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Learning Styles and Quantitative ability as Predictors of Primary Pupils' Achievement in Mathematics in Oorelope and Irepo Local Government Areas, Oyo State, Nigeria

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Abstract

Mathematics serves as a tool for an individual to live in the society and to contribute meaningful to the development of the society. Through literature searched, studies have shown that various factors do promote or inhibit the performance of students in Mathematics across all states and levels of Nigerian educational system. This study was designed to investigate the predictive power of learning styles (visual, auditory and kinesthetic) and quantitative ability on pupils' performance in Mathematics. The study adopted a correlation design. 200 primary four pupils formed the sample and the pupils were randomly selected from eight primary schools in Oorelope and Irepo local government areas, Oyo state. Three self-constructed instruments were used for data collection, the instruments were Learning Styles Scale (LSS), Quantitative Ability Test (QAT) and Mathematics Achievement Test (MAT). LSS was validated using Cronbach alpha method with the reliability coefficient of 0.87. QAT and MAT were validated with KR20 and their reliability coefficients were found to be 0.82 and 0.79 respectively. The results of the finding showed a linear relationship between the predictors and the criterion; the combination of predictor variables yielded a multiple correlation of 0.631 with students' performance in Primary mathematics. The multiple correlation of 0.631 indicated a moderate relationship between the predictors (learning styles and quantitative ability) and pupils' performance in Mathematics; it implied that the obtained regression equation resulting from the set of the four predictor variables allow reliable prediction of pupils' performance in Mathematics. The four predictor variables accounted for 39.8% of the observed variance in the students' performance in primary Mathematics. The study revealed that the four predictor variables contributed significantly to the prediction model. It implies that learning styles and quantitative ability are key determinants of pupils' performance in primary Mathematic. The study recommends that learning styles and quantitative ability should be considered in improving pupils' performance in primary Mathematics.

Keywords: Learning styles, Quantitative ability, Performance, Mathematics

Introduction

Primary education remains the foundation upon which other levels of Nigerian system of education is built. Mathematics is one of the core subject at this level of education due to its utility value in developing all round individual that will not only be useful to him/herself but will also contribute to the development of his/her community. The role of primary Mathematics according to Benin Conference of Mathematics Educator in Nigeria, 1977, includes providing pupils' with necessary numeracy skills, manipulative skills, critical thinking skills, creativity skills, helping pupils to implement/apply the skills to solve their day to day problems and introducing the knowledge of spatial relationship, record keeping and accounting. As important as the role of Mathematics is to the total development (cognitive, affective and psychomotor) of pupils, it is the most failed subject across all levels of Nigeria education sector. Different factors have been found to be accountable for this. Some of these factors are preference for learning (Vincent & Ross, 2001; Warn, 2009), quantitative ability (Adegoke, 2002) and self efficacy (Bandura, 2001) among others.

Every pupil irrespective of class has his/her own unique way of learning a concept. Some learn through observation, some learn through listening while others learn through interaction with the learning material and learning environment. Learning style is a description of an individualized way of learning otherwise known as individual differences of pupils in learning. According to Keefe cited in Nzesei (2015), learning styles are cognitive, effective, and psychosocial factors and behaviors that serve as facilitators of how students perceive, interact with, and respond to the learning environment. People learn through their senses by processing information around. Three senses commonly engaged for learning are sense of seeing, sense of hearing and sense of feeling. Based on these, the common learning styles are visual, auditory and kinesthetic learning styles.

Pupils with visual learning style are quiet by nature and learn through the sense of seeing. They learn by observing images, concrete materials and have clear imaginative power. Visual learners act as if they have a camera in their minds by thinking in images or pictures (Kanar, 1995). They visualize the details of what is read, visualize new ideas and knowledge presented and translate what they hear and read into pictures. They require visual images in a Mathematics class setting (Vincent and Ross, 2001). Pupils with auditory learning style are the most talkative and the most distracted if care is not taken. According to Kanar (1995), they understand and learn Mathematics concept best by listening to an explanation, enjoy Mathematics class by listening and making contributions during the class interaction, participate actively in class discussion, make pictures of the concept being taught in their minds, filter teachers' instruction through their listening and repeating skills by talking back to the teacher (Vincent & Ross, 1998). Kinesthetic pupils make use of tactile sense. They learn by doing, express emotions physically and as a result, they find it difficult to listen to information. They enjoy learning through hands-on activities (Kanar, 1995). They process instruction through touching and feeling whatever they are learning (Vincent & Ross, 2001).

