Investigating Students' Academic Performance in Physics Based on Kolb's Experiential Learning Model in Rivers State

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

The objective of the study was to determine the academic performance of students in physics based on their learning style. The population of the study was all science students (SS2) in Rivers state secondary schools. Sampling was done using cluster random technique. The total sample size of the study was one hundred and twenty (120) SS2 students. There were two instruments used in carrying out this study which were Kolbs' learning style inventory/questionnaire developed by David Kolb (1984) and Physics Achievement Test (PAT) which was developed by the researcher. Percentage, Mean and standard deviation was used to analyze the data collected through the Physics achievement test. Analysis of variance was the statistical tool used to test hypothesis at 0.05 level of significance. Findings of the study showed that convergers and assimilators are high academic achievers in Physics than other kinds of learning styles. The study recommended that Physics teachers should strive to understand the learning styles that is more common in his/her class and design physics lessons in that direction so as to aid understanding of the majority in the class.

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1. INTRODUCTION

Physics is one of the major natural science subjects that supplies the knowledge of the physical environment and matter to the learner [1]. Physics serves as one of the most effective tool science uses to interact or utilize matter to meet human need. This amounts to the necessity of its teaching and learning in secondary schools. However, the poor teaching and learning of physics has been recognized as one of the major challenge leading to poor performance in Physics [2].

The concepts of Physics has always been perceived by students to be very difficult and students' perception of the context of any course influence their learning. Course context is perceived differently by students and teachers because of their experiences, knowledge, goals, needs, motivations and learning style [3]. This study sought to investigate the learning styles as it contribute to students' achievement in Physics.

Learning is complex process and a product of the activity, context and culture where it is developed and used [2]. It requires the activity of the learner in authentic practices. Learning will not occur as expected unless the teacher provides specific support for the students through participation in intentional planned and systematic actions that generate this process [4]. In order to effectively address students' difficulties in teaching and learning, what they learn is as important as how they learn it [5]. The quest for how students learn effectively, puts flexibility demand on the teacher to employ appropriate instructional strategies in order to convey these concepts to learners in an uncomplicated manner [6]. Learning is stimulated in a variety of mental processes that arise during interaction with others in different contexts, and it is always mediated by language. According to Ergun in [1] in the development of students' cognitive learning and their performance in solving problems, there is a need to teach physics by understanding the learning styles of the students. Over the years, there has been various theories guiding learning processes, all towards ensuring students learn effectively.

Experiential learning theory is one of the most widely known modern educational theories which has existed for more than three decades. Experiential Learning theory involves studying in four phases connected with doing, sensing, observing, reflecting, thinking and planning [7]. Kolb's Experiential Learning Model defines learning as "the process whereby knowledge is created through the transformation of experience" [8,9]. Experiential learning, therefore, differs from the mere conveyance of information. Learning is the process whereby knowledge is created through the transformation of experience. This definition emphasizes several critical aspects of the learning process as viewed from the experiential perspective. First is the emphasis on the process of adaptation and learning as opposed to content or outcomes. Second is that knowledge is a transformation process, being continuously created and recreated, not an independent entity to be acquired or transmitted. Third, learning transforms experience in both its objective and subjective forms. Finally, to understand learning, we must understand the nature of knowledge, and vice versa [9,10].

Experiential theory provides a concrete understanding students can be taught based on their different learning style, it presents a way of constructing and aligning information to understanding of the learner. The theory has a vast range of application, including helping students realize themselves, helping teachers become reflexive teachers, identifying learning styles of students, and development of key teacher's skills. It also helps in development of group project work and deciding how information and communication technologies can aid the process of learning [7]. Experiential learning is based on the importance of personal experience in the educational process. Individuals can possess an unlimited amount of information, but may be unwilling to engage in tasks, where that information can be employed productively. Experiential learning provides students the opportunity to directly apply the information they possess in order to build self-efficacy and learn from the experiential undertakings.

McCarthy [11] posited that experiential learning model is a four stage circular process where for effective learning to occur, the learner must experience the entire cycle. Most students favor one part of the cycle over other parts hence their learning style preference. However, learning styles are not fixed and can change. The experiential learning model is a cyclical process of learning experiences. This model posits that

for effective learning to transpire, the learner must go through the entire cycle. The four stage learning model depicts two polar opposite dimensions of grasping experience – concrete experience (CE) and abstract conceptualization (AC), and two polar opposite dimensions of transforming experience – reflective observation (RO) and active experimentation (AE).

