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EDITORIAL

STEM Journal of Anambra STAN (STEMJAS) is a publication of **Science Teachers Association of Nigeria, Anambra State Chapter.** STEMJAS is developed to disseminate information on Science, Technology, Engineering and Mathematics (STEM) to teachers, teacher-trainers, researchers and other interested persons. Articles that are of relevance to STEM education are published in this journal.

We are grateful to the contributors and hope that our readers will enjoy reading these contributions.

Prof. Rita N. Nnorom

Editor-in-Chief

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LEARNING STYLE PREFERENCES AND SCIENCE LEARNING MOTIVATION AS CORRELATE OF ACADEMIC ACHIEVEMENT AMONG CHEMISTRY STUDENTS IN ANAMBRA STATE, NIGERIA.

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Abstract

This study focuses on secondary school chemistry students' learning style preferences and science learning motivation as correlate of their academic achievement. The population of the study was all SS3 chemistry students in Nnewi education zone, totaling 2011 from 49 public secondary schools in the zone. Three research questions and three hypothesis guided the study. The study adopted correlation survey research design. By means of multi-stage random sampling method, a sample of 946 SS3 chemistry students from 18 public secondary schools from the zone were selected. Two instruments were used for the study: Learning Style Preference Questionnaire (LSPQ), Science Learning Motivation Questionnaire (SLMQ) and 2020/2021 annual cumulative scores of SS3 chemistry students. The LSPQ and SLMQ were validated by experts and their reliability coefficient established at 0.85 and 0.88 respectively. The study reveals that there is a low linear relationship between learning style preferences and academic achievement in chemistry, learning style preferences and science learning motivation significantly correlate achievement in chemistry, also motivation towards science learning has positive influence on the chemistry achievement of students. However, science learning motivation does not significantly correlate the chemistry achievement of students. The findings also reveals that gender does not significantly correlate chemistry achievement. Recommendation includes that teachers' instructional designs should have recourse to individual differences in learning styles, thereby enhancing motivation to learn chemistry and subsequently improving chemistry achievement.

Keywords: Learning styles, science learning, motivation, academic achievement

Introduction

Learners learn and process information in different ways. Since individual differences exist, learning styles is liable to vary. Individuals exhibit different approaches in the learning process such that a single strategy or approach may be unable to provide optimal learning condition for all individuals. This may be as a result of students' different background, levels of motivation, ambitions, strengths, weaknesses and interests (Nursen, Murat, Sevgi, Didem & Sema, 2018). According to Murat (2013), learners have unique ways of learning, which may greatly affect the learning process and consequently their academic achievement and outcomes. The different classification on learning styles is based on the premise that students acquire and process information in different ways such as by hearing and seeing, acting and reflecting, reasoning logically and intuitively, visualizing and analyzing. While some prefer working with concrete information (experimental data, facts), others are more comfortable with abstractions (symbolic information, theories, mathematical models), (Laxman, Punita & Rekha, 2015). Teachers also vary in their teaching methods, some apply instructions, lectures or demonstration, some lead students to self-discovery, and some emphasize memory, some on understanding while others focus on principles and applications. These differences culminate in the differences seen in the performances of students in both in-school and external national examinations.

Regrettably, as important as chemistry is to national development, students' performances at senior school's certificate examinations conducted by West African Examination Council (WAEC) showed that between 2001 and 2009 (except in 2006), less than 50% of the candidates obtained credit level pass and above, (Adamu, Aminu, Isah and Shamsuddin, 2017). The failure rate continued from 2007 to 2009 (42.9%, 47.1% and 46.2%) and in 2013 (46%) with an improved performance in 2010, 2011 and 2012 (50.2%, 62.6% and 67.2%). The failure trends continued in 2014(47.83%) with an improved performance between 2015 and 2016 (51.27% and 63.94%). However, a sharp decline in performance was observed in 2018. Since then, it has been fluctuating poorly (Oguguo and Uboh, 2020; WAEC, 2020). In general, this cannot be considered an acceptable performance as many have lamented that performance of Nigeria students in chemistry and sciences in general at the Senior School Certificate Examination (SSCE) has been generally not so good (FME, 2009; Adaramola and Obomanu, 2011).

The students' poor performance in chemistry in particular and sciences in general has been attributed to many factors. These include: poor methods of chemistry instruction by the teachers, lack of proper orientation to students, insufficient number of qualified teachers, poor science and mathematics background of students at the junior secondary school, lack of indigenous textbooks, and inadequate apparatus in the chemistry laboratory. poor classroom management, teacher's belief and attitude towards chemistry, teacher's inability to improvise at the expense of standard equipment; inadequate instructional materials and aids; educational background and parental expectations on the learners; and finally students' related factors or variables like students' academic anxiety, academic self-efficacy, academic locus of control, academic motivation, students' learning style preferences, and learning motivation (Nicolaidou & Philippou, 2003; NERDC, 2009; Sani, 2012; Adedayo & Jegede, 2013).

