
Resuscitating students' attitude toward mathematics via computer-based software package instruction

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ABSTRACT

The poor attitude of students towards mathematics in Nigeria has constituted a threat to national development, considering the important of mathematics in all facet of life. This study determines the effect of computer-based software on student's attitude towards mathematics-graph, using three groups taught with computer-based software, graphic organizers and conventional strategy (discussion method). Gender and computer self-efficacy were used as moderating variables to determine the existence gender disparity in attitude towards mathematics when computer-based software was used and to establish the effect of computer self-efficacy on students' attitude towards mathematics when taught with computer-based software. The result shows that computer-based software was more effective in enhancing attitude towards graphs than graphic organizer and conventional strategy. There was also significant interaction effect of treatment and computer self-efficacy; treatment and gender; treatment, computer self-efficacy and gender on attitude towards graphs. computer-based software was found to significantly improve students' attitude towards graphs than the conventional strategy. Therefore, computer-based software for use in teaching Mathematics in secondary schools in Nigeria. To this effect mathematics teachers should be trained on the design, development and use of computer assisted instruction package in teaching.

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1. INTRODUCTION

Mathematics is a subject that is present in every sphere of human endeavor (Aikenhead, 2021; Kunwar, 2020; Ogunleye, 2019). There is almost no activity or development that can take place without mathematics. From simple activities of running homes, carrying out day-to-day personal budgeting, going about life and living to complex issues like marketing, technological, scientific and industrial development including inventions, mathematics is utilized in one way or the other, mathematics is all around us (Stokdyk, 2020).

The importance of mathematics notwithstanding, students' attitude towards mathematics is poor. Specifically, graph construction (drawing of graphs) and interpretation is an area of Mathematics which many students are deficient (Gheith & Aljaberi, 2015). Study conducted with secondary school students showed that all the participants performed poorly at all levels of

graph interpretation and described the situation as worrisome, considering the importance of graph interpretation in the economy (Ali, 2013) and this was reflective of their attitude towards the concept.

Considering the importance of graphs in economic, scientific and technological development, it is crucial that strategies that will improve graphing skills and attitude of learners should be employed in teaching the concept. Students attitude towards mathematics is very poor (Bhatti, 2019; Chand et al., 2021; Kunwar et al., 2021). It is greatly related with achievement in the subject (Hashim et al., 2021; Kennedy, 2019). Teaching strategy was noted to have great influence on students' attitude towards mathematics (Elçi, 2017). The attitude towards graphs for students of ages 13 to 15 years was observed to be poor (from negative, neutral to moderately positive) depending on learning experience (Wu & Wong, 2007). Students' attitude towards graph construction and interpretation is reflected in their achievement as those with positive attitudes have higher scores in achievement test (Kennedy, 2019). However, the issue of disparity in attitude towards mathematics and graph based on gender has been studied and there exists significant gender difference in attitude toward mathematics and graph in favour of boys (Mahanta & Islam, 2012).

Computer-based software program is a set of programmed instructions designed to inform the computer to do whatsoever it is required to do. The use of computer in teaching and learning has been found to have positive impact on the attitude of learners Shamsuddin, Aminu, Shamsiyya, & Adamu (2017) as a result computer-based software package is used in teaching graphs in comparison to graphic organizer and conventional strategy using gender and computer self-efficacy as moderator variables in this study.

The poor performance of students in mathematics in public examination has been a thing of concern. Despite mathematics being a core and compulsory subject at the secondary school level of education and a prerequisite for gaining admission to many disciplines in the tertiary institutions in Nigeria, students exhibit negative attitude towards mathematics. The students' attitude towards algebra, trigonometry and statistics has been noted to be very poor. One of the topics in mathematics in which students' poor attitude is clearly noticed is graph. Students' attitude towards graphs is unsatisfactory. They are observed to demonstrate poor attitude towards constructing and interpreting graphs of quadratic expression, trigonometric functions and cumulative frequency (ogives). The cause of this is partly due to the continuous use of conventional teaching strategy to teach graphs. Despite regular workshops, seminars and other forms of in-service training conduct by the government, national and international mathematical agencies for teachers of mathematics to improve the teaching of mathematics, it has not yielded good result. The use of computer-based software package instruction in teaching mathematics and graph have not been employed by teachers in Nigeria. This is one of the causes of students' poor attitude towards graphs. In this study computer-based software package instruction is used in teaching graphs to ensure a positive change in attitude.

