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Improving Junior Secondary School Students' Mathematics Achievement through Team-Assisted Visual Instruction

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ABSTRACT : *The study investigated the improving Junior Secondary School (JSS) Students' Mathematics Achievement through Team-Assisted Visual Instruction (TAVI) with three hypotheses tested.*
A 2x2x2 non- randomised control group Pre-test and Post-test quasi-experimental factorial design was adopted. A purposive sampling procedure was used to select four government-owned JSS in Ijebu-Ode local government areas, Ogun state and an arm of intact class JSS II students through a simple random sampling procedure. Two instruments (MAT & ISP) were developed, validated. Data analysis involved Analysis of Covariance and Multiple Classification Analysis Multiple Classification Analysis
The results showed that Treatment ($F_{(1,247)} = 14.13; P < 0.05$); possession of Textbooks ($F_{(1,247)} = 51.21; P < 0.05$) and Family Size ($F_{(1,247)} = 34.13; P < 0.05$) had significant main effects on Students' Achievement in Mathematics.
Among other recommendations, Mathematics teachers should be encouraged through seminars to teach their students Mathematics using TAVI.
Word count: *147*
Key words: *Team-Assisted Visual Instruction, Textbooks, Family Size and Students' Achievement.*

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I. Background to the problem

The importance of Mathematics in the era of Science and Technology is not a dispute any longer, as the subject serves as the language through which modern development is attained. Thus, Mathematics is a universally recognized and accepted as indispensable to self-reliance and sustainable economic development of any nation because of the perceived functional utility. Despite these, there is an ample evidence of continued poor performance in the Mathematics by the studies of (Ezeugo & Agwagah, 2000, Ifamuyiwa 2001, Ojo, 2003). In addition, Ayedun (2000) and Azuka (2000) attribute low achievement in Mathematics to the nature of the subject, poor teaching methods, shortage of qualified teachers, shortage of teaching facilities and Textbooks, high workload of Mathematics teachers and poor image of Mathematics in our society amongst other factors. Therefore, it has been observed that strategies for teaching and learning of Mathematics at both the primary and secondary school levels are still not encouraging. Hassan (2002) attributes students' poor performance to factors as poor methods of teaching Mathematics or lack of Mathematics laboratory and lack of incentive.

Since the method of teaching could be regarded as the vehicle, through which a message is delivered to the learners (Adeagbo, 2001). Therefore, this paper focused on Team-Assisted Visual Instruction (TAVI) on the students' achievement in Mathematics. TAVI is an interactive instruction that relies heavily on discussion and sharing among participants (Oyedeji, 2000 & Ojo, 2003). In the interactive instruction, students are giving opportunities to react to the ideas, experience, insights and knowledge of the teachers or of peer learners and to generate ways of thinking and feelings. Moreover, students can learn from peers and teachers to develop social skills and abilities, to organise their thoughts and to develop rational arguments (Oyedeji, 2000 & Ojo, 2003). This paper involved instructional use of three students in each group working together to maximise their own and each other's learning. The students, in a team setting, are expected to help, discuss and argue with one another, assess one another's knowledge, fill noticed gaps in one another's understanding and instructional materials are presented. The choice of TAVI for instruction in this study is based on the assumption that students learn Mathematics both independently and through collaboration and that, collaborative learning enhances social interaction as well as the spirit of cooperation among learners.

The students' possession of Mathematics textbooks plays a vital role on achievement school subjects. In other words, Textbooks have significant impact on the ability of learners to achieve their learning objectives (Omoniyi, 2007). Fakuade (1980), Fajemidagba (2000) and Ale (2001) point out that the paucity of relevant Mathematics Textbooks, stands as a basic factor, which affects the teaching and learning of Mathematics in Nigerian secondary schools.

Apart from the influence of possession of Textbooks, Family Size is another factor that has been shown to exert considerable influence on Students' Learning Outcomes. Family Size may be considered from two perspectives. At the individual (micro) level, it defines one aspect of an individual's family background or environment. As such, it represents a potential influence on the development and accomplishments of family members. At the societal (macro) level, Family Size is an indicator of societal structure that may vary over time, with concomitant implications for individual development and social relations in different cohorts. Studies on birth order, Family Size and achievement by Kessler (1991) reveal that Economists, Psychologists, and Sociologists have become increasingly aware of the role that the family plays in the future success of children. However, this study presents the effect of Family Size on Learning Outcomes on Junior Secondary School Mathematics.