1. Concrete Experience - (a new experience of situation is encountered, or a reinterpretation of existing experience).
2. Reflective Observation (of the new experience. Of particular importance are any inconsistencies between experience and understanding).
3. Abstract Conceptualization (Reflection gives rise to a new idea, or a modification of an existing abstract concept).
4. Active Experimentation (the learner applies them to the world around them to see what results).

It is based on this cycle that Kolb generated the four types of learning styles of an individuals. Each of the learning style is a combination of two cycle as seen in Fig. 1.

David Kolb categorized learning style of individuals into four styles which were accommodators (activists), divergers (reflector), assimilators (theorist) and convergers (pragmatic).

Accommodating learning style comprises of two cycles concrete experience (CE) and active experimentation (AE). Accommodators are 'hands-on' oriented persons and relies on intuition rather than logic [12]. They have strong preference for doing rather than thinking. Accommodating learners will tend to rely on others for information rather than carry out their own analysis. Their method of approach is to utilize analysis of past experiences of people or their analysis, take a practical course coupled with some experimentation as they display traits of risk taking tendencies. Information from secondary sources is vital to them because they rarely carry out their personal analysis [13]. Action and initiative defines the personality of the accommodators [14]

Diverging learning style comprises of concrete experimentation and reflexive observation. They learn by feeling and watching. These people are able to look at things from different perspectives [12]. Divergers are extensive analysers using their imaginative ability. Hence, they are proficient learners who are good at generating ideas to solve problem. Artists and brainstormers fit this style as they have regard for culture from which art stems and an inherent intrigue for information [13]. They prefer to watch rather than do, tending to gather information and use imagination to solve problems. Such learners prefer to work in groups, to listen with an open mind and to receive personal feedback. They are less concerned with theorems and generalizations. Their approach to problem solving is not systematic, but is more creative in comparison to the other learning styles [14].
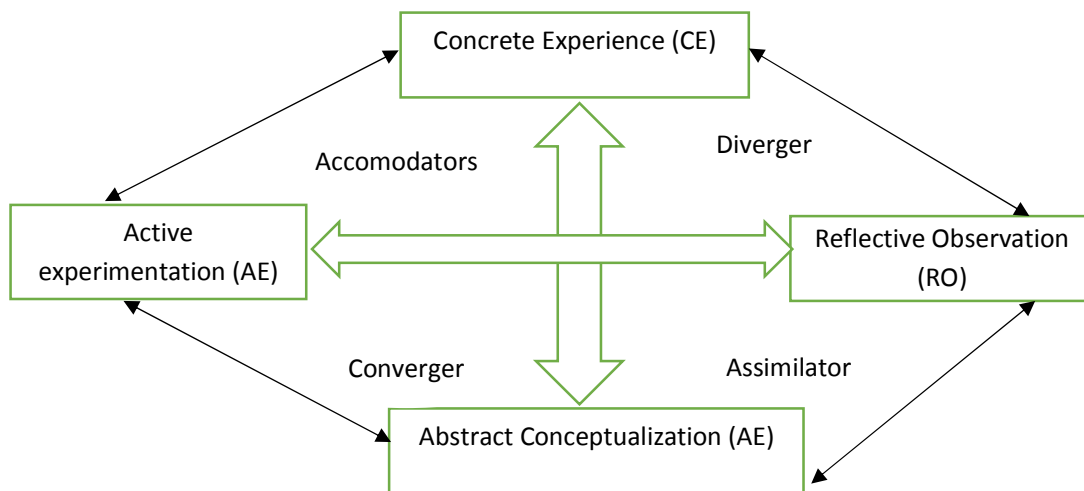

Fig. 1. Diagram of learning style

Converging learning style individuals comprises two cycles of abstract conceptualization and active experimentation. That is, these individuals learn by thinking and doing. People with a converging learning style are problem solvers and are proficient in using their learning to find solutions to practical issues. They prefer technical tasks, and are less concerned with people and interpersonal aspects [15]. People with a converging learning style are best at finding practical uses for ideas and theories. The easily arrive to a technical decision through implementation of abstract concepts in real life situations. A converging learning style enables specialist and technology abilities. People with a converging style like to experiment with new ideas, to simulate, and to work with practical application. Converging learning style enables specialist and technology abilities. Hypothetical reasoning is strong by virtue of being logical and practical. People with a converging style like to experiment with new ideas, to simulate, and to work with practical applications [9].

