Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.5, No.9, 2014

Effect of Metalinguistic Learning Approach on Students' Achievement in Secondary Schools Statistics in Makurdi Metropolis, Benue State, Nigeria

Iji, C.O.[1*], Agbo-Egwu[1] A.O.,Adikwu,O.[2]
1. Department of Science Education, College of Agricultural and Science Education, University of Agriculture,P.M.B.2373, Makurdi, Benue State, Nigeria, West Africa
2. Departments of Educational Foundations and General Studies, University of Agriculture Makurdi, Benue State. Nigeria
E-mail of Correspondence author: ijiclements07@yahoo.com

Abstract
Statistics is an indispensable aspect of mathematics that affects every facet of human endeavour. However, empirical evidence shows that students achieve poorly in mathematics at the School Certificate level due to poor attempt of statistics related questions. Research findings further indicated that this low achievement may be attributed to pedagogy and this has necessitated this study. Three research questions and three hypotheses guided the study. The study made use of a quasi-experimental design of non-randomized Pretest- Posttest control group. A sample of 350 SS2 students was drawn from a population of 2,665 SS2 students in Makurdi Metropolis using Yaro-Yamen's formula. In each of the four secondary schools, intact classes were used. Two sets of lesson plans on the topics under study were developed for the experimental and control groups respectively. Data were collected using Statistics Achievement Test (SAT).Research questions were answered using means and standard deviations while the hypotheses were tested using Analysis of Covariance (ANCOVA) at 0.05 level of significance. Findings among others include that metalinguistic learning approach improved students' achievement in statistics and MLA did not significantly differentiate between male and female students' achievement scores in statistics. Based on the findings of this study, it was recommended that mathematics teachers should be encouraged to use MLA in their mathematics classroom among others. Adequate suggestions were further made.
Keywords: Metalinguistics, Learning approach, Students' achievement, Statistics, Mathematics teachers.

1. Introduction

The knowledge of statistics is important not only for scientific progress and development but also for its day-to-day application in social sciences, arts, government, business, management studies and household chores. It is an important aspect of school mathematics that has various applications in the life of a learner especially in planning, decision making and research.

Statistics as a branch of mathematics is a body of theory and methodology employed in analyzing data and using numerical evidence to choose among several alternatives, decisions and actions when not all relevant facts are known (National Teachers' Institute, 2009). It is thus a science comprising rules and procedures for collecting, organizing, summarizing, describing, analyzing and interpreting numerical data which are used in making decisions, valid estimates, prediction and generalizations (Salami, 2001).

In recognition of the enormous importance of statistics, it is studied as an aspect of Senior Secondary School Mathematics. Mathematics as a secondary school subject thus comprises five main areas namely: algebra, geometry, number and numeration, introductory calculus and statistics. Statistics is a branch of mathematics involving the study of data presentation, measures of central tendency, measures of dispersion, graphical presentation of data and probability (Federal Ministry of Education, 2007).

Despite the importance of mathematics to students and society at large, the general achievement in school mathematics has more often than not been affected by students' poor performance in the statistics section of public mathematics examinations over the years in Nigeria. The Annual Report of the Chief Examiner of the West African Examination Council (WAEC, 2002 & 2007) has indicated that achievement in the statistics section of the public mathematics paper was low among the secondary school students.

The WAEC Chief Examiner`s Report (2004) specifically advanced reasons for students' poor achievement in Mathematics to include:

- Shallow knowledge of basic principles, concepts and appropriate application of laws and formulae;
- Confusion between similar and related topics, for instance bar chart and histogram, dependent and independent events, numerator and reciprocal factors;
- Lack of mastery of the subject language, resulting in misinterpretation of facts.

