Effects of Learning Styles on the Performances of Senior Secondary School Biology Students

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Abstract

This study ascertained the effects of learning styles on the performances of Senior Secondary School Biology students in Imo state, Nigeria. The study adopted the quasi-experimental design. The sample consisted of 300 SS II Biology students comprising of (150 males and 150 females) obtained through simple random sampling in three schools (100 students per school). Kolb Learning Style Inventory (LSI 1999 version) was used for the identification of the students' learning styles. The Biology Achievement Test (BAT) was used for the determination of the students' performance in both pretests and post-tests. The reliability of the instruments (LSI and BAT) were ascertained by the use of Cronbach alpha statistic and Kuder Richardson formula 20 (K – R) 20 respectively. The coefficients of internal consistency were established at 0.72 and 0.78 respectively. Findings from the study showed that the four learning styles of Kolb were represented amongst the biology

students; that many students preferred to learn by more than one mode of information presentation; learning style varies from one group to another and there is no significant difference in the biology mean scores of the students with interaction between learning styles and their gender. It was recommended among others that Biology teachers should identity the learning styles of their students and use teaching strategies that complements them.
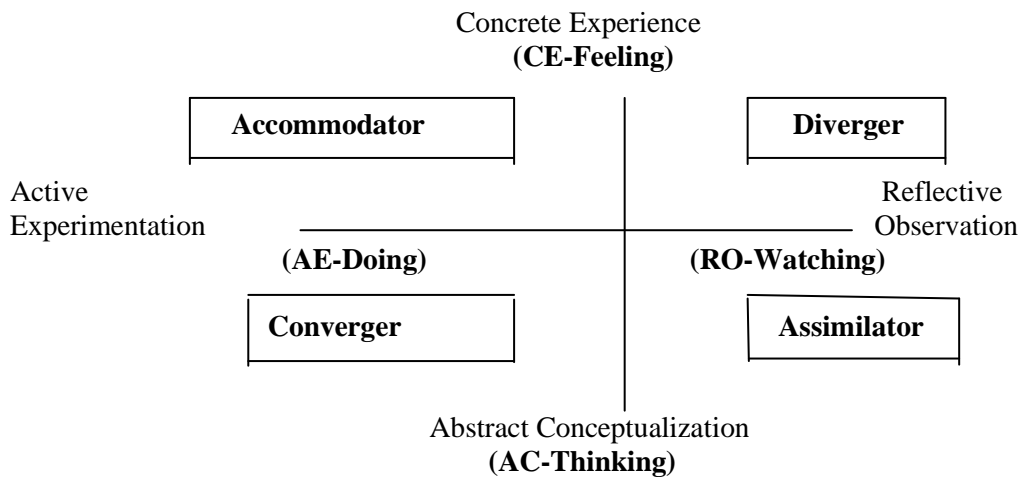
Introduction

Learning style is defined as the manner and the conditions under which learners most efficiently and effectively perceive, process, store and recall what they are attempting to learn (Zhou, 2011).The different ways of learning are referred to as learning style. To address this concern, teachers should understand their students' learning style preferences and be interested in developing teaching approaches to address the learning needs of all their students, because good teaching approach or method according to Ibe (2013) will help make the class session more effective and encourage student participation in the class.

Students have specific learning style preferences, and these preferences may be different between male and female students. Understanding a student's learning style preference is an important consideration when designing classroom instruction. To better understand the learners and their learning style characteristics, and to assist in the development of teaching strategies that will maximize motivation and learning for students of both genders, we have to develop teaching approaches that will address the learning needs of all of our students, male and female.

Although teachers are still taxed with preparing their pupils for the future, no longer are their lessons confined to the textbook and the traditional classroom, (Finson , Pedersen and Thomas ,2006).). Learning style is seen by Kolb (2000, p. 1) as "the way we prefer to absorb and incorporate new information". Different people have different ways of learning, and that *per se*, those ways are neither good nor bad" (Smith & Kolb, 1986, in Kolb, 2000).

Given various preferences for perceiving and processing information, Kolb (1984) has suggested four different learning styles: Accommodator, Diverger, Assimilator, and Converger (see Figure 1).

Figure 1: Kolb's Learning Styles

Concrete Experience
(CE-Feeling)

| **Accommodator** | | **Diverger** |

Active
Experimentation

(AE-Doing)

Reflective
Observation

(RO-Watching)

| **Converger** | | **Assimilator** |

Abstract Conceptualization
(AC-Thinking)

1. Accommodator refers to a person who favours Concrete Experiencing and Active Experimentation learning dimensions (i.e., a person who prefers to perceive information from feeling and process it by doing).

