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Effects of Learning Styles and Instructional Strategies on Students' Achievement in Nigerian Senior Secondary School Physics

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Abstract
A shift from the traditional to a progressive mode of education in the past years had led to an increase interest in learners' individual differences. The new paradigm is student-centered, based on inclusiveness, collaborative learning, critical thinking, creativity, innovation and encourages diversity of reception and processing of information. Hence, this study investigated the effects of learning styles and instructional strategies on students' achievement in the concept of electricity in Nigerian senior secondary school physics. 250 senior secondary two (SSII) physics students were used for the study. A purposive sampling technique was used to select six schools from the population. A quasi-experimental design was adopted for the study. Physics Achievement Test (PAT) with reliability coefficient of 0.82 using Kuder Richardson-21 and Index of Learning Style Questionnaire (ILSQ) with reliability coefficient of 0.88 using test-retest approach were the two instruments used for gathering the data. Analysis of covariance was used to analyze the data. The results showed that guided discovery is the most effective instructional strategy for physics students with Sensing/Intuitive learning style, demonstration is the most effective instructional strategy for physics students with Sequential/Global learning style while conventional strategy is the most effective for physics students with Visual/Verbal learning style. The results also indicated that Active/Reflective learning style was placed second in the order of facilitating students' achievement in physics when taught with guided discovery, demonstration and conventional learning strategies respectively. This implies that the three instructional strategies can be used for the enhancement of the achievement of students with Active/Reflective learning styles in the concept of electricity in physics. It is recommended among others that teachers should find out the learning styles of their students and use appropriate instructional strategies that will concise with the learning styles for effective teaching and learning to take place in physics classrooms.
Keywords: Learning Styles, Sensory/Intuitive, Sequential/Global, Visual/Verbal, Active/Reflective, Instructional Strategies, Students' Achievement, Physics, Guided Discovery, Demonstration, Conventional.

Introduction

The ultimate goal of teaching or educational experiences both in and out of school is to enable the individual to meet new situations of various degrees of relatedness and similarities more effective. The challenges in teaching is to create experiences that involve the student and support his own thinking, mode of learning, explanation, communication and application of the scientific models needed to make sense of these experiences. To equip Nigerian citizens to live in this fast changing world of the 21st century, the educational system should undergo a radical reorientation. For decades, one of the most persistent problems which teachers have struggled to solve has been how to achieve maximum results with minimum but effective medium of instruction. There has been a need to change our emphasis on teaching by the teacher to learning by the learner. Thus, rather than be a teacher-centred activity, instruction has become learner-centred. Teachers need to ascertain what their students wish to know and how it is relevant to their life and work and how they learn best. Hence, for effective teaching and learning to take place, there must be a correlation between teacher's instructional strategies and students' learning styles (Akinbobola, 2011b).

All students have difference learning styles and the function of the teacher is to identify these leaning styles and find appropriate instructional strategies that will match the preferred styles in order to enhance effective teaching and learning process. Learning style is the adoption of a habitual and distinct mode of acquiring knowledge. Riding and Rayner (1998) define learning styles as a tendency to approach cognitive tasks with a preferred mental set. Gregorc (1979) describes learning style as consisting of distinctive behaviours which serve as indicators of how a person learns from and adapts to his/her environment. It also gives clues as to how a person's mind operates. Dunn (1990) describes learning style as the way each learner begins to concentrate, process and retain new and difficult information. Learning style also represents both inherited characteristics and environmental influences. Keefe and Monk (1986) see learning style as being characteristic of the cognitive, affective, and physiological behaviours that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment. Sternburg (1990) indicates that an individual's learning style can be compared to his/her ability and is therefore not etched in stone at birth. A learning style model classifies students according to where they fit on a number of scales pertaining to the ways they receive and process information (Zywno & Waalen, 2002). This study focuses on the learning style model developed by Felder and Soloman (1998). These are Sensing/Intuitive, Visual/Verbal, Active/Reflective and Sequential/Global.

The Sensing/Intuitive learning style deals with the way information is perceived. Sensing learners get information through their senses. They solve problem by well establish methods but dislike complication. They are oriented towards procedures and facts and are practical. The learning styles of those who prefer sensing are characterized by a preference for direct, concrete experience; moderate to high degrees of structure; linear, sequential learning; and often, a need to know why before doing something. They lack confidence in their intellectual abilities and uncomfortable with abstract ideas. The path to educational excellence for sensing learners is usually from a practice-to-theory route. Intuitive learners get information through imagination, reflection and memory (Felder, 1988). They are innovative, creative, independent, conceptual and oriented towards theories and meaning but dislike repetition. Intuitives love the world of concepts, ideas, and abstractions. Their path to excellence is from theory- to- practice and they often prefer open-ended instruction to highly structured instruction. They usually demonstrate a high degree of autonomy in their learning and value knowledge for its own sake. They prefer diversity in ideas.