Studies have been conducted on the relationship between learning styles and achievement in learning. Chermahini, Ghanbari and Talab (2013) investigated the relationship between learning styles and the academic performance of students who attended an English class to learn English as a second language in Iran. The sample size for the study was 317 students. The study identified four basic learning types adopted using Kolb's Learning Styles Inventory. The four learning styles examined were accommodating, diverging, assimilating, and converging. Students' academic performance was evaluated by achievement test in the English language. The findings showed a significant relationship between the different learning styles and the performance in English test. Mazlini, Nizam, Lee, Che, Che, Marzita, Yeniq and Siti (2013) investigated the relationship between learning style and Mathematics achievement among High Performance School (HPS) students using 362 students. The findings of the study revealed that most students have mixed learning styles which were active, concrete, visual, sequential and global. However, there existed significant differences among visual, verbal, sequential and global learning styles based on gender. There was a relationship between active and reflective learning style and Mathematics achievement. Vaishnav and Chirayu (2013) carried out a study on learning styles-visual, auditory and kinesthetic (VAK) prevalent among secondary school students in Maharashtra state. The findings of the study indicated significant main effects of the learning styles - visual, auditory and kinesthetic on academic achievement of the student. The study also showed a high positive correlation between kinesthetic learning style and academic achievement. The kinesthetic learning style was found to be more prevalent than visual and auditory learning styles among secondary school students. There exist positive high correlation between kinesthetic learning style and academic achievement. Warn (2009) in his study investigated the relationship between students' learning style and their academic performance in two final year subjects using Kolb's Learning Style Inventory (LSI). In the study, the students were requested to fill two sets of LSI questionnaires in relation to two final year subjects with different final assessment orientation, such as Malaysian Taxation which is mainly computational oriented and Financial Strategy which is mainly theoretical oriented. The students' final examination results for both subjects were extracted for study of its association with their learning style. The finding of the study showed no significant relationship between the students' learning style and their academic performance

Quantitative ability has to do with pupils' ability to add, subtract, multiply, divide, estimate, and compare numerical magnitudes (Xu, Spelke, & Goddard, 2005). This ability is developed in pupils overtime and enable pupils to be fully capable of representing quantities with numbers (Feigenson, Dehaene, & Spelke, 2004; Piazza, 2010). Quantitative Ability is usually reflected in a Mathematics class through pupils' ability to manipulate numbers in a rational and logical way which is determined by pupils reasoning with numbers, pupils' ability to solve computations with ease and pupils' ability to recognise numbers series, numerical transformation and relationship between numbers. Pupils with high quantitative ability will exhibit all these features in little or no time while a pupil with low numerical ability will spend a significant amount of

time to carry out all these activities. Quantitative ability is referred to as numerical ability by some scholars and they emphasise that it is an important foundation on which the Mathematical development of pupils depend in the later years (Xu et al, 2005). This is supported by Adegoke (2002) who asserted that the knowledge of numbers serves as a good basis for academic achievement in science related subjects. A student who aspires to be good in any aspect of mathematics should be sound in manipulation of numbers such as approximation, estimation, rounding off etc.

Statement of the problem

Factors that are pupils related, school environmental related, parental related, governmental related, school administrators' related and teaching and learning process related have been advanced in the literature as contributory to pupils' achievement in Mathematics. Studies have been carried out on relationship between learning styles, quantitative ability and pupils' achievement focusing on individual of them. None of the studies reviewed examined the relationship between learning styles when combined with quantitative ability and achievement in Mathematics. It is in the light of the foregoing that this study investigated the predictive power of learning styles and quantitative ability on pupils' achievement in Primary Mathematics.

