

EFFECTS OF FELDER-SILVERMAN'S LEARNING STYLES ON STUDENTS' ACHIEVEMENT IN SECONDARY SCHOOL PHYSICS IN BASSA LOCAL GOVERNMENT AREA, PLATEAU STATE, NIGERIA


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ABSTRACT

Purpose: The study determined the achievement of students in physics when exposed to Felder-Silverman's learning styles, amongst others.

Methodology: The separate-sample pre-test, post-test quasi-experimental research design was adopted. The population was 419 senior secondary two (SSII) students offering physics in 31 schools in Bassa Local Government Area, Nigeria. A sample of 88 students obtained from four intact classes were used. The instruments used were the Index of Learning Style Questionnaire (ILSQ) and Physics Achievement Test (PAT). Construct validity and content validity were respectively performed on the ILSQ and PAT. The test-retest method was used to obtain the reliability coefficient of ILSQ as 0.86. Kuder-Richardson formula 20 was used to obtain the coefficient of PAT as 0.81. ILSQ was administered, before PAT, as pre-test so as to place students into the learning styles. After teaching for four weeks, using the lecture method, PAT was administered as post-test. The mean and ANCOVA were respectively used to answer the research questions and hypotheses.

Results: Visual/verbal and sensing/intuitive learners achieved higher than the active/reflective and sequential/global learners, amongst others.

Findings: A major finding was that sensing/intuitive and visual/verbal learning styles had significant effect on students' achievement but active/reflective and sequential/global learning styles had insignificant effect.

Recommendations/Classroom Implications: Students should be encouraged to put their learning styles into use. When students are exposed to the different dimensions of learning styles, their achievement in Physics may be improved.

Keywords: Active/reflective learners, Sensing/intuitive learners, Sequential/global learners, Students' achievement, Visual/verbal learners



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PUBLIC INTEREST STATEMENT

The findings of this study would hopefully be of benefit to students of Physics, Physics teachers and Ministry of Education. This is because when students use their preferred learning styles to learn physics, their achievement in the subject may be enhanced; Physics teachers would be able to teach their students effectively when they know their students' learning styles by adjusting their teaching styles.

INTRODUCTION

Education is the key that unlocks illiteracy which must be the priority of any nation that desires to build a great and dynamic economy. The ultimate goal of educational experiences, both inside and outside the school environment, may be to meet and make more effective, new situations of varying degrees of relatedness and similarities so as to boost the social and economic life of its citizens. In this fast-changing 21st century world, there is the need to equip Nigerian students in order to meet up with new challenges in science and technology. There are lots of expectations placed on the Nigerian educational system to inculcate the necessary skills and attitudes that will enhance collaboration, team-work, problem-solving and creativity in students. The implication is that the educational system may require radical reorientation, more so that Federal Republic of Nigeria (2014) outlined the development of a great and dynamic economy for the betterment of its citizenry, as one of the main goals of education in Nigeria. It was in that line of thought that Nigerian Educational Research and Development Council (2008) earlier specified the acquisition of basic literacy in Physics by secondary school students, for functional living in the society. One of the ways to prepare the students for functional living in the society is to explore the appropriate learning styles that will help promote their literacy in Physics.

Learning styles indicate an individual's preferential way(s) of focusing on different types of information, to enhance his or her understanding and achievement. Learning styles are various approaches which students employ to learn. These styles involve educating methods, particular to individuals, which are

presumed to allow the individual to learn effectively. This implies that students have different leaning styles and having an understanding of the learning style preferences of students can provide effective teaching strategies for teachers to use. Tuan (2011) held the view that a learning style is an individual student's comfort zone or educational conditions under which the student learns best. Even though, Zhou (2011) defined a learning style as an external skill that a student consciously employs to enhance his or her learning, Bostrom (2012) added that a student may also unconsciously employ a learning style. Students, who share a learning style that is attuned with the teaching style, remember information longer and are more optimistic about learning.