This position alludes to the fact that concepts in mathematics should be properly explained to the learners in order to improve upon their overall achievement in mathematics. The Chief Examiner's Report is an evident that

students have problems in understanding and interrelating symbols and peculiar language used in statistics. According to Salami (2001), statistics like any other subject has its own technical language. He pointed out that it is always good and beneficial for students who will use the language of statistics in their various examinations to acquaint themselves with the commonly used vocabularies, notations and symbols. The poor acquaintance of students with the commonly used terminologies, notations, formulae and symbols in statistics may result in poor achievement in the subject. Their inability to differentiate and establish relationships between vocabularies, notations and symbols in statistics could be an obstacle to their statistical achievement. Many of the students may not be able to reflect on the language of statistics and how to use the knowledge of the language to solve problems. The cause of students' poor achievement and retention in statistics may be therefore traceable to the low level of students' metalinguistic knowledge.

Metalinguistics is a compound word made up of 'meta' and 'linguistic'. Meta which is an ancient Greek term meaning 'beyond' can be interpreted in the context of language learning as going beyond communication and meaning ,and to instead focus attention on the underlying structures (Dekemel, 2003). Linguistic on the other hand refers to language and in this case, the language of statistics. The language of statistics has structure, and an implicit knowledge of this structure is essential to the students' achievement in the subject. Metalinguistics is therefore the ability of the students to reflect on and consciously ponder about oral and written language and how it is used (Wallach, 2008).

In this study metalinguistics is considered as the ability of the students to reflect on the use of the language of statistics since metalinguistics deals with the conscious knowledge of forms and meanings of relationships in a language. Metalinguistics can therefore be determined from students' ability to perceive and apply various notations, symbols, formulae and vocabularies in statistical language, judge the appropriateness of their usage, define terminologies, substitute symbols, apply formulae and understand arbitrary language. Sapir-Whorf linguistic theory postulated that grammar and language are part of the mental process, which helps to shape the way an individual interprets and views the world around him/her. It said that thoughts and behaviour are determined or are at least partially influenced by language. Since its inception in the 1920's and 1930's, the Sapir- Whorf theory has brought attention to the relationship between language, thought and culture. Neither of them formally wrote the hypothesis nor supported it with empirical evidence, but through a thorough study of their writings about linguistics, researchers have found two main ideas. First, a theory of linguistic determinism that states that the language you speak determines the way that you will interpret the world around you. Secondly, a weaker theory of linguistic relativism that states that language merely influences your thought about the real world.

The metalinguistic theory of counterfactuals forms another good ground for the study. It states that the counterfactual A>C is true if and only if C is entailed in A and some other relevant premises (Chisholm, 1946). According to Goodman (1955), the tag of metalinguistic comes from the observation that theory seeks to specify truth conditions of counterfactuals in terms of metalinguistic notions such as entailment and premises.

Udousoro (2008) investigated the relationship between students' understanding of mathematical language and their performance in the subject. A sample of 200 SS2 students comprising 100 males and 100 females, randomly selected from five secondary schools in Etina Local Government Area of Akwa Ibom State, took part in the study. Data collection was done using Test of Mathematical Language Reading Ability and Understanding (TMRAU) and Mathematics Achievement Test (MAT).The Pearson's Product Moment Correlation Coefficient (r) and a corresponding t- test of significance were used in analyzing the data. Findings showed that students' understanding of mathematical language is significantly related to their performance in the subject but that their gender had no significant effect.

Again Wasike (2006) investigated the effectiveness of a language based programme in school mathematics on students' understanding of statistics. The study was carried out in a real classroom setting that involved comparisons between the treatment and control groups in four high schools in Bungoma District, Kenya. A sample of 156 form two students that enrolled in four intact classes from the selected schools were exposed to the same content in statistics for a period of two weeks. A quasi- experimental design was employed. Three dependent measures namely the Mathematics Achievement Test (MAT), the Mathematics Skill Test (MST), and the Mathematics Classroom Environment Questionnaire (MCEQ) were used to assess the effectiveness of the programme on student's academic achievement in understanding of statistics, their skill performance and perceptions of the classroom environment during statistics lessons. The reliability of the instruments was reported. The results affirm statistically significant learning gain in favor of the treatment group. The study concludes that the use of School Mathematics Language programme has a major implication for school mathematics instruction in the area of statistics.

