LEARNING STYLES AS PREDICTORS OF STUDENTS MATHEMATICS ACHIEVEMENT IN RIVERS STATE

By

Igwe, Benjamin Nwaudo

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Dr. Fidelis O.E. Iweka
Department of Educational Psychology, Guidance and Counselling
Faculty of Education, University of Port Harcourt
Rivers State, Nigeria.

Abstract

This work investigates learning styles as predictors of students Mathematics achievement in Secondary Schools in Rivers State. Correlational research design was used. A sample of 800 students were drawn from the population of 35, 201 Junior Secondary School 3 (JSS 3) students in Rivers State, Government schools. Multiple choice questions on Mathematics of 2017 Rivers State Basic Certificate Examination were adapted/used to determine students academic achievement in Mathematics. VARK questionnaire adapted from Utica College (2006) was used to get scores for their learning styles. SPSS was used to carry out the analyses, Research Question 1-4 were answered using simple regression, their corresponding hypotheses tested using ANOVA associated with regression analysis. Research Question 5 was answered using multiple regression analysis, the corresponding hypothesis tested using ANOVA associated with multiple regression. Results of the study tested at 0.05 level of significance showed: Read/Write learning style, joint learning styles do significantly predict students academic achievement in mathematics. It is therefore recommended that students should adopt Read/Write learning styles, else the learning styles (VARK) should jointly be adopted. Educators should use the preferred students learning style for effective teaching/learning.

Introduction

All educational institutions are established with the primary goal of a holistic development of learners in the three domains; namely the cognitive, psychomotor and affective domains. This educational goal is subdivided into measurable objectives for easy achievement and assessment. When learners have acquired a particular relatively permanent change in behaviour with respect to instructional content, then learning has taken place; hence that particular objective has been achieved; of such instructional contents and subjects of which Mathematics is in most cases inclusive.

Mathematics is very vital to life. It is applied by all human being in their daily activities. Bennett (2017) opined that it is a methodical application of matter becauseMathematics is said, makes a manmethodical or systematic. Bennett further explained that, Mathematics makes our life free from chaos but promotes orderliness.Certain qualities that are developed by Mathematics are power of reasoning, creativity, abstract or spatial thinking, critical thinking, problem-solving ability and even effective communication skills. Mathematics is the beginning of all creations, without which every activity in the world will be disorderly and man thrown into confusion. Our food, clothing, shelter all involve careful calculations and decisions. A driver calculates constantly as he/she drives on the road. A cook, doctor, lawyer, teacher, pastor, etc make constant use of Mathematics in carrying out their duties.

Academic achievement as viewed by the Free Encyclopedia (2017) is the outcome of education, that is, the extent to which a student, teacher or institution has achieved their educational goals. These educational goals embrace the various forms of students academic achievement in science, arts and social science subjects such as English Language, Mathematics, Physics, Chemistry, Biology, Economics, etc. In this study, focus will be on students academic achievement in Mathematics. This choice of Mathematics in this study is because of its essentiality in life and academic pursuit. Precisely, the academic performance of students is a function of many variables. These variables include the school factor, the teacher factor, students factors, etc (Nwankwo 2007]. This means that psycho-social influences may contribute to students poor achievement in their school subjects including Mathematics, which students learning styles may be inclusive. In the process of learning, the students adopt various strategies to ensure proper coding, decoding, storage and retrieval of information taught by the teacher. These diverse strategies are referred to as learning styles. Ikechukwu (2014) posited that learning style is dispositional or trait concept in that it is about how someone usually learns. Citing Dunn, Ikechukwu (p.40) further defined learning style as a way in which individuals begin to concentrate on, process, internalize and retain new information. There are various models of learning styles but focus in this study will be on the Flemming's VARK Model.

VARK is an acronym for Visual, Auditory, Read/Write and Kinaesthetic. Visual learners take in new concepts

through the use of images, maps and graphic organizers. They prefer to internalize new ideas using shapes, paintings, sculptures and pictures.