The idea of learning styles began in the 1970s, where a growing literature and industry posited that learners have specific and individualized ways of learning that work best for them. The ideology of the concept was adapted to incorporate multiple ways people think, respond, see, hear, touch, rationalize and formulate knowledge or learning (Dunn and Dunn as cited in Ogbonna, 2017). Learning style is derived from cultural socialization and individual personality as well as from the broader influence of human development (Chen, Chiu & Huang, 2015). Once an individual's learning style has been identified and nurtured, the individual learner may have a better understanding on how to function effectively in the school environment and satisfy intellectual and emotional needs. The understanding of individual learning styles preferences can help educators develop instructions using multiple resources to ensure optimum learning. It also enhances the students' learning motive (Ghaedi & Jam, 2014). Learning style is dispositional or trait concept in that it is about how someone usually approach learning – that is, how they learn. According to Dunn (in Ogbonna, 2017), learning style is a way in which individuals begin to concentrate on, process, internalize, and retain new and difficult information. McLaughlin (in Ogbonna, 2017) defined learning style as adopting a habitual and distinct mode of acquiring knowledge. Fleming (2001) defined it as an individual's characteristics and preferred ways of gathering, organizing, and thinking about information. Thus Learning style is defined as cognitive, affective, and physiological traits that are relatively stable indicators of how learners perceive, interact with and respond to learning and learning environment'. In other words, it is the consistent pattern of behavior and performance by which an individual approaches educational tasks. It refers to the characteristic strengths and preferences in the ways

individuals take in and process information (Chen et al, 2015). Individual learning styles in most cases depend on cognitive, emotional and environmental factors as well as one's prior experience.

Scholars have classified learning styles to depict individuals' predominant ways of absorbing, concentrating, processing and internalizing information. For example, Fleming (2014) developed VARK model to explain four learning styles as Visual, Auditory (aural), kinesthetic (tactile) and Reading/Writing. In the same vein, Honey and Mumford (2006) identifies learners as activist, reflectors, theorists and pragmatists while Gregorc (in Anderson, 2004) classified learning styles into concrete sequential, concrete random, abstract sequential and abstract random learning styles. Riechmann and Grasha (2010) identifies six learning styles types as collaborative, dependent, independent, avoidant, participant and competitive learning styles while kolb (2015) classified learning styles as converging, diverging, accommodating and assimilating learning styles.

Science learning is to engage and expose students in a meaningful learning condition that constantly make them wander in a sustained culture of practice (Nhorvien, Jessie, Elvira, Agaton, Maria & Romiro, 2016). In science learning, many factors are determinants of science learning quality and process. These factors are classified as cognitive factors and affective factors. The cognitive factors include information processing, reasoning ability and academic achievements while affective factors are attitudes, self-efficacy, anxiety and motivation (Chan & Norliza, 2017). Motivation being an affective factor makes science learning effective. Cavas (2011) emphasized that students' motivation plays a crucial role in science learning such as conceptual change process, critical thinking process and scientific process skills. These processes promote students' construction of conceptual understanding of science. Hence, it has considerable impact on students' scientific attitude and achievement.

Students' motivation towards science learning may be influenced by six factors: self-efficacy, active learning strategies, science learning values, performance goal, achievement goal and learning environment stimulation (Tuan, Chin & Shieh 2005). Therefore, Bolat as cited in Jayashree and Subhayu (2018) defined science learning motivation as a desire for science learning. It is a vital part of developing and supporting a lifelong interest in science.

Understanding learning style preferences and science learning motivation would be of benefit to the students, teachers, school administrators, researchers and school guidance counselors. It will help in understanding how learning styles preferences and science learning motivations are instrumental to checking individual differences among the chemistry learners. Hence, it will help in addressing chemistry students' learning difficulties and provide guidance and direction to researchers for further studies. Despite the positivisms of learning style preferences and science learning motivation to academic achievement, the variables are often unjustly neglected especially in chemistry education. Hence, there is therefore the need to investigate the relationship of these variables with academic achievement. The present study therefore focuses to find out the relationship between students' learning style preference, science learning motivation and their academic achievement in chemistry.