Also, Binda (2006) examined the relationship between understanding the language of mathematics and performance in mathematics as well as the difficulties students encounter while learning the language and the way of tackling these difficulties. A sample of 134 males and 14 females of Senior Secondary Two was drawn from three government secondary schools. Data for the study was generated using two tests: Mathematical

Language Test (MLT) and Mathematical Performance Test (MPT). It was analyzed using Person-Product-Movement Correlation. The analysis yielded weak but positive relationship between the variables studied. This implies that mathematics teachers need to teach the language of mathematics in order to enhance classroom communication during mathematics lesson. This would increase achievement in mathematics.

Furthermore, Roehr (2004) researched into the use of language learning strategies and the relationship between metalinguistic knowledge and the second language (L2) proficiency in formal instructional settings. A sample of 27 advanced learners of German at a British university was used. Participants' L2 proficiency, metalinguistic ability and use of language learning strategies were assessed by means of a quantitative instrument whose components and language test, metalanguage test and self reported questionnaire. A supplementary interview data were also collected from five volunteers. Findings suggest that metalinguistic knowledge cuts both ways. Moderate correlations between metalinguistic ability and L2 proficiency contrast with generally positive learner perceptions of pedagogical grammar; likewise, successful implementation of pedagogical grammar contrast with misapplications during task performance. In order to identify factors determining the relative usefulness of metalinguistic knowledge, further qualitative investigation with a particular focus on online processes is proposed. The study reported that the use of language learning strategies as measured by the SILL questionnaire did not correlate significantly with either L2 proficiency or metalinguistic knowledge.

Again, Daniel (2000) investigated the effect of familiarity with mathematical symbols on achievement in mathematics in Jos, Plateau State, Nigeria. A sample of 80 students randomly and proportionally selected (male=40, female =40) for equal gender representation from two senior secondary schools was used. All the 80 students were pre-tested with a mathematics achievement-test drawn from SSCE syllabus and the treatment serves as the experimental variables. The questions used for pre and post tests were sampled from WAEC past questions in mathematics from 1990-1999. Data collected from the post tests were analyzed in line with hypothesis of no- significant difference between the mean achievement scores of the two groups. The study reveals that the mean achievement score (54.4) of the female students in the experimental group was higher than that of the male students (49.6) in the same group in the post-test. The study revealed that familiarity with mathematical symbols enhances better performance of students in mathematics even with female students.

Olagunju (2001) conducted a study to determine if sex differences have significant effect on students' performance in mathematics achievement test. A sample of 60 boys and 60 girls of SSS students randomly selected from Ondo West Local Government Area of Ondo State formed the subjects of the study. The instruments were self-constructed 40 item multiple objective mathematics achievement test prepared for each level of secondary school. The reliability of the instrument was not stated. The result shows that there was no significant difference between the general performance of boys and girls.

2. Statement of the Problem

If secondary students are to improve their achievement in mathematics at SSCE, there will be a need for appropriate and adequate approach to be adopted by the mathematics teachers. Their inability to differentiate and establish relationships between vocabularies, notations, formulae and symbols; as well as their lack of understanding and ability to interrelate the symbols and special language structure as used in statistics may have all contributed to their poor achievement in mathematics (WAEC Chief Examiners` Report, 2007).Although secondary school students are frequently required to write terminal examinations and other tests to constitute their continuous assessment, they typically have limited experience in communicating the language of statistics especially in the written form. This has resulted in low mathematics achievement among them. Research findings indicate the existence of relationship between teaching approaches and cognitive achievement (Ogunniyi, 2009). The issue then is, will the adoption of MLA improve students' achievement in statistics? Will it equally improve male and female students' achievement in statistics?