II. Statement of the Problem.

The difficulties and frustrations encountered by the students in learning Mathematics are often blamed on poor methods of teaching. In order to foster and enhance teaching for understanding of the basic concepts in Mathematics, some modern techniques and strategies emerged to meet the Students' needs in Mathematics. The study investigated the effect of Team-Assisted Visual Instruction on Students' Achievement in Junior Secondary School (JSS) Mathematics. The study would also investigate the moderating effects of Students' Possession of Textbooks and Family Size on Achievement in Mathematics.

Hypotheses

Based on the stated problem, three hypotheses were formulated as follows:

(1). There is no significant main effect of: (a). treatment; (b). students' possession of Textbooks; (c). Family Size on Students' Achievement in Mathematics.

(2). There is no significant interaction effect of: (a) treatment and students' possession of Textbooks; (b). treatment and Family Size; (c). Students' Possession of Textbooks and Family Size on Students' Achievement in Mathematics.

(3). There is no significant interaction effect of treatment, Students' Possession of Textbooks, and Family Size on Students' Achievement in Mathematics.

Research design: For this study, the researcher employed a 2x2x2 non- randomised control group Pre-test and Post-test quasi-experimental factorial design. It consisted of one independent variable (treatment), two moderating variables (Possession of Textbooks and Family Size) and one dependent variable (Mathematics Achievement).

Sampling Procedure and Sample: A purposive sampling procedure was used to select four Government-owned Junior Secondary Schools (JSS) in Ijebu-Ode Local Government Areas, Ogun state because of convenience and proximity. An arm of intact class JSS II students was selected from each selected school through a simple random sampling procedure. JSS II students were chosen because they are not being prepared for any external examination that might distract their attention from full participation in the study. The four selected classes were assigned to experimental and control groups using the simple random technique. In all, two JSS II classes were expected to take part as experimental group while the other two JSS II classes were to participate as control group.

Instrumentation

Mathematics Achievement Test (MAT): This instrument was used to determine the level of the Students' Achievement in Mathematics. It consisted of four essay test items drawn by the researcher following due process of essay test construction. Students were expected to solve four questions in the test showing necessary detail workings on the answer booklet provided within 45 minutes. The test was specifically drawn to cover four topics on Geometry such as Angles in a triangle; Angles in a quadrilateral; Total surface Area of cuboids and Total surface area of cylinder. In scoring the MAT, a marking guide that shows the solution to the problem or questions in the test and the marks attached to each step using the Bonus (B); Method (M); and Accuracy (A) for steps was provided. Hence, a test-retest method was adopted to determine the reliability of this instrument and it was found to be 0.91 using Pearson's Product-Moment Coefficient of Correlations

Instructional Strategies Packages (ISP): The ISP represents the model lesson Plan for the experimental and control groups.

Method of Data collection: The study was carried out as follows:

The teachers of the classes that formed the treatment groups were used as the research assistants for the study. They were trained for a week on the use of the ISP. The following steps guide the treatment in both the experimental and control groups:

***A.* Experimental group**

I. After taking permission from the school's authority concerned. The students in this group were made to respond to the instrument (MAT). This was done in the first week of the treatment period.

II. The research assistants presented the materials using lesson Plan model for the experimental group as well as the visual instructional materials based on the instructions received from the researcher.

III. Students in this group were organised by the research assistants into teams comprising three students of mixed sex in each team after instruction. Furthermore, appropriate exercises to test students' understanding of the lesson were then presented to the students. The research assistants gave class wide solution and the students' scripts were marked. Research assistants in this group ensured that the students worked on the exercises as a team throughout the treatment period.

IV Treatment in this group lasted for five weeks covering the prepared topics in the instructional package.

V. The sixth week was used for post testing. During this week, the students were made to respond again to the instrument.

B. Control group

I. After taking permission from the school's authority concerned. The students in this group were made to respond to the instrument (MAT). This was done in the first week of the treatment period.

II. The research assistants presented the materials using lesson Plan model for the control group. In this group, there was no use of the visual instructional materials based on the instructions received from the researcher.