The students' academic achievement plays an important role in producing the best quality graduates who will become great leaders and manpower for the country thus responsible for the country's economic and social development. Unfortunately in Nigeria, there is a consistent decline in academic achievement of secondary school students in science subjects more especially in chemistry according to WAEC and JAMB chief examiner's report (Uzoamaka, 2012). Although the WAEC Chief Examiner's Report on chemistry for year 2019 indicates that the general performance of the students were relatively good compared to year 2018, however, it reveals that the students lacked adequate knowledge of chemical concepts, exhibited poor communication skills and did not understand the demands of the questions. (WAEC, 2020).

The failure trends and the fluctuating poor performance among chemistry students necessitated the study. More so, not so much studies on socio-psychological variables have been reported in the literature of Nnewi education zone. Therefore, the present study deemed it very important to find out the correlation between learning styles preferences and science learning motivation with academic achievement of chemistry students in the zone. The statement of the problem succinctly put in question form is: what relationship does students' academic achievement in chemistry has with their learning styles and science learning motivation?

Purpose of the Study

The study is set to find the relationship among learning style preferences, science learning motivation and the academic achievement of chemistry students in senior secondary school. Specifically, it will ascertain the:

1. Relationship between students' learning styles preferences and their academic achievement in secondary school.
2. Relationship between students' science learning motivation and their academic achievement in secondary school
3. Relationship between male and female students' learning style preferences and their academic achievement in secondary school.
4. Joint relationship between students' learning style preferences and science learning motivation with their academic achievement in secondary school.

Research Questions

The following research questions guided the study;

1. What is the relationship between chemistry students' learning style preferences and their academic achievement?
2. What is the relationship between chemistry students' science learning motivation and their academic achievement?
3. What is the relationship between the learning style preferences and academic achievement of male and female chemistry students in senior secondary schools?
4. What is the joint relationship between students' learning style preference and learning motivation with their academic achievement in secondary school?

Hypotheses

The following hypotheses guided the study and tested at 0.05 alpha level.

1. There's no significant relationship between chemistry students' learning style preferences and their academic achievement
2. There's no significant relationship between chemistry students' science learning motivation and their academic achievement.
3. There is no significant relationship between male and female chemistry students' learning styles preference and their academic achievement in chemistry.

4. There is no significant joint correlation between students' learning styles preference and science learning motivation with their academic achievement in chemistry.

Literature Review

The study sought to find out the correlation among two dependent variables (learning styles and science learning motivation) and one independent variable (academic achievement). Gender as the moderating variables was incorporated. The interactions among learning style preferences and science learning motivation with students' academic achievements in sciences is conceptualized below.

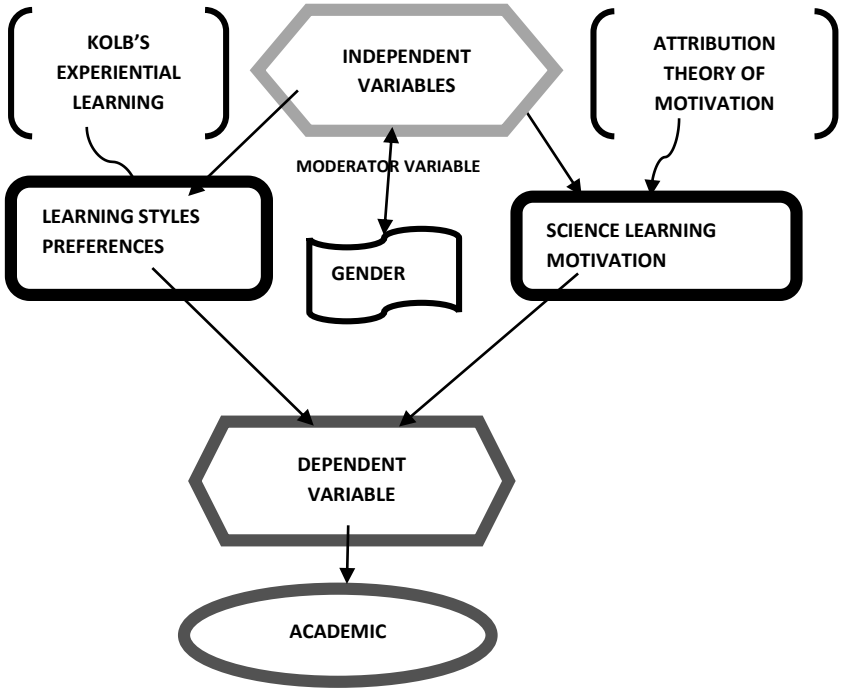

Figure 1: Schematic representation of the concept of the study

This study was based on Heider Frit's Attribution Theory and Kolb's Experiential Learning Theory. Attribution Theory is an area of social psychology which explains

how people attribute causes to events and how such cognitive perception affects their motivation. It is the way individuals envision the success or failure of their own behaviour or the behaviour of others (Weiner, 2010). Thoron and Bunch (2018), also described Attribution Theory as individual's motivation to formulate explanatory attributions (reasons) for events experience; and how these beliefs affect their emotions and motivation. It can be utilized to assist learners in developing an internal locus of control through learner-centered instructional strategies. Cook and Artino (2016) mentioned the three dimensions that can describe the "cause" perspectives in attribution theory as Locus, Stability and Controllability.