Research results revealed that when teachers pay attention to students' individual differences and learning characteristics, the quality of learning and achievement is enhanced (Safe, 2008; Tella & Adeniyi, 2009). There is the need, therefore, for Physics teachers to adapt teaching styles that favours their students' learning styles. There are lots of learning styles that have been developed; these include Kolb learning style model, Gregorc mind styles, Honey-Munford learning style I and Felder-Silverman's learning styles. Felder and Silverman (1988) developed a learning style model which has five bi-polar learning style dimensions: These dimensions are the sensing/intuitive, visual/verbal, active/reflective, sequential/global and intuitive/deductive learning styles. The model presents different dimensions that indicate learning style preferences by individual students. However, the inductive/deductive learning style dimension was later removed from the model because Felder viewed inductive presentation as not being concise and

prescriptive and also posited that many or most students prefer deductive teaching that the less effective conventional lecture method presents to them.

Felder and Spurlin (2005), Platsidou and Metallidou (2009) opined that the Felder-Silverman's learning styles model provides the teacher with a good basis for choosing teaching methods that would address the learning needs of the students they teach. It is assumed that students vary in terms of the learning styles they employ and, according to Kelly (2013) all students have some degree of the four dimensions in them. The four dimensions of Felder-Silverman's learning styles model have been explained by Dahlan, Noor and Hashim (2010), Kelly (2013), Naik (2013) and Platsidou and Metallidou (2009): Sensing/intuitive learners are also referred to as perception learners. Perception learning refers to the approaches students use to solve problems, and their tolerance for factual learning. The sensing learners (sensors) prefer perceiving information through sights, sounds and physical sensations. They enjoy learning facts and are better at memorizing those facts; they also prefer well-established methods of solving problems; they do not like surprises, complications and taking big risks. On the other hand, intuitive learners (intuitors) prefer to perceive information through memories, ideas and insights. Such learners do not tolerate learning that requires repetition, routine and memorization of facts; they are innovative and are better at grasping new concepts. Visual/verbal learners are input learners whose ability to retain information is influenced by the way the information is presented. Input learning has to do with the modality that sensory information is mostly effectively perceived by students. Visual learners prefer more visual modes of information intake such as through charts, diagrams, pictures, graphs and demonstrations, while verbal learners appreciate more verbal explanations such as written and spoken words and formulae.

Dahlan, Noor and Hashim (2010), Kelly (2013), Naik (2013) and Platsidou and Metallidou (2009) further explained active/reflective and sequential/global learning: Active/reflective learners are processing learners. This dimension of Felder-Silverman's learning style refers to students' preferred degree of involvement in solving problems. Active learners prefer being actively engaged in solving the problem such as through group discussions and practical application of concept that have been learned. Reflective learners prefer learning through introspection; they like to think over concepts taught before indulging in any practical application; they also prefer to work single-handedly rather than in groups. Sequential/global learners are referred to as understanding learners. This dimension is concerned with the ways learners understand information or organize such information, and how the learners progress towards understanding the information. Sequential learners learn in a logical progression of small incremental steps; they establish logical connections from one piece of information to another. Conversely, global learners learn holistically (in large jumps). They do not immediately see the relationships between materials, but are able to learn in large jumps; they use holistic thinking processes, putting pieces of materials together randomly before suddenly arriving at solutions.

Students' preferences on each dimension may be strong, moderate or mild, may change with time, and may vary from one subject or learning environment to another as opined by Ku and Chang (2011), Platsidou and Metallidou (2009). This implies that the learning style preferences may be affected by a students' educational experience. Omar, Mohammed and Paimin (2014) carried out a research on dimension of learning styles and students' academic achievement. The results showed that there is no significant relationship between the dimensions of learning styles and academic achievement. However, when Jiraporncharoen, Angkurawaranon,

Chockjamsai, Deesomchok and Euathrongchit (2015) conducted their study, both pre-clinical and clinical students who were sequential learners were found to achieve high in medical courses. The study also found out that high achievement was only associated with reflective learners only among pre-clinical students. Mohammad, Heong and Kiong (2017) conducted a study on learning styles and academic achievement among building construction students and the study revealed that the students tended to be visual learners. Munir, Ahmad, Hussain and Ghani (2018) conducted a research on the relationship between learning styles and performance of secondary school students and the findings indicated that there is no significant relationship between students' learning styles and their achievement. A study conducted earlier by Ling, Basit and Hassan (2017) had revealed that visual learning and sequential learning styles significantly affect students' achievement. Gender issues are global and may influence students' achievement. In the context of this study, students' achievement in Physics refer to their performance in the subject.