2. METHOD

This study adopted a pretest-posttest, control group, quasi-experimental design with a $3 \times 3 \times 2$ factorial matrix. Six secondary schools in Ogba/Ndoni/Egbema local Government of Rivers State of Nigeria were purposively selected for the study based on the availability of qualified and experienced mathematics teachers and a well-equipped computer laboratory. One intact class of senior secondary school class two was randomly selected from each school for the study. The classes were randomly assigned to treatment groups such that two intact classes each

was for experimental groups and controlled groups.

The areas of concentration were graphs of quadratic expression, trigonometry functions and cumulative frequency (Ogives). However, solutions to simultaneous and quadratic equations by graphical methods, plotting and interpretation of graphs, calculation of the gradient and intercept of graphs, calculation of maxima and minima of functions and location of points on the curves were treated. The moderating effect of gender and computer self-efficacy attitude were also determined. Some students learned with the help of computer software package, draw and interpret the various graphs and answer questions given to them as drill and simulations, while other used graphic organizer and conventional strategy.

The instruments used for data collection were: (i) Attitude towards Graphs Scale (AGS) (ii) Computer Self Efficacy Scale (CSES) (iii) Computer-based Software Package Instruction (CSPI) (iv) Instructional Guide for Computer-based Software Package Instruction (CSPI) (v) Instructional Guide for Graphic Organizer Aided Instruction (GOAI) (vi) Instructional Guide for conventional classroom Instruction on Graphs (CCIG)

Attitude scale of 25 items was given to the subjects before and after the lessons. Computer self-efficacy of twenty-five (25) items was given to all the students before the treatment. They were both constructed using five points Likert scale and were properly validated.

The experiment was carried for six weeks and data collected were analyzed using Analysis of Covariance (ANCOVA) and Sheffe's post hoc test was used to determine the significance of main effects and interaction.

3. RESULTS AND DISCUSSION

One of purpose of this test is to see the effect of treatment on students' attitude towards graphs. After processing data and statistical tests on the results of observations during the experiment, Table 1 is obtained.

Table 1. Summary of 3x3x2 Analysis of Covariance (ANCOVA) of Posttest Attitude by Treatment, Gender and Computer Self Efficacy

Dependent Variable: POSTATTITUDE

Source	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected model	45794.306 ^a	17	2693.783	172.033	.000	.913
Intercept	910812.230	1	910812.230	58167.190	.000	.995
Treatment	32149.413	2	16074.707	1026.579	.000	.881
Gender	247.953	1	247.953	15.835	.000	.054
Selfefficacy	5854.820	2	2927.410	186.953	.000	.574
Treatment x gender	143.056	2	71.528	4.568	.011	.032
Treatment x selfefficacy	1590.607	4	397.652	25.395	.000	.268
Gender x selfefficacy	46.309	2	23.154	1.479	.230	.011
Treatment x gender x selfefficacy	148.569	4	37.142	2.372	.053	.033
Error	4353.069	278	15.659			
Total	1129109.000	296				
Corrected total	50147.375	295				

a. R Squared = .913 (Adjusted R Squared = .908)

Significant at p < .05

Table 1 shows that there is a significant main effect of treatment on students' attitude towards graphs ($F_{(2,295)}=1026.58$; $p<.05$). Table 2 presents the estimated marginal posttest attitude mean scores of the treatments.