The Visual/Verbal learning style deals with the way information is presented. Visual learners get more information from visual images (schematics, graphs, diagrams, pictures and demonstrations). Verbal learners prefer written or spoken explanations and formulae. They learn information best by hearing, explanation and discussion (Akinbobola, 2011a).

The Active /Reflective learning style deals with the way information is processed. Active learners learn best through participation, working in a group, trying things out and require body movement and action for optional results. Reflective learners understand lesson best by thinking about it quietly and prefer working alone.

The Sequential/Global learning style deals with understanding. Sequential learners gain understanding in an orderly manner in linear steps and go through logical stepwise path in finding solutions to problems. Global learners learn in large jumps. They solve complex problems quickly once they have grasp of the big picture (Zywno & Waalen, 2002).

Instructional strategies are plan action adopted in the acquisition of knowledge, skills or attitudes. They are various techniques adopted by the teacher in order to make teaching and learning effective (Akinbobola, 2011b). This study focuses on three instructional strategies namely guided discovery, demonstration and conventional instructional strategies.

Guided discovery is an instructional strategy in which the principal content of what is to be learned is not given but must be discovered by the learners. In guided discovery mode which is an enquiry on the other hand, the teacher provides illustrative materials for students to study on their own. Learning questions are they asked by the teacher to enable students to think and provide conclusions through the adoption of the processes of science. If the learner is allowed to discover relationships and methods of solution by himself, make his own generalizations and draw conclusions from them, he may then be better prepared to make wider applications of the materials learned. Discovery is a success experience that reinforces the appropriate attitude and value. A learner is active in discovery learning, and provides for individual difference as well as makes the process of learning to be self-sequenced, goal directed with the goal perceived and the pace self-determined (Akinbobola & Ikitde, 2011).

Demonstration is an instructional strategy in which the teacher demonstrates an activity with explanations where necessary while students or learners watch. Demonstration links explanation with practice (Akinbobola & Afolabi, 2009). Demonstration is a technique of teaching concepts, principles or real things by combining oral explanation with the handling or manipulation of real things (Akinbobola, 2011b). According to Adeyemo (1998), demonstration is an activity strategy where the teacher does some work and the learners endeavour to do it the way he has done it. Adeyemo holds that this method is employed when the teacher wants the learners to do a piece of work the way he has done it and learn a little by listening, a little more by watching but as a rule, learn most by actually doing the piece of work.

In conventional strategy, the principal function of this pedagogy is the presentation of ideas and information meaningfully and effectively such that clear, stable and unambiguous meaning emerge and are retained over a long period of time as an organized body of knowledge. The teacher’s role is very important in the learning process and involve the selection, the organization and the translation of subject-matter content in a developmentally appropriate manner. Conventional strategy is sometimes called deductive teaching because the teacher often begins with a definition of the concepts or principles, illustrates them and unfolds their implications (Akinbobola, 2011b). The emphasis is that, the contents of the materials should be presented in a logical order, moving from generic to specific concepts, so that learners can form cognitive structures, and encode new information (Nwagbo, 2001).

The result from the findings of Akinbobola (2011a) indicates that 31.67% of the sampled students were visual learners, 26.76% were audial learners while 41.66% were kinaesthetic learners. The result also shows that students categorized as audial learners achieved significantly better than the students categorized as visual learners which in turn achieved significantly better than students categorized as kinaesthetic learners when taught using the conventional teaching method. Riding and Grimley (1999) found that learning style interacts with the structure of the materials in affecting learning. Research has found that individuals learn best when information is presented in ways that are congruent with their preferred styles (Riding & Grimley, 1999).

Statement of the Problem

It is generally agreed that the conventional teaching style prevalent in schools does not accommodate the preferences of all students equally. Hence, one of the most important challenges that school teachers face is to be tolerant and perceptive enough to recognize learning differences among their students. Many teachers do not realize that students varying the way they process and understanding information. Therefore, there is always a mismatch between the preferred learning styles of students and the instructional strategies used by the teacher. To find solution to these problems, there is need to strive for a balance of effective instructional strategies and student's individual learning styles. In the light of these, will there be any difference in the students' achievement with different learning styles taught using different instructional strategies?