Gender is the range of physical, biological, mental and behavioural characteristics pertaining to and differentiating between the feminine and masculine population. Interest in gender and physics achievement derives mainly from two concerns, equality between the sexes that focuses on the need to avoid sexual discrimination in education and for a wider interest and understanding in Physics so as to eliminate gender gap in education issues. Filgona (2016) was of the view that gender characterizes the differing roles, responsibilities, constraints, opportunities and needs of females and males in any given social context. A study conducted by Inyang & Josiah (2016) on gender showed achievement superiority in Physics of the male gender over their female counterparts. On the contrary, findings such as those of Aloa and Abubakar (2010), Bhat and Govil (2014), Mutua (2015), Ogbeba, Odoh and Adeke, (2014) and Oomen (2015) revealed that

students' achievement is not gender-biased. A study explored by Prajapati, Dunne, Bartlett and Cubbidge (2011) found out that students' gender affects their learning styles, and that female students disproportionately prefer the equivalence of active/reflective and visual/verbal dimensions of Felder-Silverman's learning styles. Nja, Umali, Asuquo and Orim (2019) also found out that a significantly difference exists between students' learning styles and their gender, with the male students having a higher mean in the learning styles preference than their female counterparts. Besides students' gender, school type is another moderating variable in studies concerning learning styles of students.

Public and private schools differ in their administrations and conditions for teaching and learning. While public schools are fully dependent on the state for their finances, private schools depend more on student fees and private charity and occasionally on government for additional support; hence private schools have the optimal conditions for higher effectiveness compared to public schools. Okon and Archibong (2015) employed a multi-level modeling to examine private and public schools' differences in students' achievement in physics and science related areas and found that the achievement of students in public schools is lower than that of students in private schools. John and Ademola (2014), Mijinyawa, Yeldu, Umar and Hussaini (2017) found out that private school students achieve higher in science (Physics, Chemistry and Biology) than their counterparts in public schools.

STATEMENT OF THE PROBLEM

Evidence exists that many students approach Physics with concern about the difficulty of the subject and doubts about their own abilities in Physics (Inyang & Josiah, 2016). Furthermore, West African Examinations Council, WAEC (2019) in its report for the years 2015 to 2018 observed weaknesses of students in Physics to include limited knowledge about application of velocity-time graph, lack of proper understanding of the

mathematical relationship between acceleration and deceleration, inability to differentiate between the general equation of uniformly accelerated motion and that for motion under gravity, inability to determine components of the velocity of a projectile at its maximum height, failure to state reason why horizontal component of the velocity of a projectile remains the same at every point of its flight, inability to provide correct definition of concepts such as wave front, inability to distinguish between loudness and intensity of sound, inability to correctly define terms in physics and correctly handle calculations involving numbers expressed in standard form. These weaknesses could have resulted from poor learning styles used by students when learning Physics. These problems call for the concern of educationists and all stakeholders. Hence, there was the need to conduct the current study. Moreover, studies involving learning styles and their effects on students' achievement in Physics in Bassa Local Government Area, Plateau state, Nigeria seemed to be unavailable.

PURPOSE OF THE STUDY

The specific objectives of the study were to:

1. find out the achievement of secondary school students in Physics before and after exposure to Felder-Silverman's learning styles.
2. ascertain the effects of gender on secondary school students' achievement in Physics before and after exposure to Felder-Silverman's learning styles.
3. determine the effects of school type on students' achievement in Physics before and after exposure to Felder-Silverman's learning styles.

RESEARCH QUESTIONS

1. What is the achievement mean score of senior secondary two (SSII) students in Physics before and after exposure to Felder-Silverman's learning styles?