The auditory learners best understand new concepts through listening and speaking in situations such as lectures and group discussions. These types of learners take advantage of mnemonics and repetitions to internalize complex information. Auditory learners simply have preference for listening, tones, chants and rhythms.

Read/Write learner: Students with strong reading/writing preferences, learn best through words. The University of Southern California (2017) maintained that these students present themselves as copious notes takers and ardent readers. The reading and writing learners are able to translate and express abstract concepts into words and essays.

The kinaesthetic learners are students who best understand new concepts through tactile representation of information. They are characterized by learning through gestures, body movements, object manipulations and positioning. They employ active exploration of the world, conducting science projects and experiments.

Students should individually adopt any of the learning models that could improve their understanding of the instructional contents and subsequently influence their academic achievement in Mathematics.

Statement of the Problem

1. Researcher's long years observation of West African School Certificate Examination [WASCE] results on Mathematics showed high failure rates; also students at the primary and the secondary levels of education would without hesitation name Mathematics as the subject they hate most. These poor Mathematics achievement at the secondary level (in particular) lay a poor foundation for further studies and life after education.

2. In view of the above menace, one would ask where the problem is from – is it from the students or from the teachers who teach this subject or otherwise. It is a known fact that all students act differently, therefore they adopt different styles in the learning process.

3. These differences in learning styles cannot be valueless in measuring academic achievement of students especially in mathematics. How this happens and how to determine them posed the problem to be solved. The problem of this study therefore, is to

investigate students learning styles as predictors of students' mathematics achievement.

Aims and objectives of the Study

The aim of the study is to investigate the predictive powers of learning styles on students Mathematics achievement, the study intends to achieve the following objectives:

1. Ascertain the predictive power of visual learning style on students academic achievement in Mathematics.

2. Determine the extent auditory learning style can predict students academic achievement in Mathematics.

3. Determine the predictive power of read/write learning style on students academic achievement in Mathematics.

4. Ascertain the extent kinaesthetic learning style can predict students' academic achievement in Mathematics.

5. Ascertain the joint predictive power of learning styles (Visual, Auditory, Read/Write, and Kinaesthetic) on students academic achievement in Mathematics.

Research Questions

The following research questions were answered to obtain the results of the study.

1. What is the predictive power of visual learning style on students academic achievement in Mathematics?

2. What is the predictive power of auditory learning style on students academic achievement in Mathematics?

3. What is the predictive power of read/write learning style on students academic achievement in Mathematics?

4. What is the predictive power of kinaesthetic learning style on students academic achievement in Mathematics?

5. What is the joint predictive power of learning styles(Visual, Auditory, Read/Write, andKinaesthetic) on students academic achievement in Mathematics

Hypotheses

The following null hypotheses were tested at 0.05 level of significance to obtain the results of the study on:

1. Visual learning style do not significantly predict students Mathematics achievement.

2. Auditory learning style do not significantly predict students academic achievement in Mathematics.

3. Read/Write learning style do not significantly predict students academic achievement in Mathematics.

4. Kinaesthetic learning style do not significantly predict students academic achievement in Mathematics.

5. Learning styles (Visual, Auditory, Read/Write, and Kinaesthetic) jointly do not significantly predict students academic achievement in Mathematics.

Significance of the Study.

1. Hopefully, the study will be beneficial to students, teachers, universities, researchers, etc. For the students, this study may lead to better achievement in future. Since students shall adopt learning styles that are appropriate at given learning period/subject matter.

2. The study likely will be beneficial to teachers. It will improve the quality of the process of teaching and learning Mathematics, also help to instill in students the importance of adopting good learning styles.

3. The study will help institutions of higher learning, because the subsequent improvement in the Mathematics achievement in the Senior School Certificates Examination (SSCE) and in the Post Unified Tertiary Matriculation Examination (PUTME) will enhance admission and placement in institutions of higher learning.