Attribution theory is appropriate for this study because it explains the differences in the motivation between high and low achievers. Although Attribution theory explains the basis for the motivation towards science learning among students but does not provide answers for the learning styles preferences among the science students for which the present study also covers. Hence, the need to review Kolb's Experiential Learning Theory which is concerned with the learners' internal cognitive processes. Kolb posits that "learning is the process whereby knowledge is created through the transformation of experience.

Experiential Learning theory focuses on learning styles and relations between learning and development. It describes learning as a cycle that begins with experience continues with reflection and later leads to action, which itself become a concrete experience for reflection.

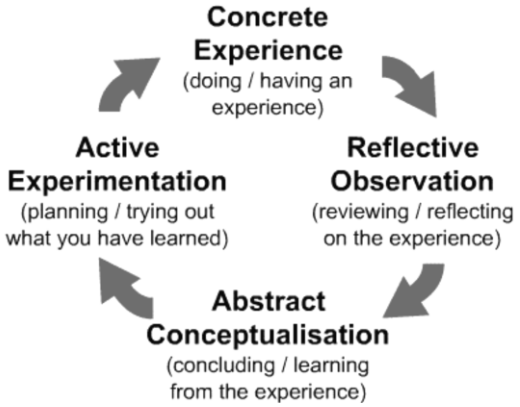

Figure 2: Kolb's learning cycle

Kolb describes effective learning as when a person progresses through a cycle of four stages of: having a concrete experience, followed by observation of and reflection on that experience which leads to the formation of abstract concepts (analysis) and generalizations (conclusion), that are then used to test hypothesis in the further situations resulting in new experience (McLeod, 2017).

Kolbs identified four learning styles from the learning cycle as:

- Accommodating: Implements plans, completes tasks and open to new experiences; good at adapting to changing circumstances. They learn best through independent discovery and being an active participant.
- Divergent: Imaginative, emotionally sensitive and aware of meaning and values. Views situations from many perspectives and comes up with alternatives. They learn best through lectures and brainstorming.
- Converging: Good problem solvers and decision-makers. Effective at applying ideas to practical situations. They learn best through hands-on instruction such as laboratories and fieldwork.
- Assimilating: Excels at inductive reasoning and creating theories for reasoning. Have high value on logical soundness rather than practical values. They learn best through lectures with accurate, clear-cut delivery and applications. (Kolb,Kolb, Passarelli and Sharma, 2014; Kolb and Kolb, 2005a; Kolb and Kolb, 2005b)

It is worthy of note that Kolb's Experiential Learning Theory is suitable for determining the learning styles of adolescence science learners and consequently adopt classroom experiences that will maximize each learning style preference of science learners.

Ibe (2015) studied 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 with 300 SS II Biology students as sample using Kolb's Learning Style Inventory and Biology Achievement Test (BAT). The study showed that the four learning styles of Kolb were represented amongst the biology students. It also revealed that 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. In a similar study, Bethel-Eke and Eremie (2017) investigated the learning styles and academic performance of junior secondary school students in Rivers State, Nigeria with implications for counseling. The correlation research design was adopted for the study with a sample size of 345 respondents using a structured

questionnaire: Learning Styles and Academic Performance. The result showed visual learning styles, auditory learning styles and kinesthetic learning styles have significant relationship with academic performance of students. Hence, the study concluded that visual, auditory and kinesthetic learning styles influence academic performance of students.

Tella (2007) investigated the impact of motivation on students' school academic achievement and learning outcomes in mathematics among secondary school students in Oyo state, Nigeria. The research adopted ex-post facto research design using Motivation for Academic Preference Questionnaire (MAPQ) and Achievement Test in Mathematics (ATM) as measuring instruments. The sample consists of 450 SS2 students randomly drawn from 10 schools in two LGAs in Ibadan, Oyo state, Nigeria. Results showed that gender difference was significant when impact of motivation on academic achievement was compared in male and female students. Also other result indicates significant difference when extent of motivation was taken as variable of interest on academic achievement in mathematics based on the degree of their motivation. In the same vein, Ibukun (2011) investigated the relationship between motivation and academic achievement of senior secondary school (SSS) students in mathematics in Anambra state, Nigeria. Correlation survey research design was adopted for the study using a sample of 192 SS2 students randomly selected from the population of 1549 SS2 students in Awka Education zone. The findings revealed that there is no significant relationship between motivational variables and academic achievement in mathematics. Empirical studies reviewed leaves a gap for this study in that the previous studies singly treated either relationship between learning styles of students or science learning motivation with their academic achievement.