2. To what extent does the achievement of SSII female students differ in Physics from that of their male counterparts, before and after exposure to Felder-Silverman's learning styles?
3. What is the mean achievement score of SSII Physics students in public and private schools when exposed to Felder-Silverman's learning styles?

HYPOTHESES

1. There is no significant main effect of Felder-Silverman's learning styles on senior secondary two (SSII) students' achievement in Physics.
2. There are no significant interaction effects of Felder-Silverman's learning styles and gender on SSII students' achievement in Physics.
3. There are no significant interaction effects of Felder-Silverman's learning styles and school type on SSII students' achievement in Physics.

METHODOLOGY

Research Design

The study adopted the quasi-experimental research design of the separate-sample pre-test, post-test type.

Population and Sample

The target population for the study consisted of all the 419 senior secondary two (SSII) students offering physics as a subject in the 31 public and private secondary schools in Bassa Local Government, Plateau state, Nigeria. Quota sampling technique was used to sample four schools from the 31 schools. The 31 schools were stratified into public and private schools (school type). 58% of the schools (18) were public schools while 42% (13) were private schools. Two schools from each of the two school types were then randomly selected. One intact class (science class) from each of the four sample schools was used for the study. A total of 88 SSII students obtained from the four intact classes was used as sample for the study.

Instrument for Data Collection

Two instruments were used to gather data for the study. These were the Index of Learning Style Questionnaire (ILSQ) and Physics Achievement Test (PAT). The ILSQ was adapted from Salomon and Felder's Index of Learning Style (ILS) instrument, and has 44 dual-choice items designed to elicit students' information on their preferred way of learning, based on the four dimensions of the Felder-Silverman learning style model.

Items 2, 6, 10, 14, 18, 22, 26, 30, 34, 38 and 42 elicited information on sensing/intuitive learning; items 3, 7, 11, 15, 19, 23, 27, 31, 35, 39 and 43 elicited information on visual/verbal learning; items 1, 5, 9, 13, 17, 21, 25, 29, 33, 37 and 41 elicited information on active/reflective learning; items 4, 8, 12, 16, 20, 24, 28, 32, 36, 40 and 44 elicited information on sequential/global learning. The Felder-Silverman learning style model is represented in figure 1.

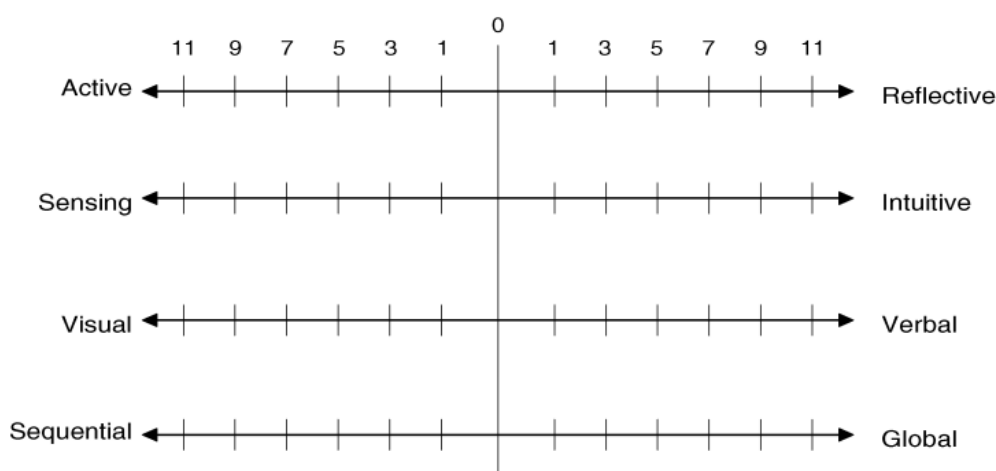


Figure 1: Dimensions of Felder-Silverman learning styles (Source: Hawk and Shah, 2007)

The scores indicate the strength of an individual students' preference for the indicated dimension. Individual students have relative preferences along each of the four dimensions but can learn to function in the reverse direction. The students were instructed to choose one of two options, in an item, that focused on some aspect of learning. Scoring was 1, 3, 5, 7, 9, and 11. A score of 1 and 3 along the dimension indicates a balanced preference, a score of 5 and 7 along the dimension indicates a moderate preference, and a score of 9 and 11 along the dimension indicates a strong preference. For instance, if a student scores +9 or +11 on the active/reflective dimension, he/she is said to be an active/reflective learner having strong preference for reflective learning. On the other hand, if a student scores -9 or -11 on the active/reflective dimension, he/she is said to be an active/reflective learner having strong preference for active learning.