III. Students in this group were not organised by the research assistants into teams.

IV Treatment in this group lasted for five weeks covering the prepared topics in the instructional package.

V. The sixth week was used for post testing. During this week, the students were made to respond again with the instruments.

Data Analysis procedure

The procedure for data analysis involved the use of descriptive and inferential statistics (Analysis of Covariance and Multiple Classification Analysis).

III. Results and Discussion

Table 1: Analysis of Covariance (ANCOVA) of Post-test mean scores by treatment, possession of Textbooks and Family Size of achievement in Mathematics.

Sources of variation	Sum of squares	df	Mean square	F ratio value	F sign.	Remark
Covariates	858038	1	858.038	13.815	.000*	S
Main effects (combined)	5241.242	3	1747.081	28.129	.000*	S
Treatment	877.816	1	877.816	14.134	.000*	S
Possession of textbook	3180.835	1	3180.835	51.214	.000*	S
Family Size	2131.978	1	2131.978	34.327	.000*	S
2-way interactions	583.543	3	194.514	3.132	.026*	S
Treatment x Possession	212.984	1	212.984	3.429	.065	NS
Treatment x Family Size	1.661	1	1.661	0.027	.870	NS
Possession x Family Size	240.396	1	240.396	3.871	.000*	S
3-way interactions						
Treatm x Possession x Family	264.511	1	246.511	4.259	.040*	S
Model	6947.333	8	868.417	13.982	.008*	S
Residual	14843.986	239	62.109			
Total	21791.319	247	88.224			

Significant effect ($P < 0.05$).

Where: S = Significant

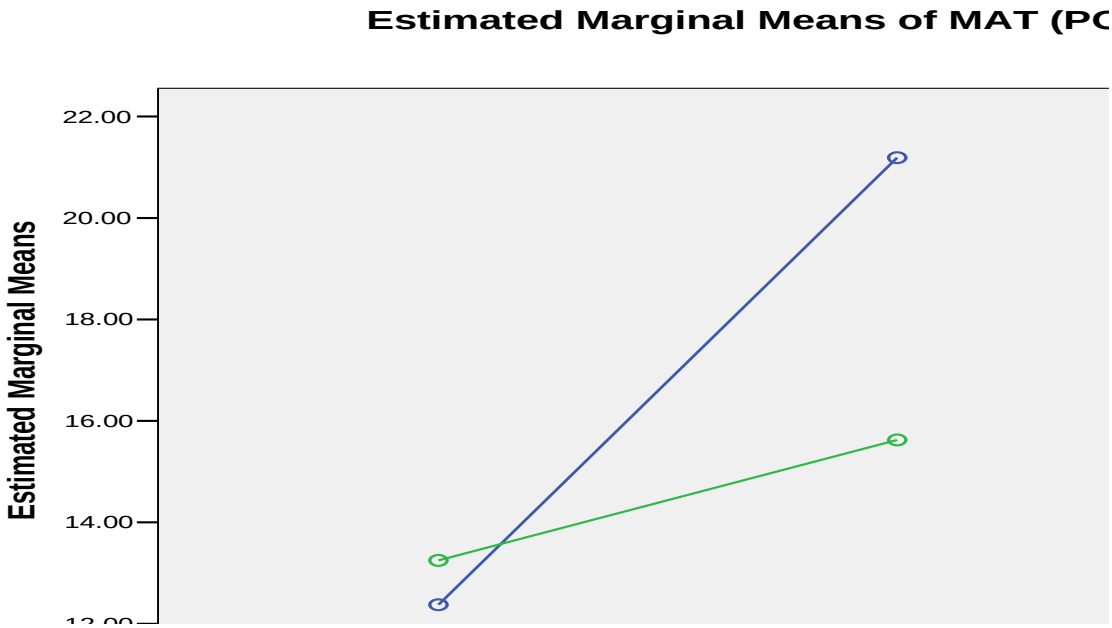
NS = Not Significant

Table 2: Multiple Classification Analysis (MCA) of Students' Achievement Mathematics according to treatment, possession of Textbooks and Family Size