2. Diverger refers to a person who favors Concrete Experiencing and Reflective Observation learning dimensions (i.e., a person who prefers to perceive information from feeling and learn about the processing of information by watching).

3. Converger refers to a person who favors Abstract Conceptualization and Active Experimentation learning dimensions (i.e., a person who prefers to perceive information by thinking and doing).

4. Assimilator refers to a person who favors Abstract Conceptualization and Reflective Observation learning dimensions (i.e., a person who prefers to learn by thinking and watching/listening).

Stages of Kolb's Learning Cycle **(Kolb, 1984, p. 5)**

Concrete Experience (CE)-*Learning from feeling:* Learning from specific experiences; Relating to people; Sensitivity to feelings and people and Open-minded and adaptable to change.

Reflective Observation (RO) - *Learning by watching and listening:* Careful observation before making a judgment; Viewing things from different perspectives and Looking for the meaning of things.

Abstract Conceptualization (AC) - Learning by thinking: Logical analysis of ideas; Systematic planning; Develop theories and ideas to solve problems and Acting on an intellectual understanding of a situation.

Active Experimentation (AE) - Learning by doing;   Ability to get things done; Risk taking and Influencing people and events through action.

The knowledge of student preferred learning styles is vital if teachers or educators are to provide tailored strategies for individual students (Fleming, 1995). Knowing students' preferred learning style also helps to overcome the predisposition of many teachers to treat all students in a similar way (Fleming, 1995) as well as motivate teachers to move from their preferred mode(s) to using others. In so doing, they can reach more students because of the better match between teacher and learner styles **(**McCarthy, 2010, Okur and Bahar, 2010, Mlambo, 2011 and Ossai, 2012**).** For example, there is a clear trend in university teaching to instruct all students in the same way (i.e., a straight lecture format). Educators use this lecture format because of the relative ease of information passing, the need to cover the content, a long history of traditional lecturing, and perhaps due to their own preferences in learning. This may require instructors to stray from their own preferred mode(s) of teaching and learn to be using a variety of styles, which will positively affect learning. By using a variety of teaching approaches, teachers will reach more students because of the better match between teacher and learner styles.

A good match between students' learning preferences and instructor's teaching style has been demonstrated to have positive effect on student's performance **(**Kinshuk and Graf ,2009) observed that when teaching style is matched with the learner's cognitive operation (learning style), teaching and learning become more productive and rewarding. Learning preference refers to a person's "natural, habitual and preferred way" of assimilating new information. This implies that individuals differ with regard to what mode of instruction or study is most effective for them. Scholars, who promote the learning preferences approach to learning, agree that effective instruction can only be undertaken if the learner's learning preferences are diagnosed and the instruction is tailored accordingly (Pashler, McDaniel, Rohrer, and Bjork, 2008). "I hear and I forget. I see and I remember. I do and I understand." (Confucius 551-479 BC) – a quote that provides evidence that, even in early times, there was a recognition of the existence of different learning preferences among people. Indeed, Mlambo (2011) reports that some students seem to learn better when information is presented through words (verbal learners), whereas others seem to learn better when it is presented in the form of pictures (visual learners). Clearly in a class where only one instructional method is employed, there is a strong possibility that a number of students will find the learning environment less optimal and this could affect their academic performance. Okur and Bahar (2010) established that

alignment between students' learning preferences and an instructor's teaching style leads to better recall and understanding. The learning preferences approach has gained significant mileage despite the lack of experimental evidence to support the utility of this approach.

The theoretical framework of the study is hinged on Dewey's Experiential Learning Theory which posits that learning is seen as a continuous and interactive process. Learning style theories help explain the way one acquires knowledge. He formed the learning theory from the combination of acquiring experience and transforming it to knowledge. According to Dewey (1938), experiential learning is the process whereby knowledge is gained through experience, and there are four distinct stages to the learning cycle, as noted in Figure 4.

Ezekoka (2010) conducted a study of "gender relationship in the learning styles preference of students in Imo State". In carrying out the research, she adopted an experimental research design and used Kolb's Learning Style Inventory (LSI) 1999 version and Biology Achievement Test (BAT) as the Instruments. The aim was to identify the learning styles preference of male and female students. She used 287 students from the sampled schools and the results showed that majority of the females (38%) were assimilators, followed by convergers (30%), and then accommodators (16.3%) and the least were divergers (15.7%). While majority of the males were convergers (51.6%), followed by assimilators (26.8%), then accommodators (13.6%) and divergers (8%). According to the finding, both the male and female students have the four learning styles as defined by Kolb, but majority of the males had converger learning styles while majority of the females had assimilator learning styles. This research was conducted on Biology students and in analyzing the data of this study, the researcher used simple percentage, but the present research will be conducted on accounting students and the analysis will be by inferential statistics – Analysis of Co-variance (ANCOVA).