Research questions

1. What type of relationship exists among the predictor variables (visual learning style, auditory learning style, kinesthetic learning style and quantitative ability) and the criterion variable (pupils' achievement in Mathematics)?
2. Does the obtained regression equation resulting from the set of four predictors (visual learning style, auditory learning style, kinesthetic learning style and quantitative ability) allow a reliable prediction of pupils' achievement in Mathematics?
3. Which of the four predictor variables (visual learning style, auditory learning style, kinesthetic learning style and quantitative ability) are most statistically influential in predicting pupils' achievement in Mathematics?
4. Are there any predictor variables that do not contribute significantly to the prediction model for achievement in Mathematics?

Methodology

The study adopted a correlation design. The population of the study comprised all primary four pupils of Oorelope and Irepo local government areas of Oyo state. The schools in Oorelope and Irepo local government areas were stratified into LGA. Four primary schools were randomly selected from each of the local government areas making eight primary schools. 50 primary four pupils were randomly chosen from each of the selected school. A total of 200 primary four pupils formed the sample. Three self constructed instruments were used for data collection. The instruments were Learning Styles Scale (LSS), Quantitative Ability Test (QAT) and Mathematics Achievement Test (MAT). The content validity ratios (CVR) of the three

instruments were established using Lashwe's formula while their reliability coefficients and internal consistencies were obtained by using Cronbach alpha method. The CVR of LSS was 0.90 that of QAT was 0.80 while that of MAT was 0.85. Also, factor analysis with the use of varimax rotation was employed to establish the construct validity of LSS and it yielded three factors which are visual learning style, auditory learning style and kinaesthetic learning style. LSS was validated using Cronbach alpha method with the reliability coefficient of 0.87. QAT and MAT were validated with KR20 and their reliability coefficients were found to be 0.82 and 0.79 respectively. The data was analysed using multiple regression. The predictors (Independent) variables (X) are;

1. Visual learning style
2. Auditory learning style
3. Kinesthetic learning style
4. Quantitative ability

The Criterion (Dependent) Variable is Achievement in Primary Mathematics

Interpretation

Research Question 1: What type of relationship exists among the predictor variables (visual learning style, auditory learning, kinaesthetic learning style and quantitative ability) and the criterion variable (pupils' achievement in Mathematics)?

Table 1: Correlation Matrix of the predictors and criterion

	Visual learning style	Auditory learning style	Kinesthetic learning style	Quantitative ability	Achievement
Visual learning style	1				
Auditory learning style	.630**	1			
Kinesthetic learning style	.502*	.925*	1		
Quantitative ability	.601	.856	.203	1	
Achievement	.60*	.54*	.35*	0.84*	1
Mean	9.86	12.70	11.34	15.40	16.20
SD	5.515	6.410	4.802	7.4645	8.212

* Correlation significant at $p<0.05$

The table 1 presents the correlation matrix showing the relationship between predictors (visual, auditory, kinaesthetic learning styles and quantitative ability) and the criterion variable (achievement in Mathematics). It can be seen from the table that visual learning style had a moderate significant relationship with achievement in Mathematics $r_{(200)} = 0.60$; $p<0.05$; auditory learning style had a positive moderate correlation which indicates a moderate significant relationship with achievement in Mathematics $r_{(200)} = 0.54$; $p<0.05$, kinaesthetic learning style had low positive significant relationship with achievement in Mathematics $r_{(200)} = 0.35$; $p<0.05$ while quantitative ability had a high positive significant relationship with achievement in

Mathematics $r_{(200)} = 0.84$; $p<0.05$.. This indicates a generally moderate significant relationship between the predictor variables and the criterion variable.

Research Question 2: Does the obtained regression equation resulting from the set of five predictors (visual learning style, auditory learning, kinesthetic learning style and quantitative ability) allow a reliable prediction of achievement in grammar?