The PAT, which was developed by the researchers, is a 40-item multiple-choice instrument to illicit students' knowledge on the concepts of motion under gravity and waves. Each question had four options A, B, C and D with only one correct answer. The items were developed from past West African Secondary School Certificate Examinations (WASSCE) and Senior School Certificate Examinations (SSCE) questions organized by WAEC and National Examinations Council (NECO) respectively, using test blueprint.

Construct validity was performed on the ILSQ by three experts in Department of Educational Foundations of the University of Jos, Nigeria. Content validity was conducted on the PAT by three experts, also from the University of Jos, Nigeria. The reliability coefficients of ILSQ and PAT were obtained. The test-retest method (measure of stability) was used to obtain the reliability coefficient of the ILSQ and was found to be 0.86 Kuder-Richardson formula 20 (K-R 20),

which measures internal consistency, was used on SPSS version 25 to obtain the reliability coefficient of PAT as 0.81.

Procedure for Data Analysis

Prior to administering PAT as pre-test to all the four groups, the researchers administered ILSQ to the sample to place the students into the four dimensions of Felder-Silverman learning styles. The students in each of the intact classes (one in each of the four sampled schools) were assigned into the four dimensions of Felder-Silverman learning styles (sensing/intuitive, visual/verbal, active/reflective and sequential/global) in accordance with their strong preference; and were encouraged by the researchers to continue learning using their identified learning styles. These dimensions served as groups for the study. The PAT was then administered the following day to gather information on the achievement of the students in Physics. Thereafter, all the groups were taught the concepts of

motion under gravity and waves for a period of four weeks, using the conventional lecture method. The PAT was then administered again, as post-test to all the students in the groups. The administrations of pre-test, teaching and post-test were carried out separately on the four groups (sensing/intuitive, visual/verbal, active/reflective and sequential/global).

Methods for Data Analysis

The data gathered were analyzed using the mean, a descriptive statistics, to answer all the research questions, and Analysis of Covariance (ANCOVA) to test all the hypotheses at 0.05 level of significance.

RESULTS

Research Question 1: What is the achievement mean score of senior secondary two (SSII) students in Physics before and after exposure to Felder-Silverman's learning styles?

Table 1: Mean and Standard Deviation of SSII Students' Achievement in Physics Before and After Exposure to Felder-Silverman's Learning Styles

F-S Learning Styles	Before Exposure			After Exposure	
	N	Mean	SD	Mean	SD
Sensing/intuitive	19	26.94	3.84	31.63	3.64
Visual/verbal	21	28.16	3.58	34.53	3.38
Active/reflective	30	21.69	4.65	25.55	4.53
Sequential/global	18	21.02	4.73	25.44	4.41
Total	88				

The findings from the results of analysis in Table 1 showed that before the exposure to Felder-Silverman's learning styles, sensing/intuitive learning style had a mean score of 26.94, visual/verbal learning had a mean of 28.16, active/reflective learning style had a mean of 21.69 and sequential/global learning styles had a mean value of 21.02. After exposure to the various dimensions of the Felder-Silverman's learning styles, it was found that visual/verbal and sensing/reflective learning styles yielded the mean scores

of 31.63 and 34.53 respectively. This implies that visual/verbal and sensing/intuitive learning styles of the Felder-Silverman model led to higher achievement mean score of senior secondary two (SSII) students in physics than active/reflective and sequential/global learning styles.

Research Question 2: To what extent does the achievement of SSII female students differ in Physics from that of their male counterparts, before and after exposure to Felder-Silverman's learning styles?