Purpose of the Study

The purpose of the study was to investigate the effects of learning styles and instructional strategies on students' achievement in Nigerian senior secondary school physics. Specifically, the study was designed to examine the achievement of physics students with different learning styles (Sensing/Intuitive, Active/Reflective, Visual/Verbal and Sequential/Global) taught using different instructional strategies (guided discovery, demonstration and conventional).

Research Hypotheses

The following hypotheses were formulated and tested at .05 level of significance.

1. There is no significant difference in the achievement of physics students with different learning styles (Sensing/Intuitive, Active/Reflective, Visual/Verbal and Sequential/Global) taught using guided discovery strategy.
2. There is no significant difference in the achievement of physics students with different learning styles (Sensing/Intuitive, Active/Reflective, Visual/Verbal and Sequential/Global) taught using demonstration strategy.
3. There is no significant difference in the achievement of physics students with different learning styles (Sensing/Intuitive, Active/Reflective, Visual/Verbal and Sequential/Global) taught using conventional strategy.

Research Method

Quasi-experimental design was adopted for the study. The population of the study consisted of all the 1,880 senior secondary two (SS2) physics students in the 44 public secondary schools in Ondo West Local Government Area of Ondo State, Nigeria. A total of 250 students took part in the study in their intact classes. Purposive sampling technique was used to select schools from the target population. The criteria are:

1. Schools that have at least one professional graduate physics teacher with at least five years of teaching experience.
2. Schools in which the concept of electricity has not been taught already.
3. Schools that are currently presenting candidates for the Senior Secondary School Certificate Examination (SSSCE).
4. Schools that have functional and well equipped laboratories.

Fourteen schools met the above criteria. Six schools among those that met the criteria were selected by balloting and the schools were randomly assigned to treatment and control groups.

Index of Learning Style Questionnaire (ILSQ) and Physics Achievement Test (PAT) were the instruments used to gather data for this study. The ILSQ was adapted from Felder and Soloman (1998) and consisted of 44 items with options A and B. The students were required to choose options that apply frequently to their learning styles. The questionnaire was used to determine students' individual learning styles (Sensing/Intuitive, Active/Reflective, Visual/Verbal and Sequential/Global). The PAT consisted of 50 multiple-choice items in the concept of electricity and were constructed by the researchers. Each item had four options with only one correct answer and the correct answer was score 2 marks. The validation of ILSQ was ascertained by three psychologists while that of PAT was ascertained by three physics educators. The instruments were trial tested with 35 students in a school that was not used for the main study. Test-retest approach was used to establish the reliability of ILSQ and the results obtained were subjected to Pearson Product Moment Correlation. The result showed that ILSQ has a reliability coefficient of 0.88. The results obtained from PAT were subjected to Kuder Richardson formula -21 and the result showed a reliability coefficient of 0.82.

Teacher quality variables were controlled by using research assistants who were the physics teachers in each school to teach each group. Training on the use of the instructional strategies was conducted for the research assistants for one week. Pretest was administered to both the experimental and control groups and the results were used as covariate measures in order to take care of possible initial differences in groups. After the pretest, the subjects were taught the concept of current electricity for 6 weeks. The experimental group 1 was taught using guided discovery, experimental group 2 was taught using demonstration while the control group was taught using the conventional strategy.

A posttest was administered to all the groups after the expiration of the treatment period. ILSQ was also administered to the students and the results were used to classified students into their respective learning styles. The data collected were analyzed using descriptive statistics, analysis of covariance, multiple classification analysis and Scheffe's post hoc test. All the hypotheses were tested at .05 level of significance.

Results

Table1: Descriptive statistics of students classified by learning styles and instructional strategies

	Guided Discovery		Demonstration		Conventional		Total	
Learning styles	N	%	N	%	N	%	N	%
Sensing/Intuitive (SI)	24	25.81	22	28.21	22	27.85	68	27.20
Visual/Verbal (VV)	22	23.66	18	23.08	19	24.05	59	23.60
Active/Reflective (AR)	19	20.43	21	26.93	20	25.32	60	24.00
Sequential/Global (SG)	28	30.10	17	21.18	18	22.78	63	25.20
Total	93		78		79		250	

The analysis in Table 1 shows that out of the 250 students sampled for the study, 68(27.20%) are Sensing/Intuitive learners, 59(23.60%) are Visual/Verbal learners, 60(24.00%) are Active/Reflective learners while 63(25.20%) are Sequential/Global learners. This implies that we have more Sensing/Intuitive learners than other types of learning styles.

Hypothesis One

There is no significant difference in the achievement of physics students with different learning styles (Sensing/Intuitive, Visual/Verbal, Active/Reflective and Sequential/Global) taught using guided discovery.
The analysis is as shown in Table 2.