Grand mean = 16.198

Variable + Category	N	Unadjusted deviation	Eta	Adjusted for indep + cov deviation	Beta
Treatment					
Experimental	135	2.595	.303	1.859	.217
Control	113	-3.100		-2.221	
Possession					
Non textbook	82	-4.368	.328	-5.557	.417
Possessed textbook	166	2.158		2.745	
Family Size					
Small	138	-1.516	.181	-2.826	.338

Large	110	1.902		3.545	
Multiple R squared Multiple R	.280 .529				



Small size = Blue Large Size = Green

Figure 1: Interactive effect of students' possession of Textbooks and Family Size on Students' Achievement in Mathematics

Hypothesis 1: There is no significant main effect of: (a). treatment; (b). students' possession of Textbooks and (c).family size on Students' Achievement in Mathematics.

To test for the Hypothesis 1 in respect of the main effects of Treatment, students' possession of Textbooks and Family size on Students' Achievement in Mathematics, the results of the Analysis of covariance (ANCOVA) as presented in Table 1 was used. The result in Table 1 revealed a significant outcome in respect of the main effect treatment on achievement in Mathematics ($F_{(1,239)} = 14.13$; $P < 0.05$). This implies that there is a significant main effect of treatment on the Students' Achievement scores in Mathematics. In order to determine the magnitude of the mean achievement scores of students' exposed to the treatment conditions, the results of the Multiple Classification Analysis (MCA) presented in Table 2 was used. The results revealed that with a grand mean of 16.198, the experimental group (TAVI) had an adjusted mean score of 18.057 (16.198 + 1.859) while the control group (TGM) had an adjusted mean score of 13.977 (16.198-2.221). This shows that the experimental group is significantly better than the control group with respect to Students' Achievement in Mathematics. The table 2 also presents a value of Beta for the treatment as 0.217 which implies that the treatment accounts for 4.709 percent $(0.217)^2$ x100% of the variation in the observed achievement in Mathematics. The result is in line with the findings of Adedayo (1995) that the post test mean score of interactive learning group materials was higher than those in the other two groups (individual use of materials and lecture method). In addition, Laws and Horsley (2007) found that there is a significant main effect of visual teaching models on the learning outcomes in Mathematics. The finding is also supported by Alebiosu (1998) which confirmed that two cooperative learning models (Jigsaws I and II) are main effects on Junior secondary school Students' Achievement in chemistry. In the study, Ifamuyiwa (2001) claimed that the students that used the packages cooperatively significantly achieved better grades Mathematics than those that used the packages competitively and individually. Research of Treas (1981) and Maria (2001) showed that the students' individualistic group did not enjoy this opportunity because there is no social support and increased cognitive complexity caused by the social interaction on a team-assisted setting.

Concerning the main effects of possession of Mathematics Textbooks on Students' Achievement in Mathematics, the result revealed that the outcome was significant ($F_{(1,239)} = 51.24$; $P < 0.05$). In order to determine the magnitude of the mean achievement scores of students' possession of Textbooks conditions, the results of the Multiple Classification Analysis (MCA) presented in table 2 was used. For the main effect of possession of Mathematics Textbooks, the non-possession of Textbooks had an adjusted mean score of 10.641 (16.198 - 5.557), while possession of Textbooks group had an adjusted mean score of 18.943 (16.198 + 2.745).

This shows that the students who also possessed Mathematics Textbooks significantly performed better than the students' without Mathematics Textbooks with respect to achievement in Mathematics. The value of Beta for the possession of Mathematics Textbooks as 0.417 which implies that possession of Mathematics Textbooks only accounts for 17.389 percent $(0.417)^2$ x100% of the variation in the Students' Achievement in Mathematics. The results confirmed the studies of Iroegbu (2000) and Maria (2001) that the readability level of Mathematics Textbooks has an effect on the performance of students in Mathematics. Nevertheless, the result contradicted Ifamuyiwa's (2001) study that the self-instructional mode group significantly achieved better in Mathematics than the Textbooks mode group.