Assimilating learning style perceive through reflexive observation and abstract conceptualization. Assimilators grasp knowledge by watching and thinking. The preference of assimilating learners is for a concise and logical approach. This kind of individuals value ideas and new concepts than personality. They experience their world symbolically and transform information through thought [16]. They are more concerned with abstract concepts rather than practical applications. These learners prefer readings, lectures and exploring analytical models [10]. They are capable of creating theoretical models by means of inductive reasoning. They are good at actively engaging with the world and actually doing things instead of merely reading and studying about them [17]. Assimilators tend to be rational, unemotional, and more interested in abstract concepts than in people.

Although various studies have proposed that the learning style does not make any difference in academic performance, yet others proved that certain learning styles are superior to the other in academic achievement. Cano and Justicia as cited in [18], stressed that students with better academic achievement scored higher in concrete experience, abstract conceptualization and reflective observation than those with poorer academic achievement. The study of [18,19] established that positive weak relationship exist between assimilating and academic performance. Then, converging showed there is a positive relationship with a moderate strength with academic performance. Furthermore, for accommodating, indicate there is a positive relationship with academic performance by signifying a moderate strength of association. Lastly, diverging indicate that positive but weak strength of relationship with academic performance of students. Ozgen, and Demirkan [14] in their study, it was found that the performance scores of converging and diverging students differed significantly in favor of converging students only in design courses. Similarly, Soghra, Ali, and Mohammad [17] posited that performance in English score significantly and negatively correlated with learning styles of accommodating, assimilating, and positively with converging, but not significant correlation with diverging.

While academic ability is a major factor in student success, the literature on learning suggests that students' individual learning style preferences may account for some differences in learning outcomes [9]. Therefore the present study sought to investigate learning style with their performance in physics.

1.1 Purpose of the Study

The purpose of the study is to investigate students' academic performance in physics based on Kolb's experiential learning model. Specifically, the study sought to

- investigate the different learning styles of physics students in Rivers state using Kolb's standardized questionnaire
- Determine the academic achievement of activist (accommodating) students in Physics in Rivers state
- Determine the academic achievement of reflector (diverging) students in Physics in Rivers state
- Determine the academic achievement of theorist (assimilating) students in Physics in Rivers state
- Determine the academic achievement of pragmatic (converging) students in Physics in Rivers state

1.2 Research Question

The following research questions guided the study.

1. What are the different learning styles of physics students in Rivers state using Kolb's standardized questionnaire?
2. What is the academic achievement of activist (accommodating) students in Physics in Rivers state?
3. What is the academic achievement of reflector (diverging) students in Physics in Rivers state?
4. What is the academic achievement of theorist (assimilating) students in Physics in Rivers state?
5. What is the academic achievement of pragmatic (converging) students in Physics in Rivers state?

1.3 Hypotheses

There is no significant difference in the mean scores of activists (accommodating) students, reflector (diverging), theorist (assimilating) and pragmatist (converging) students in physics in Rivers State.

2. METHODOLOGY

The study was carried out in Rivers State. The study used ex-post facto research design. This design was considered appropriate for the study because the study tends to measure already existing construct/data of the study. Expost facto research is used in a contexts in which it is not possible or acceptable to manipulate the characteristics of human participants (Neil, 2010). The population of the study was all science students in Rivers state secondary schools. Sampling was done using cluster random technique. Four secondary schools were purposively sampled from each of the three senatorial districts. These secondary schools were selected on the basis of availability of qualified physics teacher and well equipped laboratory. Simple random sampling is then used to select ten (10) SS2 students from each of the twelve (12) selected schools. The total sample size of the study was one hundred and twenty (120) SS2 students. There are two instruments used in carrying out this study which were Kolbs' learning style inventory/questionnaire developed by David Kolb (1984) and Physics Achievement Test (PAT) which was developed by the researcher. Kolbs' learning style questionnaire was administered to the students to determine their individual learning style alongside the Physics Achievement Test. Kolbs' questionnaire has 80 items and the scoring of the instrument is based on the set marking scheme by Kolb. Also, PAT contained 30 multiple choice questions, contents of the questions are randomly selected from the SS2 and SS1 scheme of work. Each of the items in PAT carries two marks. The two questionnaires were administered together and the individual copies carries the same identity number for easy correlation. Mean and standard deviation was used analyzed the data collected through the physic achievement test. Analysis of variance was the statistical tool used to test hypothesis at 0.05 level of significance.

3. RESULTS

Research Question 1: What are the different learning styles of physics students in Rivers state using Kolb's standardized questionnaire?