Table 2: Analysis of covariance of physics students' achievement with different learning styles taught using guided discovery

Sources of Variation	Sum of square	Df	Mean Square	F.cal.	P<.05	Decision
Covariate Pretest	95.26	1	95.26	3.26	.08	NS
Main effect	4246.72	3	1415.57	48.46	.00	*
Explained	4341.98	4	1085.50	37.16	.00	*
Residual	2570.50	88	29.21			
Total	6912.48	92	75.13			

NS=Not significant at P<.05 alpha level
* = Significant at P<.05 alpha level

The result of the main effect of treatment on students' achievement in physics as shown in Table 2 was significant at p<.05 alpha level ($F_{(2,90)}$ =48.46,p<.05). Hence, the hypothesis is rejected. This implies that the four pairs of learning styles differ significantly in their enhancement of the achievement of physics students after being taught using guided discovery. Consequence upon the observed significant difference in the learning styles, Multiple Classification Analysis (MCA) was considered to determine the variance of the dependent variable (achievement) in physics that is attributable to the influence of the independent variable (learning styles) as shown in Table 3.

Table 3: Multiple Classification Analysis (MCA) of the achievement scores of students with different learning styles taught with guided discovery

Grand Mean=73.62	N	Unadjusted		Adjusted for Independent Variable and Covariates	
Variable +Category		Dev'n	Eta	Dev'n	Beta
LEARNING STYLES			.83		.82
Sensing/Intuitive (SI)	24	10.31		10.30	
Visual/Verbal (VV)	22	-9.20		-9.25	
Active/Reflective (AR)	19	5.00		4.94	
Sequential/Global(SG)	28	-1.29		-1.25	
Multiple R. =.82					
Multiple R. square=.67					

Table 3 shows a multiple regression index (R) of .82 and multiple regression square index (R^2) of .67. This implies that 67% of the total variance in the achievement of physics students is attributable to the influence of different learning styles of students when taught with guided discovery. To find the direction of significance, the achievement scores were subjected to Scheffe multiple comparison test for a post hoc analysis as shown in Table 4.

Table 4: Result of Scheffe's post hoc analysis for multiple comparison of learning styles on students' achievement in physics using guided discovery

Dependent Variables: POST TEST SCORES						
(I) Learning Styles	(J)Learning Styles	Means Difference (I-J)	Std. Error	Sig.	95% Confidence Lower Bound	Interval Upper Bound
SI	VV	19.55*	1.66	.000	14.78	24.32
	AR	5.36*	1.70	.000	0.59	10.13
	SG	11.55*	1.53	.000	6.17	16.32
VV	SI	-19.55*	1.65	.000	-24.32	-14.78
	AR	-14.19*	1.76	.000	-18.96	-9.42
	SG	-8.00*	1.60	.000	-12.77	-3.23
AR	SI	-5.36*	1.70	.000	-10.13	-0.59
	VV	14.19*	1.76	.000	9.42	-18.96
	SG	6.19*	1.64	.000	1.42	10.96
SG	SI	-11.55*	1.53	.000	-16.32	-6.17
	VV	8.00*	1.60	.000	3.23	12.77
	AR	-6.19*	1.66	.000	-10.96	-1.42

* = The mean difference is significant at .05 level

As shown in Table 4, the mean difference between SI and VV was 19.55, between SI and AR was 5.36, between AR and VV was 14.19, between AR and SG was 6.19, and between SG and VV was 8.00. This implies that Sensing/Intuitive learning style was the most effective in facilitating students' achievement in physics when taught with guided discovery. This was seconded by Active/Reflective, followed by Sequential/Global while Visual/Verbal learning styles was the least effective in facilitating students' achievement in physics when taught with guided discovery. Hence, guided discovery is the most effective instructional strategy for physics students with Sensing/Intuitive learning style.

Hypothesis Two

There is no significant difference in the achievement of physics students with different learning styles (Sensing/Intuitive, Active/Reflective, Visual/Verbal and Sequential/Global) taught using demonstration strategy. The analysis is as shown in Table 5.