The problem

All stakeholders in Nigerian education system (parents, guardians, teachers, counsellors, etc) are so much concerned about students' achievements and maintenance of academic standard. The recurrent poor performance of secondary school students in (WASSCE) and National Examination Council (NECO) in Nigeria is disturbing and embarrassing. WAEC (2011, 2012, 2013) analysis of percentage performance of candidates in twenty popular subjects in West African senior secondary certificate examination for 2011, 2012, and 2013 revealed 55.19%, 59.10% and 60.99% percentage failure respectively in Biology . Ibe (2013) blamed poor performance of biology students in external examination on biology teachers' insensitivity to the nature of Biology when planning instructional activities in the classroom. According to her, Biology is not one of the subjects that can be mastered

by mere memorization of the basic rules. It requires total determination, sound theoretical knowledge and intensive practice in application. One begins to wonder if other factors could be responsible for the large number of failures in Biology other than the ones already identified.

1. Could knowledge and utilization of learners' learning styles in selecting appropriate teaching methods help to improve performance?

2. Would matching teaching strategies with students learning styles, make their performance to be enhanced? This is the problem of this study.

The study investigated: The existence of the four learning styles as identified by Kolb which are Accommodating, Converging, Assimilating and Diverging; and how these affect the students' performance in Biology

Specifically, the study sought to:

1. find out the learning preferences of the biology students;

2. ascertain whether interaction of gender and learning style has any effect on students' performances in biology

The following research questions were raised to guide this study:

1. What are the effects of the learning styles that exist amongst SS II Biology students in Imo State?

2. What effects have the interaction of gender and learning styles on the performance of SS II Biology students in both internal and external examinations?

Ho$_1$: There is no significant difference in the Biology means scores of students with different learning styles at 0.05 level of significance.

Ho11: There is no significant difference in the interaction of gender and learning styles on the performance of SS II Biology students in both internal and external examinations

Method

This study was carried out using quasi-experimental research design. This type of research deign was used because the researcher did not have full control over some of the intervening variables, that is, those things capable of impinging on the results such as classroom arrangements, health, studying together and or comparing notes, resource available to students beyond treatment session and or after school, etc. The study aimed at finding out the learning style preferences of Biology students of senior secondary school students in Imo State focusing on Owerri Municipal Council of Imo State and how the same affect their performances in both internal and external

examinations. The research design involved intact groups, pretest, treatment-control and post-test

The sample that was used in this study was 300 SS II Biology students comprising of (150 males and 150 females) obtained through simple random sampling from the three sampled secondary schools in Owerri Municipal Council, 100 students from each sampled school.

Kolb Learning Style Inventory (LSI 1999 version) was used for the identification of the students' learning styles. The Learning Style Inventory is derived from an experiential theory and model of learning developed by Kolb (1999). It is practical self-assessment instruments that can help the students assess their unique learning styles; it tells them their preferred approach to learning in everyday life. The instrument contains 12 questions; this required the subjects to rank statements that reflect the four modes for perceiving and processing information, which helped to identify the individual's preferences for each of the modes. These modes of perceiving and processing information are the four learning styles adopted from Kolb (1999); these are Accommodating, Diverging, Converging and Assimilating.

The Biology Achievement Test (BAT) was used for the determination of the students' performance in both the pretests and post-tests. In this study, the BAT was used for both the pre-tests and post-tests, but at the post-tests level, it was rearranged. The purpose of the rearrangement was to test the students' ability and control their test wiseness. The BAT that is based on the SS II biology scheme of work comprising of twenty (20) multiple-choice questions were designed by a team of three SS II Biology teachers

The Kolb Learning Style Inventory has been proven to have a high degree of internal validity (Cornwell and Manfredo, 1994). The Learning Style Inventory (LSI) was presented to two experts in Measurement and Evaluation, two experts in Curriculum Studies and to another one expert in Science Education for re-validation. Kolb Learning Style Inventory has in-built validity and reliability being a universal accepted instrument.

In the same vein, the Biology Achievement Test (BAT) on the other hand, was constructed based on the Biology Lesson that was taught which was presented to a team of four (3) Biology teachers to determine the appropriateness of each item to the class level and as well rate the appropriateness of each item to the behaviour(s) it measures. This was based on the Biology Lesson that was taught. At the end of the validation, only 20 items of the BAT was deemed appropriate by the teachers.