Table 2: Mean and Standard Deviation of SSII Male and Female Students' Achievement of in Physics Before and After Exposure to Felder-Silverman's Learning Styles

F-S Learning Styles	Before Exposure				After Exposure			
	Gender	N	Mean	SD	Gender	N	Mean	SD
Sensing/intuitive	M	11	40.21	9.50	M	23	48.03	7.90
	F	08	36.34	10.50	F	25	44.15	7.10
Visual/verbal	M	12	41.60	8.50	M	23	49.10	8.55
	F	9	38.60	10.05	F	25	52.00	9.10
Active/reflective	M	15	34.20	10.35	M	23	46.90	10.25
	F	15	38.61	9.15	F	25	40.10	9.64
Sequential/global	M	12	36.82	8.36	M	23	44.51	10.45
	F	06	34.45	9.25	F	25	42.37	9.13
Total		88						

The results of analysis in Table 2 indicated that before exposure to sensing/intuitive learning styles of Felder-Silverman model, male and female students had a mean score of 40.21 and 36.34 respectively, and mean scores of 48.03 and 44.15 after exposure to that learning style. Also, male and female students that learnt physics using the visual/verbal learning styles had respective mean scores of 41.60 and 38.60 before exposure to the learning style and mean values of 49.10 and 52.00 respectively after exposure. Furthermore, the results showed that male and female students that used active/reflective learning had respective achievement mean scores of 34.20 and 38.61 before exposure to the learning style and the respective mean values of 46.90 and 40.10 after exposure. Similarly, male and female students that used sequential/global learning style had

mean scores of 36.82 and 34.45 respectively before exposure to the learning style and respective achievement mean scores of 44.15 and 42.37 after exposure to the learning style. The findings from the results of the analysis, therefore, revealed that male students exposed to sensing/intuitive, active/reflective and sequential/global learning styles had a higher mean achievement scores than their female counterparts, while female students had a higher mean achievement score than their male counterparts when exposed to visual/verbal learning styles of the Felder-Silverman model.

Research Question 3: What is the mean achievement score of SSII Physics students in public and private schools when exposed to Felder-Silverman's learning styles?

Table 3: Mean Achievement Scores of SSII Students in Physics in Public and Private Schools after Exposure to Felder-Silverman's Learning Styles

F-S Learning Styles	School Type	N	Mean	SD
Sensing/intuitive	Public	10	47.00	9.25
	Private	7	48.30	8.80
Active/reflective	Public	12	49.02	10.80
	Private	15	41.50	9.45
Visual/verbal	Public	16	48.11	9.50
	Private	10	48.40	10.20
Sequential/global	Public	10	48.25	7.05
	Private	8	49.39	6.20
Total		88		

The findings in Table 3 showed that Physics students in public and private schools had respective mean achievement scores of 47.00 and 48.30 after exposure to sensing/intuitive learning styles of the Felder-Silverman's model. This means that sensing/intuitive learners in private schools had a marginally higher mean score than those in private schools. Also, it was found that students' exposure to active/reflective learning styles in private and public schools had mean scores of 49.02 and 41.50 respectively; this implies that

active/reflective learners in public schools had a higher mean achievement scores. Furthermore, it was revealed that students exposed to sequential/global learning in public and private schools had respective mean achievement scores of 48.25 and 49.39.

Hypothesis 1: There is no significant main effect of Felder-Silverman's learning styles on senior secondary two (SSII) students' achievement in Physics.

Table 4: Summary of ANCOVA on Main Effect of Felder-Silverman's Learning Styles on Senior Secondary SS II Students' Achievement in Physics

Source of Variations	Type III Sum of Squares	Df.	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	233.827 ^a	3	133.827	2.748	.775	.104
Intercept	3243.008	1	3243.008	6.371	.000	.174
Sensing/intuitive	3.117	1	3.117	.726	.025	.504
Visual/verbal	3.725	1	3.674	.065	.000	.539
Active/reflective	2.365	1	1.858	.579	.125	.181
Sequential/global	1.845	1	.452	.436	.642	.084
Error	948.445	83	7.107			
Total	2157.000	88				
Corrected Total	952.273	87				

R Squared = .474 (Adjusted R Squared = .351)