3. Purpose of the Study

The main purpose of this study is to determine the extent to which the adoption of MLA will affect the achievement of senior secondary school students in statistics. Specifically the study sought to:

i Find out if the adoption of MLA will improve students' achievement in statistics.

ii Ascertain if the mean achievement scores of male and female students will improve due to the use of MLA.

iii Ascertain interaction effect of MLA on male and female students' achievement in statistics.

4. Research Questions

The following research questions were raised to guide the study:

i What are the mean achievement scores in SAT of students taught statistics in experimental and control groups?

iii What are the mean achievement scores in SAT of male and female students in the experimental group?

iii What is the interaction effect of MLA on male and female students' mean achievement scores in SAT?

5. Research Hypotheses

The following research hypotheses were formulated and tested at 0. 05 level of significance:

i There is no significant difference between the mean achievement scores in SAT of the students taught statistics in experimental and control groups.

ii There is no significant difference between the mean achievement scores in SAT of the male and female students taught statistics in experimental group.

iii There is no significant interaction effect of MLA on male and female students' mean achievement scores in SAT.

6. Methodology

The design used for this study was a quasi-experimental of pre-test post-test non-randomization group design. It was carried out in Makurdi metropolis of Benue State, Nigeria. The population consisted of all the 2665 senior secondary school two (SSS2) in all the 21 government grant-aided senior secondary schools in the study area. The instrument used for the study was Statistics Achievement Test (SAT) that had a 50 multiple choice objective items with four options. This instrument was validated by experts in mathematics education, educational measurement and evaluation. Pre-test was formally administered to the subjects of study before the commencement of the study. The SAT reliability coefficient was found to be 0.81 using Kuder-Richardson, Kr-20 formula. The data collected were analyzed using means and standard deviations to answer the research questions asked while Analysis of Covariance (ANCOVA) was used to test the hypotheses formulated.

7. Results

The result of this study was presented according to research questions asked and their corresponding hypotheses.

Research Question One

What are the mean achievement scores in SAT of students taught statistics in experimental and control groups? The answer to this research question is presented in table 1.

TABLE 1: MEAN ACHIEVEMENT SCORES AND STANDARD DEVIATIONS OF STUDENTS TAUGHT STATISTICS IN EXPERIMENTAL AND CONTROL GROUPS.

Test	Group	Mean	Std. Deviation	N
Pre-SAT	Experimental	28.42	9.11	175
	Control	24.55	3.28	175
	Total	26.49	7.11	350
Post-SAT	Experimental	58.46	10.92	175
	Control	52.77	9.64	175
	Total	55.62	10.67	350

From Table 1, the mean achievement scores in pre-SAT of experimental and control groups are of 28.42 and 24.55 respectively with their standard deviations as 9.11 and 3.28. The difference between the mean achievement scores of the experimental group and the control group is 3.88. On the other hand, the mean achievement scores in post-SAT of experimental and control groups are 58.46 and 52.77 respectively with their standard deviations as 10.92 and 9.64. The mean difference in achievement of students taught statistics in experimental and control groups is 5.69 in favour of the experimental group.

Hypothesis One

There is no significant difference between the mean achievement scores in SAT of the students taught statistics in experimental and control groups. The test to this hypothesis is presented in table 2.

TABLE 2: ANCOVA TEST OF STUDENTS TAUGHT STATISTICS IN EXPERIMENTAL AND CONTROL GROUPS

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	3596.00	2	1798.00	17.25	.00
Intercept	54308.61	1	54308.61	521.00	.00
Pre-SAT	761.67	1	761.67	7.31	.00
Group	1908.41	1	1908.41	18.31	.00
Error	36170.70	347	104.24		
Total	1122410.00	350			
Corrected Total	39766.70	349			

P = .00 < .05

In table 2, it could be seen that F(1,349) = 18.31, P=.00<0.05. This means there is a significant difference in the mean achievement scores of the two groups. Thus, the null hypothesis of no significant difference is rejected.

Research Question Two

What are the mean achievement scores in SAT of male and female students in the experimental group? The answer to this research question is presented in table 3.