Concerning the main effects of Family Size on Students' Achievement in Mathematics, the result revealed that the outcome was significant ($F_{(1,239)} = 34.327$; $P < 0.05$). In order to determine the magnitude of the mean achievement scores of students' Family Size conditions, the results of the multiple classification analysis (MCA) presented in Table 2 was used. For the main effect of Family Size, the small Family Size group had an adjusted mean score of 13.372 (16.198 - 2.826) while the large Family Size group had an adjusted mean score of 19.743 (16.198 + 3.545). This clearly revealed that students who came under large Family Size had better performance than students under small Family Size with respect to achievement in Mathematics. The table 2 also indicates a Beta value of 0.338 for the Family Size which implies that the Family Size alone accounted for 11.42 percent $(0.338)^2$ x 100% of the variation in Students' Achievement in Mathematics. This outcome contradicted the findings of Kessler (1991); Maria (2001) and Black, Devereux & Salvaries (2005) that large Family Size has negative effect on child learning outcomes. That is, children from large families have lower average education levels. In addition, Black, Devereux & Salvaries (2005) reported the extent to which children from different sized families influence educational attainment. He also found that children from smaller families were more likely to spend time in intellectual and cultural pursuits, to spend time playing alone, to have been read to, and to have had music or dance lessons. Hence, the three variables when combined (treatment, possession of Textbooks and Family Size) jointly accounted for 28.0% of the variation obtained in the students' school in Mathematics.

Hypothesis 2: There is no significant interaction effects of: (a). treatment and students' possession of Textbooks; (b).treatment and Family Size and (c).students' possession of Textbooks and Family Size on Students' Achievement in Mathematics.

To test for Hypothesis 2 in respect of the interaction effects of treatment and, students' possession of Textbooks, treatment and Family Size, and students possession of Textbooks and Family Size on Students' Achievement in Mathematics, the result of the Analysis of covariance (ANCOVA) as presented in Table 1 was used. The result in Table 1 revealed no significant outcome in respect of the interaction effect of treatment and students' possession of Textbooks on Students' Achievement in Mathematics ($F_{(1,239)} = 3.429$ at $P > 0.05$). This implies that there is not significantly affected by the interaction effect of treatment (TAVI and TGM) and possession of Textbooks on the Students' Achievement scores in Mathematics.

Concerning the interaction effects of treatment and Family Size on the Students' Achievement in Mathematics, the result in table 1 revealed no significant outcome in respect of the interaction effects on the Students' Achievement in Mathematics ($F_{(1,239)} = 0.027$, $P > 0.05$). Therefore, there seems to be no significant interaction effects of treatment and Family Size on the Students' Achievement in Mathematics.

However, there is significant interaction effect on the possession of Textbooks and Family Size on Students' Achievement in Mathematics (($F_{(1,239)} = 3.871$; $P < 0.05$). Moreover, Figure 1 revealed the mean of interaction effect on the possession of Textbooks and Family Size on Students' Achievement in Mathematics. It also indicated that students who had Mathematics textbooks performed better than those who did not have Mathematics Textbooks in the small Family Size. However, the Figure 1 showed that students with Mathematics Textbooks performed lower than students without Mathematics Textbooks in the large Family Size. Studies reported that the constructs of knowledge and attitudes are significantly influenced by several variables that abound within an individual's environment. Some of such variables are income, educational attainment, location, employment status, family size (Jordan & Joanna, 1997).

Hypothesis 3: There is no significant interaction effect of treatment, students' possession of Textbooks and Family Size on Students' Achievement in Mathematics.

To test for Hypothesis 3 in respect of the interaction effect of treatment, students' possession of Textbooks, and Family Size on Students' Achievement in Mathematics, the results of the Analysis of covariance (ANCOVA) as presented in Table 1 was used. The result in Table 1 revealed a significant outcome in respect of the interaction effect of treatment, students' possession of Textbooks and Family Size on Students' Achievement in Mathematics ($F_{(1,239)} = 4.259$ at $P < 0.05$). This implies that treatment (TAVI and TGM), possession of Mathematics Textbooks and Family Size have significant influence on the Students' Achievement in Mathematics.

Conclusion and Recommendations

TAVI is more effective in promoting Students' Achievement in Mathematics. Therefore, Mathematics teachers should be encouraged through seminars to teach their students Mathematics using TAVI and students should be encouraged by their teachers to purchase relevant Textbooks when they use TAVI irrespective of Family Size. This will facilitate uniformity in teaching, learning and assessment. This will help students to gain knowledge of the subject matter and aid the development of good problem-solving culture.

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