The findings from the ANCOVA results in Table 4 revealed $F(1,83)=2.748, p=.775$, which means that $p>0.05$. This implies that there was no significant main effect of Felder-Silverman's learning styles on senior secondary two (SSII) students' achievement in Physics. However, it was found that sensing/intuitive and visual/verbal learning styles of the Felder-Silverman's model revealed $p<0.05$, which suggests that these learning styles had significant effect on SSII students' achievement in Physics. The results also showed that active/reflective and sequential/global

learning styles had $p>0.05$, meaning that they had insignificant effect on physics students' achievement. The estimated partial eta squared values of 0.504 and 0.539 implies that the effect was moderate. The coefficient of the Adjusted R squared revealed that 35.1 percent of the changes in SSII students' achievement in physics were due to the use of the Felder-Silverman's learning styles.

Hypothesis 2: There are no significant interaction effects of Felder-Silverman's learning styles and gender on SSII students' achievement in Physics.

Table 5: Summary of ANCOVA on Interaction Effect of Felder-Silverman's Learning Styles and Gender on Senior Secondary Two (SS II) Students' Achievement in Physics

Source of Variations	Type III Sum of Squares	Df.	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	742.255 ^a	4	297.779	2.475	.810	.313
Intercept	215.899	1	215.899	1.635	.000	.347
F-S Learning Styles	4.354	1	2.177	2.686	.016	.224
Gender	3.000	1	5.767	2.378	.215	.213
F-S Learning * Gender	3.142	1	5.484	2.232	.623	.281
Error	1779.017	84	.474			
Total	2584.261	88				
Corrected Total	846.273	87				

R Squared = .333 (Adjusted R Squared = .308)

Table 5 revealed that $F(1,84)=2.475, p=.810$, which implies that $p>0.05$. The conclusion is that there was no significant interaction effects of Felder-Silverman's learning styles and gender on the achievement of SSII students in Physics. The study found that gender alone ($p>0.05$) has no significant effect on SS II secondary school students achievement in Physics. From the results it was observed that a significant interaction effect of Felder-Silverman's learning styles on the students' achievement in Physics exists ($p<0.05$). The adjusted R squared value of .308

implies that the variables, which are Felder-Silverman's learning styles and gender, were responsible for only 30.8 percent changes (improvement) in SSII Physics students' academic achievement in the study area. The coefficient of the partial Eta Squared which is .281 shows that the interaction effect was significantly small.

Hypothesis 3: There are no significant interaction effects of Felder-Silverman's learning styles and school type on SSII students' achievement in Physics.

Table 6: Summary of ANCOVA on Interaction Effect of Felder-Silverman's Learning Styles and School Type on Senior Secondary Two (SS II) Students' Achievement in Physics

Source of Variations	Type III Sum of Squares	Df.	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	393.114 ^a	5	1312.038	1.750	.138	.113
Intercept	324.008	1	324.008	2.648	.000	.153
F-S learning Styles	2.286	1	1.143	.572	.004	.411
School Type	2.456	1	1.103	.367	.812	.313
F-S Learning styles *	3.532	1	1.780	.834	.237	.272
School Type						
Error	5585.159	85	116.049			
Total	2514.000	88				
Corrected Total	741.273	87				

R Squared = .453 (Adjusted R Squared = .418)

The findings from the ANCOVA analysis in Table 6 revealed $F(1,85)=1.750, p=.138$ means that $p>0.05$; this implies that no significant interaction effect was found in the students' achievement in Physics due to Felder-Silverman's learning styles and school type. In other words, there was no significant interaction effect of Felder-Silverman learning styles and school type on SSII students' achievement in Physics in the study area ($p>0.05$), even though the learning styles alone had an effect on the students' achievement ($p<0.05$). The adjusted R squared value of .418 means that 41.8 percent of the changes or improvement in SSII students' achievement in Physics can be attributed to the interaction effects of Felder-Silverman's learning styles and school type. The coefficient of the partial Eta square for Felder-Silverman's learning styles and school type showed that the interaction effect was mild.