Table 5: Analysis of covariance of students' achievement in physics with different learning styles taught using demonstration method

Source of Variation	Sum of Square	Df	Mean Square	F.cal.	P<.05	Decision
Covariate Pretest	1.60	1	1.68	0.10	.79	NS
Main effect	1422.42	3	474.14	27.68	.00	*
Explained	1424.10	4	356.03	20.78	.00	*
Residual	1250.12	73	17.13			
Total	2674.22	77	34.73			

NS = Not significant at p<.05 alpha level
* = significant at p<.05 alpha level

The result of the main effect of treatment on students' achievement in physics as shown in Table 5 was significant at p<.05 alpha level ($F_{(2,75)} = 27.68, p<.05$). Hence, the hypothesis is rejected. This implies that the four pairs of learning styles differ significantly in their enhancement of the achievement of physics students after being taught using demonstration. Consequence upon the observed significant difference in the learning styles, Multiple Classification Analysis (MCA) was considered to determine the variance of the achievement in physics that is attributable to the influence of learning styles as shown in Table 6.

Table 6: Multiple Classification Analysis (MCA) of the achievement scores of students with different learning styles taught with demonstration

Grand Mean=70.65	N	Unadjusted		Adjusted for Independent Variable and Covariates	
Variable + Category		Dev'n	Eta	Dev'n	Beta
LEARNING STYLES			.79		.78
Sensing/Intuitive (SI)	22	-0.70		-0.68	
Visual/Verbal (VV)	18	-4.55		-4.51	
Active/Reflective (AR)	21	2.36		2.29	
Sequential/Global (SG)	17	8.20		8.00	
Multiple R =.78					
Multiple R. Square =.61					

As shown in Table 6, the multiple regression (R) was .78 while the multiple regression squared index (R^2) was.61. This implies that 61% of the total variance in the achievement of physics students is attributable to the influence of different learning styles of students when taught with demonstration. To find the direction of significance, the achievement scores were subjected to Scheffe multiple comparison test for a post hoc analysis as shown in Table 7.

Table 7: Result of Scheffe's post hoc analysis for multiple comparison of learning styles on students' achievement in physics using demonstration

Dependent Variables: POST TEST SCORES						
(I) Learning Style	(J) Learning Style	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
SI	VV	3.83*	1.32	.062	-0.25	7.91
	AR	-2.97*	1.25	.166	-7.05	1.11
	SG	-8.68*	1.32	.062	-12.76	-4.60
VV	SI	-3.83*	1.32	.000	-7.91	0.25
	AR	-6.80*	1.35	.000	-10.88	-2.72
	SG	-12.51*	1.41	.000	-16.59	-8.43
AR	SI	2.97*	1.25	.166	-1.11	7.05
	VV	6.80*	1.35	.000	2.72	10.88
	SG	-5.71*	1.35	.001	-9.79	-1.63
SG	SI	8.68*	1.32	.000	4.60	12.76
	VV	12.51*	1.41	.000	8.43	16.59
	AR	5.71*	1.35	.001	1.63	9.79

* = The mean difference is significant at .05 level

As shown in Table 7, the mean difference between SI and VV was 3.83, between AR and SI was 2.97, between AR and VV was 6.80, between SG and SI was 8.68, between SG and VV was 12.51, and between SG and AR was 5.71. This implies that Sequential/Global learning style was the most effective in facilitating students' achievement in physics when taught with demonstration. This was seconded by Active/Reflective, followed by Sensing/Intuitive while Visual/Verbal learning style was the least effective in facilitating students' achievement in physics when taught with demonstration. Hence, demonstration is the most effective instructional strategy for physics students with Sequential/Global learning styles.

Hypothesis Three

There is no significant difference in the achievement of physics students with different learning styles (Sensing/Intuitive, Active/Reflective, Visual/Verbal and Sequential/Global) taught using conventional strategy. The analysis is as shown in Table 8.

Table 8: Analysis of covariance of physics students' achievement with different learning styles taught using conventional strategy

Source of Variation	Sum of Square	Df	Mean Square	F.cal.	P<.05	Decision
Covariate Pretest	27.46	1	27.46	2.26	.12	NS
Main effect	936.24	3	312.08	25.62	.00	*
Explained	963.70	4	240.93	19.78	.00	*
Residual	901.98	74	12.18			
Total	1865.68	78	23.62			

NS = Not significant at p<.05 alpha level
* = significant at p<.05 alpha level

The result of the main of treatment of students' achievement in physics as shown in Table 8 was significant at p<.05 alpha level ($F_{(2,76)}$ = 25.62, p<.05).Hence, the hypothesis is rejected. This implies that the four pairs of learning styles differ significantly in their enhancement of the achievement of physics students after being taught using conventional strategy. Consequence upon the observed significant difference in the learning styles, Multiple Classification Analysis (MCA) was considered to determine the variance of achievement in physics that is attributable to the influence of the learning styles as shown in Table 9.