Method

This study adopted correlation survey research design which seeks to establish the relationship between two or more variables by collecting data on, and evaluation in a systematic manner the characteristics, features or facts about a given population (McCombes, 2020). It also indicates the magnitude and direction of the relationship. This study collected data through the use of questionnaires on students' learning styles preferences and on science learning motivation, in order to find the relationship between the chemistry students' learning styles preferences and academic achievement, as well as the relationship between their science learning motivation and academic achievement in chemistry.

The dependent variable is academic achievement while the independent variables are learning style preference and science learning motivation. The area of the study was Nnewi education zone which comprises of four local government areas having both urban and rural communities. It also has notable commercial and industrial centers with eight tertiary institutions and research centers. The study covered only senior secondary class three (SS3) chemistry students of government owned secondary schools in Nnewi Education Zone, Anambra State. The choice of senior secondary class three (SS3) is because they are in a better position to answer to the science learning motivation since they have studied chemistry for two years. The study was also restricted to the 2020/2021 academic year cumulative score of senior secondary class three (SS3) students in chemistry. To the best of the researchers' knowledge, no research on learning style preferences and science learning motivation has been carried out within Nnewi education zone.

The population of this study consists of all the senior secondary schools three (SS3) students offering chemistry in the forty-nine (49) public senior secondary schools within Nnewi education zone. The sample consists of nine hundred and forty-six (946) senior secondary schools three (SS 3) chemistry students (420 males and 526 females) drawn from eighteen (18) public senior secondary schools in Nnewi education zone. Multistage sampling procedure involving proportionate stratified random sampling and purposive random sampling techniques were used to obtain the sample.

Two questionnaires were used for data collection: Learning Styles Preference Questionnaire (LSPQ) and Science Learning Motivation Questionnaires (SLMQ). LSPQ was adapted from Kolb's Learning style Inventory (1999 version). It is the most widely accepted learning styles model and has received a substantial amount of empirical support (Manolis, Burns, Assudan and Chinta, 2013; Ibe, 2015; Obiefuna and Oruwari, 2015). The LSPQ was adapted to suit the peculiarities of the subject matter and the respondents' understanding who are adolescent science students. The LSPQ has four sub-scales with 5-items each, on a four-point rating scales as follows: Strongly Agree(SA)=4, Agreed(A)=3, Disagreed(D)=2, Strongly disagreed(SD)=1

The SLMQ is an instrument adapted from Science Motivation Questionnaires (SMQ) with reliability co-efficient of 0.93 by Glynn and Koballa (2006) and from Students' Motivation towards Science Learning Questionnaires (SMTSLQ) with reliability co-efficient of 0.89 by Tuan, et al (2005). The Science Learning Motivation Questionnaire (SLMQ) is therefore, a 20-items instrument with four sub-scales adapted to measure

students' motivation towards chemistry learning. It is a likert-type questionnaire on a five point rating scales as follows: Neve =1, Rarely = 2, Sometimes = 3, Usually = 4, Always = 5. The instruments were revalidated and their reliability coefficients established using Cronbach Alpha (α). The reliability coefficient for LSPQ was 0.85 while the reliability coefficient for SLMQ was 0.88. The values are high which give an attribution of reliability to the instrument.

The researcher engaged four research assistants (one from each of the four LGAs in the study area) for ease of distribution and collection of the research instruments. The questionnaires were retrieved on the spot after filling and the promotion examination results taken from the class teacher with the permission of the school authority. The data from the study were analyzed using Pearson Product Moment Correlation (PPMC) and Multiple Regression analysis. Research questions and hypotheses 1, 2, 3 and 4 were answered using PPMC. The research question 5 and hypothesis 5 were answered using Multiple Regression analysis. The Adjusted $R^2$was used to determine the strength of the relationship and the contribution of the joint variables (Learning styles preferences and Science learning motivation) to students' academic achievement while the calculated ANOVA was compared with the stipulated level of significance (0.05).

Results

The results of the analysis are presented in tables, in line with the research questions and hypotheses.

Research Question 1: What is the relationship between chemistry students' learning style preferences and their academic achievement?

Table 1: Correlation Table for learning styles preference of chemistry students and their academic achievement.