Table 2: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.631[a]	.398	.376	7.099

a. Predictors: (Constant), visual learning style, auditory learning, kinaesthetic learning

Table 3: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	1306.444	4	326.611	6.413	.000[a]
	Residual	9931.350	195	50.930		
	Total	3534.000	199			

a. Predictors: (Constant), visual learning style, auditory learning, kinaesthetic learning style

b. Dependent Variable: Achievement in Mathematics

The multiple regression correlation coefficient (R) as seen in table 2 (model summary) shows a significant linear relationship between the predictors (visual learning style, auditory learning style, kinesthetic learning style and quantitative ability) allow a reliable prediction of pupils' achievement in Mathematics. It is seen that R was 0.631, which indicated a moderate relationship between all the predictors and the criterion. In table 3, R^2 was 0.398 which implies that 39.8% of the observed variance in achievement in pupils' Mathematics is accounted for by the predictors (visual learning style, auditory learning style, kinesthetic learning style and quantitative ability). Table 3 shows the ANOVA table with $F(4,195) = 6.413$, $p<0.05$, which shows that the regression model was significant in predicting pupils achievement in Mathematics.

Research Question 3: Which of the four predictor variables (visual learning style, auditory learning, kinaesthetic learning style and quantitative ability) are most statistically influential in predicting pupils' achievement in Mathematics? **Table 4: Coefficients**

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	**Std. Error**	**Beta**	**t**	**Sig.**
(Constant)	28.924	3.306		8.749	.000
Visual learning style	2.021	.476	1.010	2.045	.022
Auditory learning style	-2.168	.373	-1.081	3.451	.002
Kinaesthetic learning style	2.172	.627	1.406	3.464	.001
Quantitative ability	-2.863	.621	-1.554	4.610	.000

Table 4 shows the contribution of each of the predictor variables (visual learning style, auditory learning style, kinaesthetic learning style and quantitative ability) to the prediction model of pupils' achievements in Mathematics. It can be seen that all the predictor variables (visual learning style, auditory learning style, kinaesthetic learning style and quantitative ability) contributed significantly to the prediction model of pupils' achievements in Mathematics. Visual learning style $\beta = 2.021$, $t_{(200)} = 2.045$; $p<0.05$, auditory learning style $\beta = -2.168$, $t_{(200)} = 3.451$; $p<0.05$; kinaesthetic learning style $\beta = 2.172$, $t_{(200)} = 3.464$; $p<0.05$ and quantitative ability $\beta = -2.863$, $t_{(200)} = 4.610$; $p<0.05$. All of the predictor variables were influential on the prediction model.

Research Question 4: Are there any predictor variables that do not contribute significantly to the prediction model for pupils' achievement in Mathematics?

Table 4 shows that none of the predictor variables (visual learning style, auditory learning style, kinaesthetic learning style and quantitative ability) do not contribute significantly to the prediction model.

Discussion of the findings

The findings of the study showed that there is linear relationship between the predictors and the criterion. The combination of predictor variables yielded a multiple correlation of 0.631 which indicated a moderate relationship with pupils' achievement in Mathematics. The obtained regression equation resulting from the set of the four predictor variables allow reliable prediction of pupils' achievements in Mathematics. The four predictor variables accounted for 39.8% of the observed variance in the pupils' achievements in Mathematics. The four predictor variables contributed significantly to the prediction model of pupils' achievement in Mathematics.

The findings of this study has established that visual learning style, auditory learning style, kinaesthetic learning style and quantitative ability focussed and considered in this study, when taken together, have positive effects on pupils' achievement in Mathematics. Also, all of them when considered individually were found to have strong influence on pupils' achievement in Mathematics. It implies that the learning styles whether visual, auditory and kinaesthetic as well as the quantitative ability of the pupils has a great implications in their performance in Mathematics. The findings of the study corroborate the study of Vaishnav and Chirayu (2013) and Warn (2009) that found a significant relationship learning styles and academic achievement. In the same vein, the study supports the studies of Booth & Siegler, 2006, 2008 and Bugden and

Ansari, 2011 that discovered that quantitative ability relates and affect students' achievement. While teaching a visual learner, according to Vincent and Ross (2001), the Mathematics teacher should consider the following

(i) Use video equipment.
(ii) Use if chart and graphs to explain a concept
(iii) Use of pictures during class interactions
(iv) Providing information in writing form.