Table 1 shows the learning styles of physics students who are engaged in the study. The individual learning style was determined using Kolbs' standardized questionnaire. The questionnaire was scored based on the scheme set by Kolb (1984). There were eighty items in the questionnaire, 25 percent of the students responded to question 7, 13, 15, 16, 25, 28, 29, 31, 33, 36, 39, 41, 46, 52, 55, 60, 62, 66, 67 and 76 were categorized as divergers (reflectors). Similarly, 18.33 percent of the respondents responded to questions 5, 9, 11, 19, 21, 27, 35, 37, 44, 49, 50, 53, 54, 56, 59, 65, 69, 70, 73 and 80 were classified as convergers (pragmatists). Also, 33.33 percent of the students who responded to question 2, 4, 6, 10, 17, 23, 24, 32, 34, 38, 40, 43, 45, 48, 58, 64, 71, 72, 74 and 79 were classified as accommodators (activists). Lastly, 23.33 percent of the students who responded to question 1, 3, 8, 12, 14, 18, 20, 22, 26, 30, 42, 47, 51, 57, 61, 63, 68, 75, 77, and 78 were classified as assimilators (theorist).

Table 1. Learning styles of physics students in Rivers State using Kolbs' standardized questionnaire

S/N	Learning styles	Frequency	Percentage (%)
1	Divergers (reflector)	30	25.0
2	Convergers (Pragmatist)	22	18.33
3	Accomodators (Activist)	40	33.33
4	Assimilators (theorist)	28	23.33

Field survey, 2020

Table 2. Mean score of students in physics achievement test (PAT) who are accommodators (activists)

Accomodating (Activist)	N	Mean	Standard deviation	Mean difference	t-test	t-crit	Remark
Male	25	15.15	4.23	0.33	0.57	1.684	NS
Female	15	15.48	2.03				

Field Survey, 2020. NS-Not Significant

Table 3. Mean score of diverging (reflector) students in physics

Diverging (Reflector)	N	Mean	Standard deviation	Mean difference	t-test	t-crit	Remark
Male	12	17.09	10.25	0.23	0.02	1.701	NS
Female	18	16.86	9.80				

Field Survey, 2020. NS-Not Significant

Table 4. Mean score of assimilating (theorist) students in physics

Assimilating (theorist)	Frequency	Mean	Standard deviation	Mean difference	t-test	t-crit	Remark
Male	13	18.97	4.56	0.34	0.18	1.706	NS
Female	15	19.31	5.02				

Field survey, 2020. NS-Not Significant

Research Question 2: What is the academic achievement of accommodating (activist) students in Physics in Rivers state?

Table 2 shows the academic achievement of accommodating students in physics. Result showed that the mean score of male accommodating students was 15.15 while the female mean score was 15.48. The mean difference was 0.33. The t-test results showed that there were no statistically significant differences between male and females activists students in physics academic achievement.

Research Question 3: What is the academic achievement of divergers (reflector) students in Physics in Rivers state?

Table 3 presents the academic achievement of diverging (reflector) students in physics. Result showed that the mean score of male students of this category was 17.09 and female was 16.86. The mean difference was 0.23. The test of significance showed that the mean difference is quite insignificant at 0.05 level of significance.

Research Question 4: What is the academic achievement of assimilating (theorist) students in Physics in Rivers State?

Table 4 presents the male and female Mean score of assimilating (theorist) students in Physics achievement test. Result showed that male had mean score of 18.97 while females had mean score of 19.31. The mean difference was 0.34. The difference was subjected to test of significance and it was found that the existing difference is of no significance.

Research Question 5: What is the academic achievement of Convergers (pragmatic) students in Physics in Rivers state?

Table 5 shows the academic achievement of convergers (pragmatic) students in Physics in Rivers state. Result revealed that male students of this category had mean score of 19.95 while female students had mean score of 18.68. The mean difference was 0.97 favoring the males. The test of significance showed that the difference is of no significance.

3.1 Hypotheses

There is no significant difference in the mean scores of accommodating (activists), diverging (reflector), assimilating (theorist) and converging (pragmatist) students in physics in Rivers State.