4. The study shall be of great importance to subsequent researchers who shall embark on similar investigation as the findings from the study may serve as empirical review for the researchers.

Scope of the Study

The study focused on the academic achievement of secondary school students in Mathematics which is the dependent variable of the study. Students learning styles are the independent variables in the study.

Learning styles models identified by Wikipedia (2017) are Kolb Experiential Learning Theory, Gregorc Learning Style Model, Felder and Silverman Learning Style Model, Flemming's VARK Model, etc. However, the VARK (Visual, Auditory, Read/Write and Kinaesthetic learning styles) model was used in this study to investigate students learning styles. These variables were selected for investigation because, best known to the researcher, no study have been conducted on the topic in the public secondary schools in Rivers State.

Area of the Study

The area of this study is in Rivers State. Rivers State is one of the states in the South – South geo-political zone of Nigeria. It is bounded by Abia State, Akwa-Ibom, Bayelsa, Delta and Imo State. Port Harcourt is its capital city. The State comprises of twenty-three (23) Local Government Areas which are merged into three (3) senatorial districts : [i] Rivers East senatorial district- made up of eight (8) Local Government Areas with one hundred and twelve (112) public schools.[ii] Rivers West senatorial district- made up of eight (8) Local Government Areas with ninety nine (99) public schools and [iii] the Rivers South – East senatorial district which consists of seven (7) Local Government Areas with a number of seventy five (75) public schools, bringing the total of public schools in the State up to two hundred and eighty six (286) schools as at 2017/2018 academic session (source: Rivers State Ministry of Education). There are also not less than eight (8) tertiary institutions located in the state.

The people of the State are mainly farmers, civil servants, politicians and artisans. The State has multinational oil companies such as Nigerian Agip Oil Company (NAOC), Total Fina- Elf, Shell Petroleum Development Company (SPDC) etc. It has a sea port as well as an airport. All these gave rise to persons from other states residing in the state, hence English language is the most common language used in Rivers State. The researcher being an experienced teacher of Mathematics in the state has observed poor performance among students in Mathematics, of which appropriate learning styles can play a role to correct. Consequent upon the above reason, coupled that the area has adequate sample size due to the population of students believed can respond well to the instrument to be used; the area is considered appropriate for this study.

Research Design

The design used for the study is the correlational research design. A correlational study determines whether or not two variables are correlated. This means to study whether an increase or decrease in one variable corresponds to an increase or decrease in the other variable - (Kpolovie, 2010, Nwankwo, 2011). Specifically, the design for the study is predictive design. Both simple and multiple predictions were adopted. The study adopted this design because the researcher collected sets of data on students learning styles (predictor variable) and Maths achievement test (criterion variable) and ascertained the

predictive ability of the former on the later.

Population for the Study

The population for this study consists is 35,201, the enrolment for 2017/2018 JSS3 students in Rivers State (Source, Rivers State Ministry of Education 2018).

Sample and Sampling Technique

Sample of 800 students were used for the study. These sample size was based on Taro Yamene sample size formula. A random sampling technique in multi-stage was used to compose the sample of students from JSS 3 students from the public secondary schools in Rivers State.

Instruments for Data Collection

Two instruments were used to collect data for the study. The first instrument used for the study is the Basic Education Certificate Examination multiple choice questions in Mathematics for 2016/2017 session. This instrument was used because it suitably applies to the population under investigation.

The second instrument is the VARK Questionnaire which gives scores for each of the categories: Visual, Aural (Auditory), Read/Write and Kinaesthetic. It measured preferred learning styles of students. Students choose the answer which best explains their preferred learning style and

circled the letter next to it. Student left blank any question which does not apply, but gave an answer for at least 12 of the 14.