Variable	N	R	Remark
Convergent learning style	690	-.13	Low negative relationship
Divergent learning style	706	-.11	Low negative relationship
Assimilative learning style	700	.01	Low positive relationship
Accommodative learning style	706	-.04	Low negative relationship

Results in Table 1 showed that convergent learning style, divergent learning style and accommodative learning style have low negative relationship with academic

achievement of , r = -.13, -.11, and -.04 respectively. While assimilative learning style have low positive relationship with academic achievement, r = .01

Research Question 2: What is the relationship between chemistry students' science learning motivation and their academic achievement?

Table 2: Correlation Table for Science learning motivation of chemistry students and their academic achievement.

Variable	N	R	Remark
Science learning motivation	686	.02	Low positive relationship

Results in table 2 showed that science learning motivation of chemistry students have low positive relationship with academic achievement, r = .02

Research Question 3: What is the relationship between male and female chemistry students' learning style preferences and their academic achievement?

Table 3: Correlation Table for learning styles preference of male chemistry students and their academic achievement.

Variable	N	r	Remark
Convergent learning style	372	-.21	Low negative relationship
Divergent learning style	376	-.30	Low negative relationship
Assimilative learning style	370	.08	Low positive relationship
Accommodative learning style	376	-.12	Low negative relationship

Results in Table 3 showed that convergent learning style, divergent learning style and accommodative learning style of male chemistry students have low negative relationship with academic achievement of , r = -.21, -.30, and -.12 respectively. While assimilative learning style have low positive relationship with academic achievement, r = .08

Table 4: Correlation Table for learning styles preference of female chemistry students and their academic achievement.

Variable	N	R	Remark
Convergent learning style	318	-.04	Low negative relationship
Divergent learning style	330	.13	Low positive relationship
Assimilative learning style	330	-.08	Low negative relationship
Accommodative learning style	330	.02	Low positive relationship

Table 4 shows that convergent learning style and accommodative learning style of female chemistry students have low negative relationship with academic achievement of , r = -.04 and -.08 respectively. While divergent assimilative learning style have low positive relationship with academic achievement, r = .13 and .02

Research Question 5: What is the joint relationship between students' learning style preferences and learning motivation with their academic achievement in secondary school?

Table 5: Model Summary for a Joint Contribution of students' learning style preferences and learning motivation with their academic achievement in secondary school

				Std. Error of	Change Statistics					Durbin-
Model	R	R Square	Adjusted R Square	the Estimate	R Square Change	F Change	df 1	df2	Sig. F Change	Watson
1	.143[a]	.021	.019	12.08502	.021	13.882	1	662	.000	
2	.211[b]	.045	.042	11.94442	.024	16.677	1	661	.000	
3	.264[c]	.070	.065	11.79553	.025	17.792	1	660	.000	1.790

a. Predictors: (Constant), self-efficacy, convergent LS, intrinsic motivation

Data in Table 5 reveals that self-efficacy, convergent learning styles and intrinsic motivation contributed positively (r = .264) to the academic achievement of secondary school students in Anambra State with a coefficient of determination of .070. This indicates that 7 percent variation in chemistry students' academic achievement is jointly accounted for by self-efficacy, convergent learning style and intrinsic motivation. Therefore, self-efficacy, convergent learning style and intrinsic motivation jointly contributed 7 percent to the academic achievement of secondary school students offering chemistry in Anambra State.

Hypothesis 1: There is no significant relationship between chemistry students' learning style preferences and their academic achievement.

Table 8: Relationship between learning styles preference of chemistry students and their academic achievement.

Variable	N	r	Sig	Remark
Convergent learning style	690	-.13**	.000	Low negatively significant
Divergent learning style	706	-.11**	.002	Low negatively significant
Assimilative learning style	700	.01	.742	Low positively non-significant Low negatively non-significant
Accommodative learning style	706	-.04	.223	

Table 8 shows that convergent and divergent learning styles had significant low negative relationship with academic achievement of secondary school students, r = -.13, and -.11 $p>.05$ while assimilative learning style had non-significant positive relationship with academic achievement, r(700) = .01, $p>.05$. Also, accommodative learning style had non-significant low negative relationship with chemistry students' academic achievement, r = -.04, $p>.05$. Therefore, the null hypothesis was not rejected for assimilative and accommodative learning styles and but rejected for convergent and divergent learning styles.

Hypothesis 2: There is no significant relationship between chemistry students' science learning motivation and their academic achievement.

Table 9: Relationship between chemistry students' science learning motivation and their academic achievement.