TABLE 3: MEAN ACHIEVEMENT SCORES AND STANDARD DEVIATIONS OF MALE AND FEMALE STUDENTS TAUGHT STATISTICS IN EXPERIMENTAL GROUP.

Test	Sex	Mean	Std. Deviation	N
Pre-SAT	Male	33.74	8.08	94
	Female	22.25	5.73	81
	Total	28.42	9.11	175
Post-SAT	Male	60.93	10.66	94
	Female	55.60	10.58	81
	Total	58.46	10.92	175

From table 3, the mean achievement scores of male and female students in Pre-SAT of the experimental groups are 33.74 and 22.25 respectively with their corresponding standard deviations of 8.08 and 5.73.The mean difference between male and female students in experimental group is 11.50. On the other hand, the mean achievement scores of male and female students in Post-SAT are 60.93 and 55.60.

Moreover, the male students had a mean gain of 27.19 over their mean achievement score in Pre –SAT while the female students gained 33.35 above their mean achievement score. This means that both sexes have improved on their achievement scores in statistics concepts taught during the period of this study. However, the female students have improved more than their male counterparts.

Hypothesis Two

There is no significant difference between the mean achievement scores in SAT of the male and female students taught statistics in experimental group. The test of this hypothesis is presented in table 4.

TABLE 4: ANCOVA TEST OF MALE AND FEMALE STUDENTS TAUGHT STATISTICS IN EXPERIMENTAL GROUP.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1357.08	2	678.54	6.02	.00
Intercept	31429.37	1	31429.37	278.62	.00
Pre-SAT	125.41	1	125.41	1.11	.29
Sex	406.38	1	406.38	3.60	.06
Error	19402.43	172	112.81		
Total	618893.00	175			
Corrected Total	20759.51	174			

P = .06 > .05

Table 4 shows that F(1,174) = 3.60, P = 0.06>0.05.This implies that there is no significant difference in the mean achievement scores of the male and female students taught statistics with MLA during this study. The hypothesis is therefore not rejected.

Research Question Three

What is the interaction effect of MLA on male and female students' achievement scores in SAT?

The answer to this research question is presented in table 5

TABLE 5: ANOVA OF INTERACTION EFFECT OF MALE AND FEMALE STUDENTS TAUGHT STATISTICS IN THE EXPERIMENTAL GROUP.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	4515.48	3	1505.16	14.77	.00	.11
Intercept	1069199.12	1	1069199.12	10494.47	.00	.97
Group	2757.28	1	2757.28	27.06	.00	.07
Sex	1584.26	1	1584.26	15.55	.00	.04
Group * sex	96.17	1	96.17	.94	.33	.00
Error	35251.22	346	101.88			
Total	1122410.00	350				
Corrected Total	39766.70	349				

P = .33 > .05

From table 5, it can be seen that the gender interaction is 0.00. Since Partial Eta Squared is the effect size statistic, this implies that gender had a small interaction effect on the achievement of male and female students in MLA.

8. Major Findings

Based on the analysis of this study, the following major findings were made:

i Subjects of the experimental groups improved on their statistics achievement more than those in the control group.

ii Both male and female students improved upon their statistics achievement. However, this improvement was not statistically significant.

iii There was no statistically significant interaction effect of MLA on sex of students and their statistics achievement.

9. Discussion of Findings

From Table 1, Metalinguistic Learning Approach class had a higher mean in the achievement score which was statistically significant. This indicates that MLA enhanced achievement of students in statistics concepts taught during the period of this study better than the conventional teaching approach. This finding is in agreement with Wasike (2006) who found that the application of the language of statistics in the course of teaching enhanced high school students' achievement in statistics in Kenya. Other researchers like Daniel (2000), Binda (2006), and Udousoro (2008) all found that MLA improved achievement in mathematics. The finding is as well in agreement with Roehr (2004) who found that learners' metalinguistic ability influenced their second language proficiency and their general use of language learning strategies.