Validity of Instrument

The first instrument, the Basic Certificate Education Examination (Junior WAEC) Mathematics multiple choice questions for 2016/2017 session was designed by subject specialists as well as experts in Measurement and Evaluation using the appropriate syllabus for each subject. These experts validated the tests in terms of clarity of words, class level suitability, content relevance and construct validity. The second instrument is VARK Questionnaire. It was adapted from UTICA (2006) and re-validated, it has an overall construct validity of 0.77. However, the VARK questionnaires were presented to two psychometricians who also approved of the instrument.

Reliability of the Instrument

The first instrument is the Junior Secondary Certificate Examination (JSCE) Mathematics multiple choice questions for 2016/2017 session. This instrument was designed by subject specialists as well as experts in Measurement and Evaluation using the appropriate syllabus for each subject. This instrument has been used over the years for certification,

employment admission and placement. It is therefore considered reliable for this investigation.

The second instrument is VARK Questionnaire which was adapted from UTICA (2006). The researcher made use of test retest method to establish the reliability of the instrument. The sub-scales had the following coefficients of reliability: Visual (0.781), Auditory (0.860);Read/Write (0.721); Kinaesthetic (0.826). These coefficients are considered high enough for this investigation.

Method of Data Collection

The two instruments were given to each of the respondents at their schools on different days. This was personally done by the researcher with the help of an assistant at each chosen school. The scripts were collected and scored. The scores obtained were used for the analyses, using SPSS.16

Method of Data Analysis

The data collected were analyzed using simple and multiple regression analyses, and Anova associated with regressions [simple and multiple] were used to test the null hypothesis at 0.05 level of significance.

Research Question 1: What is the predictive power of visual learning style on students academic achievement in Mathematics?

Table 1: Regression Analysis on Visual Learning Style and Academic Achievement inMathematics [visual learning style-independent variable, mathematics achievement test-dependent variable]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.050[a]	.002	.001	15.46511

In **Table 1**, the correlation between visual learning style and students Maths achievement has a coefficient of 0.050, a weak positive relationship between these two variables.

Hypothesis 1: Visual Learning Style do not significantly predict students academic achievement in mathematics, was tested using analysis of variance (ANOVA) associated with Simple Linear Regression. The results obtained are presented in table 2.

Table 2:

	Model	Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	476.974	1	476.974	1.994	.158[b]
	Residual	190857.346	798	239.170		
	Total	191334.320	799			

Table 2 reveals that the value of F is 1.994 and was obtained at degree of freedom of 1 and 798 at 0.158 level of significance ($p = 0.158 > 0.05$). Hence, Visual learning style do not significantly predict students academic achievement in Mathematics.

Research Question 2: What is the predictive power of auditory learning style on students academic achievement in Mathematics?

Table 3: Regression Analysis on Auditory Learning Style and Academic Achievement in Mathematics

Sig. F Change	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.045[a]	.002	.001	15.46891

Auditory learning style-independent variable; Mathematics achievement test-dependent variable

In **Table 3** the correlation between auditory learning style and academic achievement of students in Mathematics has a coefficient of 0.045, a weak positive relationship between these two variables.

Hypothesis 2: Auditory Learning Style do not significantly predict students academic achievement in Mathematics, was tested using analysis of variance (ANOVA) associated with Simple Linear Regression. The results obtained are presented in table 4.
Table 4.

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	383.032	1	383.032	1.601	.206[b]
	Residual	190951.288	798	239.287		
	Total	191334.320	799			

Table 4 reveals that the value of F is 1.601 and obtained at degree of freedom of 1 and 798 at 0.206 level of significance ($P = 0.206 > 0.05$). Hence, auditory learning style do not significantly predict students academic achievement in Mathematics.

Research Question 3: What is the predictive power of read/write learning style on students academic achievement in Mathematics?
Table 5: Regression Analysis on Read/write Learning Style and Academic Achievement in Mathematics

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.120[a]	.014	.013	15.37322

Read/Write-independent variable; Mathematics achievement test-dependent variable.