Table 2. Estimated Marginal Mean Scores of Students' Attitude across the Group

Treatment	N	Mean	Std. Error
CONTROL(Conventional Strategy)	100	46.177	.414
EXP 1 (Interactive BASIC Programmed Package)	97	72.663	.413
EXP 2 (Graphic Organizer)	99	58.718	.447

Table 2 shows that students exposed to Interactive BASIC Programmed package higher adjusted Attitude mean score ($\bar{x} = 72.663$; SE = 0.413) than those exposed to graphic organizer ($\bar{x} = 58.718$; SE = 0.447) and the conventional strategy ($\bar{x} = 46.447$; SE = 0.414). This information is represented in Figure 1.

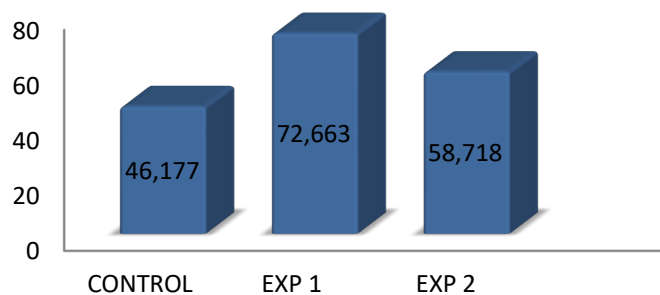


Figure 1. Pictorial representation of the adjusted posttest attitude scores across the groups

In order to determine the source of the significant difference among the groups, Table 3 presents the pairwise comparison based on Scheffe's post hoc test.

Table 3. Scheffe pairwise comparison of posttest attitude across the groups

Treatment	Mean Score	Control	Exp.1	Exp. 2
Control	49.669		*	*
Exp. 1	67.288	*		*
Exp.2	53.639	*	*	

*pairs of groups significantly different at $p < .05$

Table 3 shows that, the significant difference obtained as a result of significant difference between Control group and Experimental 1; Control group and Experimental group 2; Experimental groups 1 and 2. This implies that students exposed to Interactive BASIC Programmed Package Instruction performed significantly better than those exposed to Graphic Organizer Aided instruction, and Conventional Strategy. Likewise, students exposed to Graphic Organizer performed significantly better than those in Control Group. As a result all three pairs of groups contributed significantly to the effect of treatment on attitude towards graphs.

As we know from Table 1, it is observed that there is significant main effect of Computer Self Efficacy on students' attitude towards graphs ($F_{(2,295)} = 186.953$; $p < .05$). Therefore hypothesis HO_2 (b) is rejected. There is significant difference in the attitude of students with high, moderate and low computer skills towards graph. The estimated marginal mean attitude inventory scores based on the various levels of computer self-efficacies are shown in Table 4.

Table 4. Estimated Marginal Mean Attitude Scores of Students with low, moderate and Computer Self-Efficacy

COMPUTER SELF-EFFICACY	N	Mean	Std. Error
Low	68	53.314	.495
Moderate	99	59.243	.406
High	129	65.002	.362

Table 4 shows that students with high Computer skills had higher Attitude score ($\bar{x} = 65.002$; SE =0.362) than those with moderate computer skills ($\bar{x} = 59.243$; SE =0.406) and low computer skills ($\bar{x} = 53.314$; SE =0.495); whereas those with moderate computer skills performed better than students with low computer skills in attitude inventory. The representation of Attitude inventory scores based on the levels of computer self-efficacy is given in Figure 2.

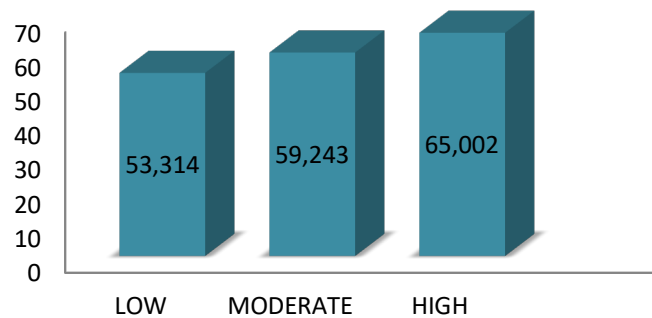


Figure 2. Pictorial Representation of the Adjusted Post Attitude Scores across the Different levels of Computer Self-Efficacy.