Table 5. Mean score of converging (pragmatic) students in physics

Converging (Pragmatic)	N	Mean	Standard deviation	Mean difference	t-test	t-crit	Remark
Male	12	19.95	9.64	0.97	0.223	1.725	NS
Female	10	18.68	10.78				

Field Survey, 2020. NS-Not Significanct

Table 6. Analysis of variance on the mean scores of students with difference in learning styles

	Sum of squares	Df	Mean Square	F	Sig
Between Groups	1122.759	3	374.253	3.251	0.024
Within Groups	13353.208	116	115.114		
Total	14475.967	119			

Table 7. Multiple comparisons

Dependent Variable:	Scores						
	(I) groups	(J) groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	DV	CV	4.6833	2.5913	.027	-2.071	11.438
		ACC	.3833	3.0116	.099	.147	15.847
		ASS	7.9970*	2.8193	.032	-6.966	7.732
	CV	DV	-4.6833	2.5913	.027	-11.438	2.071
		ACC	3.3136	2.8479	.042	-4.110	10.737
		ASS	-4.3000	2.6437	.078	-11.191	2.591
	ACC	DV	-7.9970*	3.0116	.099	-15.847	-.147
		CV	-3.3136	2.8479	.042	-10.737	4.110
		ASS	-7.6136	3.0567	.029	-15.582	.354
	ASS	DV	-.3833	2.8193	.032	-7.732	6.966
		CV	4.3000	2.6437	.078	-2.591	11.191
		ACC	7.6136	3.0567	.029	-.354	15.582

*. The mean difference is significant at the 0.05 level

Table 6 shows the analysis of variance on the physics mean scores of students with accommodating (activists), diverging (reflector), assimilating (theorist) and converging (pragmatist) learning style. The result showed that the f-cal was 3.251 at 0.05 level of significance and df_b=3, df_w=116. Since the p-value (0.024) is less than 0.05 the hypothesis is rejected. This implies that there are significant differences in the mean scores of accommodating (activists), diverging (reflector), assimilating (theorist) and converging (pragmatist) students in physics achievement test (PAT). To determine which of the four groups caused the differences multiple comparisons analysis was carried out using Tukey HSD post hoc test.

Table 7 revealed multiple comparisons on each of the four groups under study. Scores of the divergers compared with convergers shows significant difference with 0.027, accommodators shows insignificant difference with p-value of 0.099, assimilators shows that the difference between the scores are significant with p-value of 0.032.

Scores of the convergers (CV) compared with; divergers (DV) shows significant difference with p-value of 0.027, accommodators' shows significant difference with p-value of 0.042 and assimilators shows insignificant difference with p-value of 0.078.

Also scores of accommodators (ACC) compared with; divergers shows insignificant difference with p-value of 0.099, convergers shows that difference in the scores are significant with p-value of 0.042, assimilators shows significant difference with p-value of 0.029.

Lastly, scores of assimilators compared with; divergers shows significant difference with p-value of 0.032, convergers shows insignificant difference with p-value of 0.078, accommodators shows significant difference with p-value of 0.029.

4. DISCUSSION OF FINDINGS

The post hoc test revealed that convergers and assimilators are the learning style group that caused significant differences with other groups of learning styles but the difference existing between them are insignificant. Convergers and assimilators performed better than other learning styles in physics. The both learning style has one thing in common in the Kolbs' cycle which is abstract conceptualization. This high performance could be due to the fact that Physics involves a lot of abstract conceptualization task and implementation of theories and models. This findings is in line with [18] who stressed that students with better academic achievement scored higher in concrete experience, abstract conceptualization and reflective observation than those with poorer academic achievement. Similarly, [14] in their study, found that the performance scores of converging and diverging students differed significantly in favor of converging students only in design courses. Also [17] posited that performance in English score significantly and negatively correlated with learning styles of accommodating, assimilating, and positively with converging, but not significant correlation with diverging.

5. CONCLUSION

Based on the findings of the study it was study concluded that, in many other subjects learning style may not be a good measure in predicting the performance of a students because learning style are not superior to each other [9]. Each styles of learning has its own unique qualities. However, some learning style may be better off in certain subjects than the other. In this study, it was concluded that convergers and assimilators are high academic achievers in Physics than other kinds of learning styles.

6. RECOMMENDATIONS

The study recommends that

- Physics teachers should strive to understand the learning styles that is more

common in his/her class and pattern physics lessons in that direction so as to aid understanding of the majority in the class.
- It is a very difficult tasks for the teacher to teach a single lesson to a preferable style of learning of each individuals. However, in order to help this plight, arms of classes should be categorized using the learning style of each students. For instance, convergers can be in class SS1A, assimilators SS1B, accommodators SS1C and diverger SS1D.

CONSENT

As per international standard or university standard students' consent have been collected and preserved by the authors.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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