Table 9: Multiple Classification Analysis (MCA) of the achievement scores of students with different learning styles taught with conventional strategy

Grand Mean=62.41	N	Unadjusted		Adjusted for Independent Variable and Covariates	
Variable + Category		Dev'n	Eta	Dev'n	Beta
LEARNING STYLES			.74		.73
Sensing/Intuitive (SI)	22	-3.25		-3.27	
Visual/Verbal (VV)	19	5.90		5.86	
Active/Reflective (AR)	20	2.47		2.45	
Sequential/Global (SG)	18	-0.52		-0.40	
Multiple R. = .73					
Multiple R. Square = .53					

Table 9 shows a multiple regression index (R) of .73 and multiple regression square index (R^2) of .53. This implies that 53% of the total variance in the achievement of physics students is attributable to the influence of different learning styles of students when taught with conventional strategy. To find the direction of significance, the achievement scores were subjected to Scheffe multiple comparison test for a post hoc analysis as shown in Table 10.

Table 10: Results of Scheffe's post hoc test for multiple comparison of learning styles on students' achievement in physics taught using conventional strategy

Dependent Variables: POST TEST SCORES

(I) Learning styles	(J) Learning styles	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
SI	VV	-9.13*	1.06	.000	-12.21	-6.05
	AR	-5.72*	1.02	.000	-8.80	-2.64
	SG	-2.87*	1.12	.035	-5.95	0.21
VV	SI	9.13*	1.06	.000	6.05	12.21
	AR	3.41*	1.04	.017	0.33	6.49
	SG	6.26*	1.14	.000	3.18	9.34
AR	SI	5.72*	1.02	.000	2.64	8.80
	VV	-3.41*	1.04	.017	-6.49	-0.33
	SG	2.85*	1.10	.075	-0.23	5.93
SG	SI	2.87*	1.13	.035	-0.21	5.95
	VV	-6.26*	1.14	.000	-9.34	-3.18
	AR	-2.85	1.10	.075	-5.93	0.23

*= The mean difference is significant at .05 level

As shown in Table 10, the mean difference between VV and SI was 9.13, between VV and AR was 3.41, between VV and SG was 6.26, between AR and SI was 5.72, between AR and SG was 2.85, and between SG and SI was 2.87. This implies that Visual/Verbal learning styles was the most effective in facilitating students' achievement in physics when taught with conventional strategy. This was seconded by Active/Intuitive, followed by Sequential/Global while Sensing/Intuitive was seen to be the least effective in facilitating students' achievement in physics when taught with conventional strategy. Hence, conventional strategy is the most effective instructional strategy for physics students with Visual/Verbal learning style.

Discussion of Results

The result of hypothesis one showed that guided discovery is the most effective instructional strategy for physics students with Sensing/Intuitive learning style. This might be due to the fact that guided discovery exposes the students to more realities of life and they tends to work as scientist and acquire knowledge by themselves in which the teacher serves as a guide and correct their misconceptions (Afolabi & Akinbobola, 2009). Discovery is intrinsically motivating and thus promotes the comprehension of inquiry. Also, the path to educational excellence for sensing learners is usually from a practice- to- theory route. Sensing learners are practical and make use of their senses to solve problem. Similarly, intuitive learners are creative, innovative and can work independently. Hence, the enhancement of Sensing/Intuitive learners through guided discovery. The result is in agreement with the findings of Zywno and Waalen (2002) that students with sensing preferences have higher achievement in technology-enabled education through hypermedia-assisted mode of learning.

The result of hypothesis two showed that demonstration is the most effective instructional strategy for physics students with Sequential/Global learning style. This might be due to the fact that demonstration technique enables the students and teachers to interact fully for effective academic achievement (Skinner, 1990). Also, the ability to store information in the memory can be developed, not by lengthy practice in memorization only but by using suitable methods of demonstration, which enhance the storage and remembrance of facts. The study is in agreement with the findings of Onyejiaku (1987) that in the learning process involve reacting, doing and experiencing such as demonstration, information is better registered because the hearer sees the instructor demonstration strategy over conventional strategy. Also, sequential learners gain understanding through an orderly manner in linear steps and go through logical stepwise path in finding solutions to problems (Zywno and Waalen, 2002). This is line with demonstration procedure that has a logical and orderly arrangement which enhance problem solving skills. Demonstration also assists students to solve complex problems once the lay down principles and procedures are followed. This is in line with global learners that learn in large jumps.

The results of hypothesis three showed that conventional strategy is the most effective instructional strategy for physics students with Visual/Verbal learning style. This might be due to the fact that visual learners get more information from visual images such as graphs, diagrams and pictures, and verbal learners prefer written or spoken explanations, and formulae, which are characteristics of conventional strategy. This is in line with the findings of Akinbobola (2011a) that audial and visual learners achieved significantly better than students categorized as kinaesthetic learners when taught using the conventional instructional strategy.