In **Table 5,** the correlation between read/write learning style and students

Maths achievement has a coefficient of 0.120, a weak positive relationship between these two variables.

Hypothesis 3: Read/Write Learning Style do not significantly predict students Maths achievement, was tested using analysis of variance (ANOVA) associated with Simple Linear Regression. The results obtained are presented in table 6`.

Table 6

Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	2738.208	1	2738.208	11.586	.001[b]
1	Residual	188596.112	798	236.336		
	Total	191334.320	799			

Table 6 reveals that the value of F is 11.586 and obtained at degree of freedom of 1 and 798 at 0.001 level of significance(p=0.001 < 0.05). Hence, read/write learning style significantly predicts students' academic achievement in Mathematics.

Research Question 4: What is the predictive power of kinaesthetic learning style on students academic achievement in Mathematics?

Table 8: Regression Analysis on Kinaesthetic Learning Style and Academic Achievement in Mathematics

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.058[a]	.003	.002	15.45855

Kinaesthetic-independent variable; Mathematics achievement test-dependent variable. In **Table 8**, the correlation between kinaesthetic learning style and academic achievements of students in Mathematics has a coefficient of 0.058, a weak positive relationship between these two variables.

Hypothesis 4: kinaesthetic Learning Style does not significantly predict students Maths achievement was tested using analysis of variance (ANOVA) associated with Simple Linear Regression. The results obtained are presented in table 9`.

Table 9

Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	638.788	1	638.788	2.673	.102[b]
1	Residual	190695.532	798	238.967		
	Total	191334.320	799			

Table 9 reveals that the value of F is 2.673 and obtained at degree of freedom of 1 and 798 at 0.102 level of significance (p=0.102>0.05). Hence, Kinaesthetic learning style does not significantly predict students' academic achievement in Mathematics.

Research Question 5: What is the joint predictive power of students learning styles (Visual, Auditory, Read/Write, Kinaesthetic - VARK) on their academic achievement in Mathematics?

Table 10: Regression Analysis on joint Learning Styles (V, A, R, K) and Academic Achievement in Mathematics

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.161[a]	.026	.021	15.31026

VARK-independent variable; Mathematics achievement test-dependent variable.

In **Table 10**, the correlation between the joint learning styles (V, A, R, K) andstudents Mathematics achievement has a coefficient of 0.161, a weak positive relationship between these two variables.

Hypothesis 5: Joint Learning Styles (V, A, R, K) do not significantly predict students maths achievement, was tested using analysis of variance (ANOVA) associated with Multiple Regression. The results obtained are presented in table 11.

Table 11

Model		Sum of Squares	Df	Mean Square	F	Sig.
	Regression	4983.127	4	1245.782	5.315	.000[b]
1	Residual	186351.193	795	234.404		
	Total	191334.320	799			

Table 11 reveals F − value of 5.315 was obtained at degree of freedom of 4 and 795 at 0.001 level of significance (p = 0.001 < 0.05). Thus, joint learning styles (V, A, R, K), significantly predict students academic achievement in Mathematics.

Discussion of Results

The results are discussed in line with the research questions and under the various students learning styles with respect to their academic performance in Mathematics.

The Predictive Power of Visual Learning Style on Students Mathematics Achievement

The result revealed that the coefficient of determination between visual learning styles and students Maths achievement is 0.001 implying that only 0.1% changes in the students Maths achievement is accounted for by changes in their visual learning styles.

The result further revealed that the probability of 0.158 is not significant at 0.05(prob.> 0.05, F = 1.994, df = 1, 798). Hence, students' visual learning styles do not significantly predict their academic achievement in mathematics (**Table 1**).

The Predictive Power of Auditory Learning Style on Students Maths Achievement.

The result shows the coefficient of determination between auditory learning style and students Mathematics achievement is 0.001, implying that only 0.1% changes in the students Maths achievement is accounted for by changes in their auditory learning style.