Pupils with auditory learning style should be provided with auditory stimuli as much as possible. Such stimuli include verbal reinforcement, group activities and class discussions. In line with this, Mathematics teachers can apply this by

(i) allowing pupils to say what they have learnt during the previous lessons
(ii) Making tapes of Mathematics concepts and allowing pupils to listen to them.
(iii) Encouraging pupils to ask questions
(iv) Encouraging pupils to participate in class interaction
(v) Allowing pupils to read questions out loud.

Mathematics teachers should take note of the following in catering for the kinaesthetic/tactile pupils in his/her class

(i) Writing notes for pupils
(ii) Allowing pupils to have short break during lesson. This may be used for stretching of legs e.t.c.
(iii) Underlining important information in the textbook.
(iv) Drawing pictures of what is learned.

In addition, Vincent and Ross (1998) provided the following general guidelines for good teaching of all styles of learning. These principles should also be applied in Mathematics class by the teacher

(i) Always remember that learning is best when accompanied by a pleasant feeling; for example, suitable environment, non-threatening atmosphere.
(ii) Know the material well before beginning to teach.
(iii) Write objectives and keep objectives in focus from planning to evaluation.
(iv) Let the students know what the objectives are.
(v) Determine the learning styles of students before teaching.
(vi) Educate students on their own learning style and how to cope.
(vii) Match teaching style to the learning style of a majority of the students, giving attention to students with other learning styles.
(viii) Motivate learners by introducing the subject in view of its future relevance to them.
(ix) Use audiovisual aids and activities that allow student participation wherever

possible (make the instruction vivid).

(x) Divide a complex task into smaller, achievable learning units.

(xi) Use questions and answers to assess learning.

(xii) Watch for nonverbal clues to determine status of learning.

(xiii) Give students time to think.

(xiv) Vary activities to sustain the learner's attention.

(xv) Provide immediate feedback.

(xvi) Assign tasks that allow for self-learning; for example, library readings, case problems, group projects.

(xvii) Incorporate hands-on activities into the lesson wherever possible.

Implications of the findings for Primary Mathematics Education

The findings of this study have succinctly indicated the necessity of learning styles and quantitative ability as major determinants of students' performance in Mathematics. It is therefore implies that awareness and knowledge of different learning styles and quantitative ability are necessary for pupils' teachers, school counsellors, school administrators and parents for an improved planning and implementation of Mathematics curriculum. Through these awareness and knowledge, pupils would be able to identify their predominant learning styles and engage them in learning Mathematics concepts. Teachers can identify pupils by their learning styles and apply such during planning, implementation and evaluation of Mathematics instructional process. This can be done with the use of various instructional materials, eclectic instructional strategies and variety of evaluation techniques that cater for the three major types of learning styles for better learning of Mathematics concepts. Parents can also help their children learn better when helping them in home assignments.

Conclusion

Based on findings of the study, it can be inferred that all the three learning styles (visual, auditory and kinaesthetic) and quantitative ability are principal contributors to pupils' achievement in primary Mathematics. In the same vein, all of them whether taken together or considered individually are significantly germane to the achievement of pupils in primary Mathematics.

Recommendations

Arising from the findings and conclusion of the study, the following suggestions were made:

- Educators should learn new ways to address the various learning styles of pupils in Mathematics class so as to build pupils and contribute to the improvement of learning achievement of pupils in Mathematics.
- Curriculum planners and policy makers in the area of primary Mathematics should take into cognizance the different learning styles of the pupils in the process of the designing Mathematics curriculum.
- Primary pupils should understand their different learning styles and make use of the available opportunities relating to their styles in the Mathematics classroom.
- Primary Mathematics teachers should consider their pupils' learning styles in the process of planning of the instructional activities in a typical Mathematics class. The class

interaction should accommodate variety of learning styles to accommodate pupils' individual differences in learning.

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