Factor analysis was carried out with the (12 items for LSI and 30 items for BAT) to determine the construct validity. The items of (LSI and BAT) respectively were subjected to factor analysis to determine the items that were factorially pure.

Any item which has factor loading less than 0.35 was considered as having low loading and thus rejected (Ibe, 2012). On the other hand, any item that was loaded on more than one factor was regarded as having complex loading and as such was also rejected. Eventually, only twenty items out of the initial thirty items for BAT survived the factor analysis while all the twelve items for LSI survived it. These were the items that were used in building the final version of the instrument.

The reliability of the instruments (LSI and BAT) were ascertained by the use of Cronbach alpha statistic and Kuder Richardson formula 20 (K – R) 20 respectively. The subjects used for the reliability measure were thirty in number and are drawn outside the sample for the study. The reliability coefficients for the two instruments were: LSI was gotten at 0.72 while that of BAT was r = 0.78.

Experimental procedure

Pre-Treatment Phase

The researcher first of all made her intentions known to the Principals and Biology teachers of the sampled schools. This was to bring about cordial relationship between the researcher and the officials of the schools and discussion on the best way of conducting the research and getting the desired results. Thereafter, the researcher was introduced to the students by the Biology teachers. Then, the researcher administered the instrument (Kolb Learning Styles Inventory – LSI) to 100 SS II Biology students for each sampled school. Before administering the inventory, the biology teachers and the assistants helped the researcher to organize the students in two classes of 50 students each and then the inventory was given to them to fill. The researcher explained the purpose of the inventory to the students as well as difficult items in the inventory as was indicated by the students. This is to identify the students' learning styles which helped to categorize them according to their learning styles (Accommodating, Diverging, Converging and Assimilating). The determination of the students' learning style preference yielded the baseline data for the study.

The pre-treatment phase also included the administration of the Biology Achievement Test (BAT) to the students as a pre-test. The purpose of the pre-test was to identify the students' level of performance before the actual lesson was delivered to them (the experimental treatment). The result of the pre-test when compared with that of the post-test helped to determine whether there was improvement after the treatment.

Treatment Phase

The students were assigned to five experimental groups respectively based on the result of the inventory. Each experimental group comprised 10 students with the

same learning style. These experimental groups were taught using separate teaching method(s) that match their learning styles. The experiment lasted for five (5) weeks.

- **Experimental group 1 – E_1 (Accommodators):** This group of learners learns by feeling and doing and therefore they needed visual aids and were provided with charts, models, etc. as curriculum materials. Accommodators are mainly seen in Faculties of Education because they learn by experience from the teachers. Discussion, demonstration and discovery methods are appropriate for this class of learners.

- **Treatment group 2 – E_2 (Divergers):** The divergers learn by feeling, watching and observing. They are imaginative oriented. This type of learning style is mainly seen in Faculty of Humanities. The above curriculum materials for Accommodators were provided for them. The teaching methods appropriate for them are lecture method and teacher demonstration.

- **Treatment group 3 – E_3 (Convergers):** They learn by thinking and doing. They are practical or experimental learners. They learn by doing or experimenting. This type of learning style is mainly found in Engineering and other practical courses. Curriculum materials were also provided for them and the teaching methods used for them are lecture method with questioning and students' demonstration.

- **Treatment group 4 – E_4 (Assimilators):** This group of learners learns by thinking and reasoning. They are rationale or analytic in nature. This type of learning style is mainly found in Medicine and other related courses. Curriculum materials were as well provided for them while conventional lecture teaching method was used to teach them.

- **Treatment group 5 (control) :** This group was taught with lecture methods only and no instructional materials were provided for them. This is to match their performances with those taught with appropriate teaching methods as well as with instructional materials and determine if there are differences in their performances.

Post-Treatment Phase

After the various treatments for each group, the BAT was administered to the students as a post-test, at the same time and under the same conditions. The research questions were answered using mean and standard deviation while the hypotheses on the other hand were tested using Analysis of Co-Variance (ANCOVA).

Results: Mean scores of Biology students for the groups and control at post-test

GROUP	Biology mean scores	mean difference
Assimilating	51.94	18.93
Control	33.01	
Accommodating	42.68	9.67
Control	33.01	
Converging	59.83	26.74
Control	**33.01**	
Diverging	43.23	9.14
Control	**33.01**	

Data presented on table 1 shows that the Biology means scores of the Assimilating and Control groups at posttest are 51.94 and 33.01 respectively. Table 1 also shows that the difference in the Biology means is 18.93. It can therefore be inferred that there is a difference in the Biology mean scores of the Assimilating and Control groups at posttest with Assimilating group achieving better than the Control group.