Variable	N	R	Sig	Remark
Science learning motivation	686	.02	.501	Positively non-significant relationship

Table 9 shows that science learning motivation have non-significant low positive relationship with academic achievement of secondary school chemistry students, r = .02, $p>.05$. Therefore, the null hypothesis that there is no significant relationship between chemistry students' science learning motivation and their academic achievement was not be rejected.

Hypothesis 3: There will be no significant relationship between male and female chemistry students' learning style preferences and their academic achievement.

Table 10: Relationship between male chemistry students' learning style preferences and their academic achievement

Variable	N	r	Sig	Remark
Convergent learning style	372	-.21**	.000	Low negatively significant
Divergent learning style	376	-.30**	.000	Low negatively significant
Assimilative learning style	370	.08	.124	Low positively non-significant
Accommodative learning style	376	-.12*	.019	Low negatively significant

Table 10 shows that convergent, divergent and accommodative learning styles have significant low negative relationship with academic achievement of male secondary school students, r = -.21, -.30 and -.12 $p>.05$ while assimilative learning style had non-significant positive relationship with academic achievement, r(370) = .08, $p>.05$. Therefore, the null hypothesis was not be rejected for assimilative learning styles and was rejected for convergent, divergent and accommodative learning styles.

Table 11: Relationship between female chemistry students' learning style preferences and their academic achievement

Variable	N	r	Sig	Remark
Convergent learning style	318	-.04	.443	Low negatively non-significant
Divergent learning style	330	.13*	.013	Low positively significant
Assimilative learning style	330	-.08	.106	Low negatively non-significant
Accommodative learning style	330	.02	.614	Low positively non-significant

Table 11 shows that divergent learning styles have significant low positive relationship with academic achievement of female secondary school students, r = .13, $p>.05$ while accommodative learning style had non-significant positive relationship with academic achievement, r(330) = .02, $p<.05$. Convergent and Assimilative learning styles both had low negative non-significant relation with academic achievement of female

secondary students, r = -.04, -.10 respectively. Therefore, the null hypothesis was not be rejected for divergent learning styles but was rejected for convergent, assimilative and accommodative learning styles.

Hypothesis 4: There will be no significant joint correlation between students' learning style preferences and learning motivation with their academic achievement in secondary school.

Table 12: Model Summary for Joint correlation between students' learning style preferences and learning motivation with their academic achievement in secondary school

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	67.063	4.213		15.919	.000
	Self-efficacy	.824	.165	.192	5.002	.000
	Convergent LS	-.810	.181	-.168	-4.420	.000
	Intrinsic Motivation	-.671	.159	-.160	-4.218	.000
	R	.264[c]				.000
	R^2	.070				.000
	F	17.792				.000

The result in Table 12 shows that the multiple regression coefficient (R) was .264 while R^2 was .070. This is an indication that the predictor variables jointly contributed 7% to explain the variances in response and the corresponding F (2, 294) = 17.792, was statistically significant ($p < .05$). Therefore, the finding indicates that the presence of self-efficacy, convergent learning style and intrinsic motivation would have a greater impact on the academic achievement of secondary school chemistry students in Anambra State. The null hypothesis was rejected implying that self-efficacy, convergent learning style and intrinsic motivation jointly correlated the academic achievement of secondary school chemistry students in Anambra State.

Discussion

This study focused on the relationship between learning style preferences and science learning motivation of secondary school chemistry students and their academic achievement. There is a low linear relationship between learning style preferences and academic achievement in chemistry. The low negative relationship implies that students with convergent and divergent learning styles preferences achieve poorly while the achievement of students with accommodating learning styles is negatively non-significant. It can be noted that preference for divergent, convergent and accommodating learning style will not increase achievement in chemistry. Those who tend to achieve more in chemistry adopt more of assimilating learning style. This is the implication for teachers to teach with students' centered instructional techniques which will aid students to discover and assimilate concepts taught them in chemistry.

From findings, it can be noted that male chemistry students' academic achievement has significantly low negative linear relationship with their learning styles. However, male chemistry students with assimilating learning styles show a non-significant low positive relationship in their chemistry achievement. This implies that male students who adopt less of divergent, convergent, and accommodating learning styles achieve more in chemistry while adopting more of assimilating learning style tends to increase the chemistry achievement. The chemistry achievement of female students on the other hand, indicates a low negative non-significant relationship for convergent and assimilating learning styles. It also shows a significantly low positive relationship for divergent learning style and a non-significant low positive relationship for accommodating learning style. This implies that gender does not significantly correlate chemistry achievement, even though learning styles influence both gender differently. For example, both genders show low negative relationship between convergent learning style and their chemistry achievement but the relationship is significant among male and non-significant among females.

