda	.846	8.352[b]	2.000	92.000	.000	.154
	Hotelling's Trace	.182	8.352[b]	2.000	92.000	.000	.154
	Roy's Largest Root	.182	8.352[b]	2.000	92.000	.000	.154
CBNI * GEFT	Pillai's Trace	.008	.370[b]	2.000	92.000	.692	.008
	Wilks' Lambda	.992	.370[b]	2.000	92.000	.692	.008
	Hotelling's Trace	.008	.370[b]	2.000	92.000	.692	.008
	Roy's Largest Root	.008	.370[b]	2.000	92.000	.692	.008
	Mauchly's test of sphericity assumption						

Table 4a. Analysis of Covariance showing the Moderating Effect of Gender on Knowledge of Learned Arithmetic Concepts between Field-Dependent and Field-Independent Pupils

		Hierarchical Method					
		Sum of Squares	df	Mean Square	F	Sig.	B
Covariates	Pre-Test	32.744	1	32.744	1.670	.200	.1 66
Main Effects	(Combined)	.676	2	.338	.017	.983	
	Cognitive Style	.031	1	.031	.002	.968	
	Sex	.645	1	.645	.033	.856	
2-Way Interactions	Cognitive Style * Sex	56.159	1	56.159	2.865	.094	
Model		89.579	4	22.395	1.142	.342	
Residual		1764.379	90	19.604			
Total		1853.958	94	19.723			

Model goodness of fit for factors and covariate
R = 0.134
R Square = 0.018

Table 4b. Multiple Classification Analysis of Knowledge Scores Adjusted for Factors (Gender and Cognitive Styles) and Covariate

		N	Predicted Mean		Deviation	
			Unadjusted	Adjusted for Factors and Covariates	Unadjusted	Adjusted for Factors and Covariates
Cognitive Style	F-Independent	45	9.09	9.01	.068	-.006
	F-Dependent	50	8.96	9.03	-.061	.006
Sex	Female	57	8.89	8.95	-.126	-.069
	Male	38	9.21	9.12	.189	.103

a. Post-Test by Cognitive Style, Sex with Pre-Test

Table 5: Two-way Repeated Measures Analysis of Variance Showing the Effect of Computer-Based Numeracy Instruction (CBNI) on Retention of Learned Arithmetic Concepts by Cognitive Styles

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
CBNI	Pillai's Trace	.157	8.375b	2.000	90.000	.000	.157
	Wilks' Lambda	.843	8.375b	2.000	90.000	.000	.157
	Hotelling's Trace	.186	8.375b	2.000	90.000	.000	.157
	Roy's Largest Root	.186	8.375b	2.000	90.000	.000	.157
CBNI * GEFT	Pillai's Trace	.009	.424b	2.000	90.000	.656	.009
	Wilks' Lambda	.991	.424b	2.000	90.000	.656	.009
	Hotelling's Trace	.009	.424b	2.000	90.000	.656	.009
	Roy's Largest Root	.009	.424b	2.000	90.000	.656	.009
CBNI * Gender	Pillai's Trace	.012	.555b	2.000	90.000	.576	.012
	Wilks' Lambda	.988	.555b	2.000	90.000	.576	.012
	Hotelling's Trace	.012	.555b	2.000	90.000	.576	.012
	Roy's Largest Root	.012	.555b	2.000	90.000	.576	.012
CBNI * GEFT * Gender	Pillai's Trace	.048	2.292b	2.000	90.000	.107	.048
	Wilks' Lambda	.952	2.292b	2.000	90.000	.107	.048
	Hotelling's Trace	.051	2.292b	2.000	90.000	.107	.048
	Roy's Largest Root	.051	2.292b	2.000	90.000	.107	.048
	Mauchly's test of sphericity assumption						

A pre-test of Achievement Test on Numeracy (ATN) was conducted with the assistance of the class teacher. A post-test of Achievement Test on Numeracy was also conducted after the pupils' exposure to computer instruction. A retention test of Achievement Test on Numeracy was re-conducted two weeks after being exposed to computer instruction. The same tests were administered to the pupils irrespective of their cognitive learning styles.The analysis of the study was based on the scores of the Ninety Five (95) pupils who started and completed the exercises. Data gathered from the tests results were subjected to descriptive and inferential statistics.

The fundamental aim of this study was to investigate the effects of the computer-based instruction on the performance in Numeracy of field-dependent and field-independent primary school pupils in Ile-Ife. In the GEFT, a score of 0-4 indicates a level of field-dependence while 5-10 indicates a level of field-independence. 45 of the participants were determined to be field-independent while 50 were determined to be field-dependent.
From table 2, it showed that there was a significant difference in the pupils' mean score based on their cognitive styles of learning ($F_{1, 92} = 0.02$, $p < 0.05$). The table also reflected that previous knowledge of the pupils as obtained from the pre-test ($F_{1,92} = 1.636 > 0.05$) had no significant contributory effect on the pupils post-test score. Table 3 showed that CBNI had a significant contributory effect on retention of learned arithmetic concepts ($F_{(2, 92)}=8.352$, $p<0.001$). However, there was no significant effect of CBNI on retention when between field-dependent and field-independent pupils ($F_{(2, 92)} =0.370$, $p=0.692$). These results suggested that no field-dependent pupils significantly retain arithmetic knowledge more than the field-independent pupil while according to Table 4a, there was no significant interaction effect of gender and cognitive styles ($F_{(1, 90)} =2.865$; $p=0.094$) on pupils' knowledge of Arithmetic Concepts in the study area. Table 4b showed that unadjusted for factors and covariate (initial level of understanding of arithmetic concept), field-dependent pupil had higher score (mean=9.09, Unadjusted Deviation (UD) =0.068) than field-independent (mean=8.96, UD=-0.061). However, when adjusted for factors and covariate, field-independent pupil had a slightly higher score (mean=9.03; AD=0.006) than field-dependent (mean=9.01; AD= -0.006). Male pupils had higher unadjusted (mean=9.21, UD =0.189) and adjusted scores (mean=9.12, AD=0.103) scores than female counterparts, mean=8.89, UD= -0.126 and mean=8.95, AD= -0.069 respectively. Hence, the result confirms that there is no significant difference in knowledge scores by gender and cognitive styles when adjusted for interactions of the factors and covariate. As shown in table 5, Mauchly's test indicated that the assumption of sphericity (equal variance of differences), had been met, $\chi^2 = 0.411$, df=2, $p = 0.814$. The results showed that there was no significant moderating effect of gender on retention of arithmetic knowledge between field-dependent and field-independent pupils ($F_{(2, 90)} =0.292$, $p=0.107$).

Based on the findings of this research work, it was concluded that there was a significant difference in the pupils' mean score based on their cognitive styles of learning and that previous knowledge of the pupils as obtained from the pre-test had no significant contributory effect on the pupils post-test score. In addition, it could be concluded that there exists a negligible difference in the pupils' retention mean score based on their cognitive styles of learning and that post-test knowledge of the pupils as obtained from the pre-test had no significant contributory effect on the pupils post-test score. It was also observed from the model that computer-based numeracy instruction has significant effect on retention ability of the pupils irrespective of their cognitive style of learning. Overall observation showed that sex as a moderating variable had no effect on knowledge of learned Arithmetic concepts and retention.

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