Data presented on still table 1 shows that the Biology means scores of the Accommodating and Control groups at posttest are 42.68 and 33.01 respectively. Table 1 also shows that the difference in the Biology means is 9.67. It can therefore be inferred that there is a difference in the Biology mean scores of the Accommodating and Control groups at posttest with Accommodating group achieving better than the Control group.

Still on table 1, data shows that the Biology means scores of the Accommodating and Control groups at posttest are 59.83 and 33.01 respectively. Table 1 also shows that the difference in the Biology means is 26.74. It can therefore be inferred that there is a difference in the Biology mean scores of the Converging and Control groups at posttest with Converging group achieving better than the Control group.

Still on table 1, data shows that the Biology means scores of the Diverging and Control groups at posttest are 43.23 and 33.01 respectively. Table 1 also shows that the difference in the Biology means is 9.14. It can therefore be inferred that there is a difference in the Biology mean scores of the Diverging and Control groups at posttest with Dverging group achieving better than the Control group.

Table 2: ANCOVA of Mean scores on Learning styles preferences of Biology students at posttest

Source	Sum of Squares	Df	Mean square	F-Computed	F-Critical
Covariate/Pretest	1766.17	1	1766.17		
Group	11807.80	4	2951.95	10.41	2.40
Gender	56.65	1	56.65	0.19	1.84
Group X Gender	408.83	4	102.21	0.35	2.40
Error	10810.50	291	77.77		
Total	552300.00	299			

Data presented on table 2 shows that the computed-F (10.41) is greater than the critical-F (2.40). This result rejects the null hypothesis that there is no significant difference in the biology mean scores of students in the learning styles groups (Assimilating, Accommodating, Converging and Diverging) and Control group at posttest. Equally the table shows no significant gender by group interaction since the F- computed (0.35) is less than the critical-F (2.40). The null hypothesis of no significant difference is upheld.

Discussion

The finding shows that the four learning styles of Kolb were represented amongst the biology students. The study shows that many students preferred to learn by more than one mode of information presentation. Learning style varies from one group to another based on the nature of the studies, culture or ethnicity, past experience, gender and the characteristics of students. The highest mean score for the converging students could be due to the fact that biology is a subject that involves application in the sense that it uses facts and figures to build ideas, it also involves problem solving, that is, being practical. In biology, students are meant to do a lot of calculations in form of practical work.

It could also be because biology students learn by doing and working on problems and cases that allow them to evaluate alternatives and to arrive at answers logically. These findings agree with the findings of Ezekoka (2010) and Mlambo, (2011) who ascertained preferred learning styles of biology and biochemistry students of undergraduates.

Findings on the Interaction effect of gender with learning styles on the academic performance of biology students show no significant difference in the biology mean scores of the students with different learning styles and their gender.

This is evidenced on table 2 where the result shows that computed-F (0.67) is less than critical-F (**2.37**), and the level of significance (0.05) is less than Prob. (0.345).

The reason for this result could be that the four learning styles of Kolb are gender friendly in the sense that it does not favour a particular gender. It could also be that there is a positive interaction among the students posited by the teacher's good understanding of the different learning styles that exist among the students and the application of appropriate teaching methods in lesson delivery. In the same vein, the above finding could be attributed to the characteristics of four learning styles as propounded by Kolb. They have teaching strategies that are learner friendly and easy to implement. The learning styles are cognitively based in that they promote thinking at every stage in the classroom, and equally encourage learners' active participation in the classroom. This finding agrees with Demirbas and Demirkan (2007) who ascertained "Learning styles of design students and the relationship of academic performance and gender in design education".

Conclusion

This study investigated students' learning styles and their performances in biology in the senior secondary schools in Imo State, Nigeria. The significant difference in the mean scores of learning styles for biology students show that the four learning styles by Kolb must be adopted by teachers. This is to ensure that all learners are carried along in the learning place. The study showed that the Converging learners had the highest mean in this study while the Diverging learners had the least mean in comparison to the four groups.

Recommendations

Based on the findings of the study, the researcher made the following recommendations:

1. For better performances in biology, Biology teachers should identity the learning styles of their students and use teaching strategies that complements them. The use of multiple teaching methods will greatly enhance the process of teaching and learning and make it effective and rewarding.

2. Varieties in the teaching and learning process like grouping and teaching of students on the basis of their learning style preferences when possible will enhance their understanding and appreciation of the subject matter

3. Students–at-risk of poor academic achievement especially the low ability learners should be identified and direct individual and group counselling approaches should be utilized to help them improve their learning styles

4. Adequate relevant instructional materials and facilities should be provided for schools. This is to help the teachers perform better and be more productive in their work.

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