DISCUSSIONS

The study observed that visual/verbal and sensing/intuitive learning styles of the Felder-Silverman's model led to higher achievement mean score of senior secondary two (SSII) students in Physics than the active/reflective and sequential/global learning styles. Further findings revealed that there was no significant main effect of Felder-Silverman's learning styles on senior secondary two (SSII) students' achievement in Physics. This concurs with the findings of Omar, Mohammed and

Paimin (2014) that there is no significant relationship between the dimensions of learning styles and students' achievement. However, sensing/intuitive and visual/verbal learning styles of the Felder-Silverman's model had significant effects on SS II students' achievement in Physics in the study area, while active/reflective and sequential/global learning styles did not have significant effect on the students' achievement.

The findings also revealed that male students exposed to sensing/intuitive, active/reflective and sequential/global learning styles had higher mean achievement scores than their female counterparts. A striking finding was that the female students in the visual/verbal learners group achieved slightly higher than their male counterparts. This is corroborated by Prajapati, Dunne, Bartlett and Cubbidge (2011) who found out that female students are disproportionate in their preference to visual/verbal learning. Further findings revealed that gender alone had no significant interaction effect on the achievement of SSII students in Physics in the study area. This disagrees with the findings of Aloa and Abubakar (2010), Bhat and Govil (2014), Mutua (2015) Ogbaba, Odoh and Adeke, (2014) and Oomen (2015) that students' achievement in Physics is not gender-biased.

Findings showed that active/reflective learners in public schools had a higher mean achievement score

than their counterparts in private schools. It also indicated that there was no much difference in the mean achievement scores of visual/verbal learners in the two school types; even though, on the average, students in private schools achieved slightly higher than their counterparts in public schools. Furthermore, sequential/global learners in private schools had a marginally higher mean achievement score than those in public schools.

The findings equally revealed that there was no significant interaction effects of Felder-Silverman's learning styles and school type on the achievement of students in Physics in the study area ($p > 0.05$), even though the learning styles alone had an effect on the students' achievement ($p < 0.05$). This disagrees with the findings of John and Ademola (2014), Mijinyawa, Yeldu, Umar and Hussaini (2017) that students' achievement is affected by the type of school students attend. The implication of the findings for classroom is that the Felder-Silverman's learning style model, especially sensing/intuitive and visual/verbal learning styles, may be employed by both teachers and students to teach and learn Physics in Bassa Local Government Area, Plateau state, Nigeria. Moreover, this study found out that students' achievement is not affected by their gender and the type of school they attend, but by the learning styles they use.

CONCLUSION

Based on the findings and discussions of this study, the following conclusions were made: Felder-Silverman's learning styles had no statistically significant effect on students' achievement in Bassa Local Government Area, Plateau State, Nigeria and does not select gender, but cuts across all gender in terms of achievement and it does not discriminate between types of school.

RECOMMENDATIONS

In view of the findings and implications for classroom interaction, the following recommendations were made:

1. Teachers should be encouraged to incorporate the dimensions of Felder-Silverman's learning styles into various instructional strategies in the classroom for students' achievement to be enhanced.
2. Curriculum planners for senior secondary school Physics should be encouraged to design the curriculum in such a way that it may be of benefit to students who exhibit multiple learning styles.
3. Since students have their preferred learning styles, they should be counseled and encouraged to put them into use when learning.
4. Government and stakeholders should develop a gender-sensitive programme of career guidance in order to encourage female students to study physics and physics-related courses.

Conflicts of Interest

The authors declare no conflict of interest.

Disclaimer Statement

This work is part of a thesis submitted to the University of Jos, Nigeria, for the award of a Master of Science degree in Physics Education; the title of the thesis is "Effects of Felder-Silverman's learning styles model on students' achievement in secondary school Physics in Bassa Local Government Area, Plateau state." The thesis, which was supervised by Macmillan M. Josiah (Ph.D) had about 50% of the thesis extracted for the purpose of this work and has not been published elsewhere; and all citations in this article were acknowledged.

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Authors' Level of Contributions

All the authors contributed equally in research, such as in the review of literature, design of the test instrument and analysis of data.

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