Conclusion

The results of the administration of Index of Learning Style Questionnaire (ILSQ) on the sampled students indicated that 68(27.20%) students were Sensing/Intuitive learners, 59(23.60%) are Visual/Verbal learners, 60 (24.00%) are Active/Reflective learners while 63 (25.20%) are Sequential/Global learners. This implies that we have more Sensing/Intuitive learners than other types of learning styles. The result also showed that guided discovery is the most effective instructional strategy for physics students with Sensing/Intuitive learning style in the concept of electricity while demonstration is the most effective instructional strategy for physics students with Sequential/Global learning style in the concept of electricity. Also, conventional strategy is the most effective instructional strategy for physics students with Visual/Verbal learning style in the concept of electricity. The results also showed that Active/Reflective learning style is placed second in the order of facilitating students' achievement in the concept of electricity in physics when taught with guided discovery, demonstration and conventional learning strategies respectively. This implies that the three instructional strategies can be used for the enhancement of the achievement of students with Active/Reflective learning styles in the concept of electricity in physics.

Recommendations

Based on the findings of this study, the following recommendations are made:

1. Teachers should find out the learning styles of their students and use appropriate instructional strategies that will concise with the learning styles for effective teaching and learning to take place in physics classrooms.
2. Workshops and seminars should be organized for physics teachers to update their knowledge and familiarize themselves with the index of learning style questionnaire for possible use in order to identify their students' learning styles with a view to incorporate them into appropriate instructional strategy during lesson.
3. Curriculum planners for senior secondary school physics should design the curriculum in such a way that will benefit students with multiple learning styles.

4. Students should have knowledge of their preferred learning style. They should be offered counseling on how to adapt their learning styles to various instructional styles they will encounter in schools.
5. Students' learning style should be used to direct teachers to incorporate various instructional strategies. The guidelines for teaching various learning styles include:

A. Guidelines for teaching Visual/Verbal learners

- Start the lesson with a story, an anecdote or humor that relates to the content or to the students own experiences (Verbal).
- Use questions to introduce topics followings students' answers (Verbal).
- Proceed step by step through details that need to be absorbed in order to acquire skills (Verbal).
- Provide instant feedback on tests and assignments as soon as possible (Verbal).
- List all relevant information about assignments, work requirements, objectives and direction on paper or have the students copy from the board (Verbal).
- Use a teacher-organized learning situation (Verbal).
- Motivate learning through grades and competition (Verbal).
- Provide a balance of abstract concepts and concrete information (Verbal).
- Use of conventional teaching (expository) strategy (Verbal/Visual).
- Use video tape for instruction (Visual).
- Use computer assisted instruction ((Visual).
- Use concept maps for illustration (Visual).
- Use pictures, simple sketches, graphs and schematics before, during and after presentation of verbal materials (Visual). (Akinbobola, 2011b).

B. Guidelines for teaching Sensing and Intuitive learners

- Use computer assisted instruction (Sensing).
- Provide practical exercises that involve drilling and the development of psychomotor skills (Sensing).
- Show films through video tape or projector during instruction (Sensing).
- Use different demonstrations activities for illustrations (Sensing).
- Use simple sketches, graphs, diagrams and pictures before, during and after the presentation of verbal materials (Sensing).
- Use practical applications of the concept taught and its relevance to real life situations (Sensing).
- Provide concrete examples during illustrations such as facts, realia or hypothetical experiments and their results and follow scientific procedure in presenting theoretical materials (Sensing).
- Provide explicit illustrations of sensing patterns through empirical illustration and observation of surroundings (Sensing).
- Emphasize practical problem-solving strategies such as guided discovery and inquiry (Sensing).
- Provide a balance of abstract concepts such as theories, mathematical models and principles with concrete concepts such as facts, realia and data with their results (Intuitive).
- Provide materials that emphasize fundamental understanding (Intuitive).
- Develop theories and formulate hypotheses (Intuitive).
- Provide some open-ended questions and exercises that call for analysis and synthesis (Intuitive).
- Encourage creative solutions and motivate students that give incorrect answers (Intuitive).