Also the finding that male and female students improved on their statistics achievement is encouraging. This implies that the use of MLA had brought about improvement in their statistics knowledge. However, the girls improved more than the boys in their mean achievement scores though their mean difference was not statistically significant. This therefore means that the boys and the girls in the experimental group performed equally in the study of statistics concepts taught during the period of this study. This finding is in agreement with the research result of Daniel (2000) who found out that familiarity with mathematical symbols enhances students' better achievement in mathematics even with female students.

Furthermore, the finding that there was no statistical significant interaction effect of the MLA and gender on students' achievement scores in statistics is a good one. That is, achievement of male and female students in statistics is not affected by gender factor. Thus, the change in the achievement scores of male and female students in the MLA group was the same within the period of this study. This finding is in consonance with Olagunju (2001) who found no significant difference between the general performance of boys and girls in mathematics achievement test. It is therefore hoped that the utilization of MLA in the nation's mathematics classroom will help in reducing the phobia exhibited towards the subject by students especially the female ones.

10. Recommendations

The following recommendations were made based on the findings of this study and their implications for education:

i. Ministries of education, State secondary school education boards and other relevant stakeholders are encouraged to promote MLA by organizing regular conferences, seminars and workshops for serving teachers to acquaint them with the procedures of using MLA.

ii. Curriculum planners and mathematics text book writers should be encouraged to include MLA in their books

as complementary to other teaching methods.
iii. School administrators and inspectors in collaboration with ministries of education should encourage mathematics teachers to use MLA in their mathematics classroom.

11. Conclusions

In conclusion, the study takes a detail look at the efficacy of MLA through experimentation. This was done through extensive review of related and relevant literature which revealed some relevant gaps the study eventually filled. The MLA proved to be efficient as students improved upon their statistics achievement. Most importantly is the friendly nature of MLA which does not discriminate on the basis of gender. This is because the difference between the mean achievement scores of both boys and girls is not statistically significant.

References

Chisholm, W. (1946). "The contrary-to-Fact Conditional". *Mind* 55 (289 – 307)
Dekemel, K. P. (2003). Intervention in Language Arts: A practical Guide for Speech Language Pathologists. Butterworth Heinemann.
Federal Ministry of Education (2007). Senior Secondary Education Curriculum (Mathematics for SS1 – 3). Abuja: Nigerian Educational Research and Development Council (NERDC).
Goodman, N. (1955). Fact, Fiction, and Forecast Indianapolis. Bobbs-Merrill. *A Journal of Philosophy* 44(1), 13-28.
National Teachers' Institute (2009). Statistical Methods in Education: Modeule one, unit one. Post Graduate Diploma in Education. Kaduna
Ogunniyi, M.B. (2009). Science, technology and mathematics. International *Journal of Science Education. 18(3), 267 – 284.*
Olagunju, S.O. (2001). Sex, age and Performance in Mathematics. *ABACUS: The Journal of Mathematical Association of Nigeria*. 26(1), 15-18.
Salami, K.A. (2001). Introduction to Basic Statistics in Management. In Adeyanju, A. (Ed). Introduction to Educational Management. Oyo: Green Light Press and Publishers.
Udousoro, U.J. (2008). Relationship between students' understanding of mathematical language and their achievement in mathematics. *IJOTRE* 11(1), 49-56.
Wallach, G. P. (2008). Language Intervention for School-Age Students: Setting Goals for Academic Success: Mosby Elsevier.
Wasike, D.W. (2006). Effectiveness of a language based programme in school mathematics on students' understanding of statistics. *Euvasia Journal of Mathematics, Science and Technology Education.* 2(3), 80-87, December 2006.
West African Examination Council (2002). Chief Examiners' Report. Lagos: WAEC Statistics Division.
West African Examination Council (2004). Chief Examiners' Report WASSCE May/June.WAEC Statistics Division.
West African Examination Council (2007). Chief Examiners' Report. Lagos; WAEC Statistics Division.