The result further revealed that the probability of 0.206 is not significant at 0.05(prob.> 0.05, F = 1.601, df = 1 & 798). Hence, students auditory learning style do not significantly predict their academic achievement in mathematics (**Table 3**).

ThePredictive Power of Read/Write Learning Style on Students Maths Achievement

The result shows the coefficient of determination between read/write learning style and students Mathematics achievement is 0.013 implying that only 1.3% changes in their Mathematics achievement is accounted for by changes in the read/write learning style.

The result further revealed that the probability of 0.001 is significant at 0.05(prob. < 0.05, F = 11.586, df = 1, 798). Hence, students read/write learning

style significantly predicts their academic achievement in mathematics (**Table 5**).

The Predictive Power of Kinaesthetic Learning Style on Students Maths Achievement

The result shows the coefficient of determination between kinaesthetic learning style and students Maths achievement is 0.002 implying that only 0.2% changes in the students Maths achievement is accounted for by changes in kinaesthetic learning style.

The result further revealed that the probability of 0.102 is not significant at 0.05(prob.> 0.05, F = 2.673, df = 1, 798). Hence, students' kinaesthetic learning style do not significantly predict their academic achievement in Mathematics (**Table 8**).

The Joint Predictive Power of Students Learning Styles (V, A, R, K) on their Academic Achievement in Mathematics

The result shows the adjusted coefficient of determination gotten for predicting Mathematics achievement of students on joint learning styles is 0.021 implying that only 2.1% changes in the academic achievement of students in Mathematics is accounted for by changes in their learning styles. It further revealed that the probability of 0.001 is significant at 0.05

(prob.< 0.05, F = 5.315, df = 4 & 795). Hence, students learning styles jointly, significantly predict their academic achievement in mathematics (**Table 10**).

Conclusions

From the results obtained, the following conclusions were made: Only a small aspect of the changes in students Mathematics achievement is accounted for by changes in their various learning styles. Greater changes in the students Maths achievement are due to other variables than these ones considered in this investigation. Despite all these, only read/write learning style and students joint learning styles, significantly predict their Maths achievement, the other variables do not.

Implications of the Study

The results of this study have some educational implications. Specifically, the findings of the study imply that students will study better by knowing their preferred learning style that will improve their Maths achievement. This will demystify Mathematics which has been a terror to many students. The findings of this study also imply that educational institutions will improve in standard of teaching and learning Mathematics, hence better graduates will be produce to fill our labour market.

Recommendations

1. With regard to the findings of this study, the researcher recommends that:

2. Students should adopt the read/write learning style in learning Mathematics

3. Students should adopt the learning styles jointly in learning Mathematics.

4. Educators should find out their Students prevalent learning styles and use them for effective teaching/learning.

5. It is desirable and equally important for Educational Institutions to recognize that mature people have different learning styles and should therefore pattern learning instructions to the characteristics stage in which the adult would like to learn.

Suggestions for further Research

Based on the findings of this study, the following suggestions for further studies:

1. A study be conducted on predictive powers of the visual, auditory and kinaesthetic learning styles on students mathematics achievement in other geopolitical zones.

2. A study be conducted on predictive powers of the various learning styles on Mathematics achievement using secondary school students in other geopolitical zones.

Limitations of the Study

1. The generalizations made in this study are subject to the following limitations: The research area of this study is large and some of the schools are located in its interior part, hence, accessibility was difficult. However, the researcher was assisted by indigenes to locate some of these schools, and the time to administer the research instruments to the students.

2. Some administrators refused to permit the researcher use their schools and this posed a challenge to the researcher. The researcher had to redraw his samples to ensure the sample size is representative of the population.

Contributions to Knowledge

1. This study made it known that usage of prevalent learning style or styles for a group of learners can enhance their intake of new information.

2. This study has revealed that Learning Styles have positive effect on Students academic achievements in Mathematics.

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