C. Guidelines for teaching Active/Reflective learners

- Emphasize practical problem-solving strategies such as laboratory strategy and project (Active).
- Provide hands-on activities (Active).
- Use computer assisted instruction (Active).
- Discovery through group learning, brain storming and case study (Active).
- Provide practical exercises that involve drilling and the development of psychomotor skills (Active).
- Allow students to interact with each other and give them option of cooperating on homework assignments. (Active).
- Provide materials that emphasize fundamental understanding (Reflective).
- Provide intervals of time for students to think about what they have been taught before starting teaching another concept (Reflective).
- Provide some open-ended questions and exercise that call for analysis and synthesis (Reflective).
- Provide little practical exercises that involve drilling and the development of the three educational domains (Reflective).
- Use guided discovery, demonstration and conventional (expository) strategies for teaching (Active/Reflective).

D. Guidelines for teaching Sequential/Global learners

- Develop theories and formulate hypotheses (Sequential).
- Follow laid down principles and scientific procedures in presenting theoretical materials (Sequential).
- Show how the theory or hypothesis can be validated, deduce its consequences and present applications (Sequential).
- Use demonstration strategy for teaching (Sequential/Global).
- Provide practical exercises that involve drilling in a logical and sequential order (Sequential).
- Teach from general to specific (Global).
- Students should be exposed periodically to advanced concepts before these concepts would normally be introduced (Global).
- Assign creativity exercises that involve generating alternative solutions and bringing in materials from other courses or disciplines (Global).
- Give students the freedom to devise their own ways of solving problems (Global).
- Relate the material to be taught with previous knowledge of the students and their personal experiences (Global).
- Encourage creative solutions and motivate students that give incorrect answers (Global).

REFERENCES

Adeyemo, P.O. (1998).*Principles of education and practices.* Ado-Ekiti, Nigeria: Omolayo Standard Press and Bookshop Co. Ltd.

Afolabi, F. & Akinbobola, A.O. (2009). Constructivist problem based learning technique and the academic achievement of physics students with low ability level in Nigerian secondary schools. *Eurasian Journal of Physics and Chemistry Education,* 1, 45-51.

Akinbobola, A.O. (2011a). Visual, auditory and kinaesthetic learning styles and students' achievement in Nigerian senior secondary school physics. *IRCAB Journal of Arts and Education,* 1(1), 140-146.

Akinbobola, A.O. (2011b). Teaching methods, study habits, school location and gender factors as determinants of retention ability of physics students in Nigeria senior secondary schools. *IRCAB Journal of Arts and Education,* 1(1), 152-158.

Akinbobola, A.O. & Afolabi, F.(2009). Constructivist practices through guided discovery approach: The effect on students' cognitive achievements in Nigerian senior secondary school physics. *Bulgarian Journal of Science and Educational Policy,* 3(2), 233-252.

Akinbobola, A.O. & Ikitde, G.A. (2011).Strategies for teaching mineral resources to Nigeria secondary school science students. *African Journal of Social Research and Development,* 3(2), 130-138.

Dunn, R. (1990). Understanding the Dunn and Dunn learning styles model and the need for individual diagnosis and prescription. *Reading, Writing and Learning Disabilities,* 6,223-247.

Felder, R.M. & Soloman, B.A. (1998).*Index of learning styles.* Online version of the questionnaire, available at North Carolina State University, http://www2.ncsu.edu/unity/lockers/users/f/felderpublic/ILSdir/ILS-a.htm. Retrieved 20/7/2008.

Felder, R.M.(1988).Learning and teaching styles in engineering education. *Engineering Education,* 78(7), 674-681.

Gregorc, A.F. (1979). Learning/teaching styles:Potent forces behind them. *Educational Leadership,* 36,234-236.

Keefe, J.W. & Monk, J.S. (1986). *Learning styles profile.* Reston, VA: National Association of Secondary School Principals.

Nwagbo, C. (2001). The relative efficacy of guided inquiry and expository methods on the achievement in biology of students of different levels of scientific literacy. *Journal of the Science Teachers Association of Nigeria,* 36(1& 2), 43-51.

Onyejiaku, F.O. (1987). *Technique of effective study. A manual for students in schools, colleges and universities*. Calabar, Nigeria: Wusen Press Ltd.

Riding, R. & Grimley, M. (1999). Cognitive style and learning from multimedia materials in 11-year children. *British Journal of Educational Technology,* 30(1), 43-59.

Riding, R. & Rayner, S. (1998). *Cognitive styles and learning strategies.* London: David Fulton Publishers.

Sternburg, R.J. (1990). Thinking styles. Keys to understanding students' performance. *Phi Delta Kappan,* 71(5), 366-371.

Skinner, B.F. (1990). The science of learning and art of teaching. *Havard Educational Review,* 80(1), 102-108.

Zywno, M.S. & Waalen, J.K. (2002). The effect of individual learning styles on students' outcomes in technology-enabled education. *Global Journal of Engineering Education,* 6(1), 1-10.