From the regression analysis, it reveals that male and female chemistry students show opposite relationship on their learning style preferences. This implies that male chemistry students do not demonstrate the same preference for learning styles as the female chemistry students. Male students have different learning style preferences from the female students. In other words, they have different learning style preferences even though it does not significantly correlate to chemistry achievement.

Findings also showed there is a low positive linear relationship between motivation for science learning and chemistry achievement. This implies that all forms of motivation towards science learning has positive influence on chemistry achievement. The more students are motivated towards learning science, the less they achieve poorly. In other words, the more students are motivated towards science learning, the more they achieve highly. It shows that high motivation would lead to increase in students' achievement in chemistry.

Results indicated that the science learning motivation do not significantly correlate the chemistry achievement of students. This does not agree with Sukor, Mohd , Norhasnida and Nor (2017) who observed a positive significant relationship between motivations and academic performance of students. Kusurkar, Ten, Westers, Vos and Croiset (2012) found a positive effect of interest on the academic performance of students. The study indicated that students' motivation towards science learning has a significant correlation with students' science achievement. This suggests that there should be other factors responsible for chemistry achievement among students. Okolo (2018) identified such other factors as parents, teachers, environment and peer group factors which also impacted on achievement of chemistry learners.

The result of regression analysis shows that learning style preferences and science learning motivation contributed positively to the chemistry achievement of students. The result indicated that 7% variation in chemistry achievement is accounted for by the joint interaction of learning style preferences and science learning motivation. Therefore, hypothesis 4 was rejected, showing that learning style preference and science learning motivation of secondary school chemistry students significantly correlate their achievement in chemistry, the p-value being less than 0.05 level of significance. This agrees with the findings that there is a significant relationship between achievement in chemistry and student learning styles (Stanislava & Jasna, 2018; Nja, Umali, Asuquo & Orim, 2019 and Ibitham, 2020)

Conclusion

If equal educational opportunity must be attained, then the students' classrooms should be structured in such a way that individual learning styles are accommodated. The study brought to view the fact that individual differences occur among chemistry learners. This implies that even though students learn differently, yet a common precursor can be chosen to link different styles of learning.

Self-efficacy and intrinsic motivation enhances students' academic achievement in chemistry. This means that motivation is needed to help learners concentrate and determines the enthusiasm to pursue the learning task. Convergent learners who prefer experimenting with ideas and participating in simulations are seen to significantly differ negatively in their academic achievement. This may suggest that conventional methods of teaching may not enhance their academic achievement. The negative relationship may be a pointer that the classroom teaching has not been accommodating their styles of learning.

Therefore, to appeal to learners with divergent and convergent learning styles, teachers should adopt varying teaching methods including group work, laboratory experiences and practical applications of learning. Hence, it will be inappropriate to conclude that a "one size fits all" teaching strategy can be effectively applied when teaching chemistry students. Teachers needs to take into account their students' diverse learning styles and to design instructional methods that can take care of those diversities and remain sensitive of such during the instruction process. Finally, teachers should also help their students to understand their learning style preferences and make use of such to develop life-long learners. It is worthy of note thus that high achievement in science learning is possible when learning involves interactive, purposeful and meaningful engagements.

Implications of the Findings

The findings of this study have some educational implications. It has provided empirical evidence for the individual differences existing in the classroom. While some learn by doing and watching, others prefer thinking and feeling.

The study will be used to understand, predict and eventually plan for individual differences involving the pedagogical requirements for managing students' success in

chemistry. It will require teachers to reorganize the instructional environment and procedures; to change from lecture-dominated methods of teaching to flexible classrooms that facilitate several simultaneous approaches to learning chemistry.

By knowing the students' learning styles, the teacher would use teaching methods that maximize student's learning. This is done by adapting a wide range of teaching methods in an effective way to regulate the teaching-learning process in desirable direction. Thus, the students' participation in the learning process is enhanced which is adequate motivation to sustain learning.

Comprehension of the study findings can provide teachers with the theory and knowledge upon which to base decisions, such as making more intelligent decisions about instruction methods. This would help teachers to reduce frustration for themselves and their students. Teachers can apply the understanding of the research findings by differentiating instruction or varying instructional strategies to meet the needs of the different types of learners encountered in chemistry classroom.

Recommendations

1. Periodic workshops and seminars should be organized to equip chemistry teachers with the right skills, techniques and methodology for handling learning style differences in classroom.
2. Teachers should design their teaching method to connect with all the four learning styles using various combinations of experience, reflection, conceptualization and experimentation. This is possible by introducing variety of experiential elements into the classroom such as concept mapping, sound (music) and visuals.
3. School administrators should make provision for innovative teaching such as field work, group work, problem-based learning and differentiated science inquiry approaches.

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