To determine the source of significant difference among the three levels of computer self-efficacy, Table 5 presents the pairwise comparison of Scheffe post hoc test carried out.

Table 5. Scheffe Pairwise Comparison of Post Attitude across the levels of Computer Self-Efficacy

Computer Self-Efficacy	Mean Score	Low	Moderate	High
Low	53.314		*	*
Moderate	59.243	*		*
High	65.002	*	*	

*pairs of groups significantly different at $p < .05$

Table 5 shows that the significant difference is due to the significant difference obtained in the attitude inventory scores between students with low and moderate computer skill; moderate and high computer skills; and low and high computer skills.

The answer of another question in the test as shown from Table 1 reveals that there is significant main effect of gender on students' attitude towards graphs ($F_{(1,295)} = 15.835$; $p < .05$). Therefore H_{O3} (b) is rejected. Table 6 shows the estimated mean scores of male and female students on attitude towards graphs.

Table 6. Estimated marginal mean scores of male and female students attitude towards graphs

Gender	N	Mean	Std. Error
Male	153	60.163	.340
Female	143	58.210	.354

From Table 6 male students obtained higher attitude mean score ($\bar{x} = 60.163$; $SE = 0.340$) than their female counterpart ($\bar{x} = 58.210$; $SE = .354$).

The next thing reveals from Table 1 that there is a significant interaction effect of treatment and computer self-efficacy on students attitude towards graphs ($F_{(4,295)} = 25.395$; $p < .05$). Therefore H_{04} (b) is rejected. Figure 3 shows the direction of the interaction effect. At all levels the attitudinal change of subjects in Experiment 1 was higher, followed by Exp2.

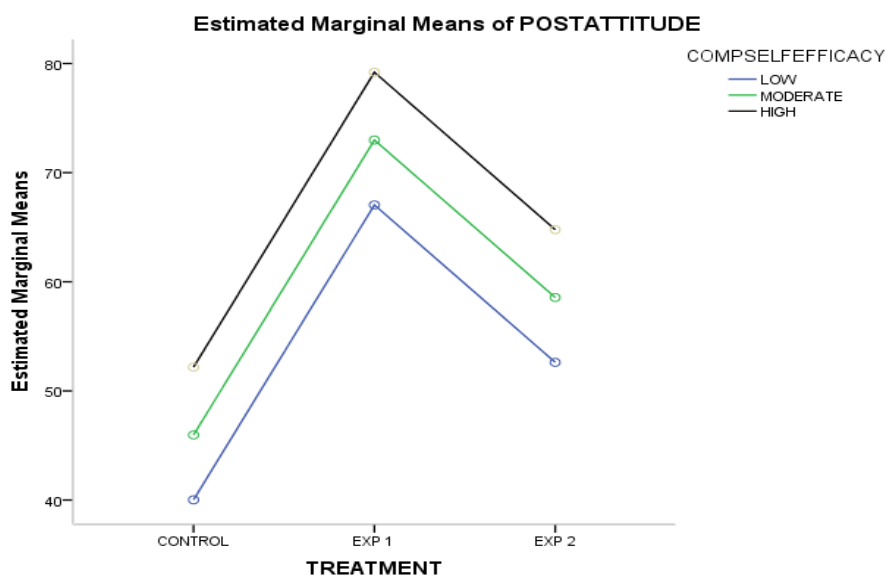


Figure 3. Pictorial representation of interaction of treatment and computer self-efficacy on attitude

Table 1 reveals that there is significant interaction effect of treatment and gender on students' attitude towards graphs ($F_{(2,295)} = 4.568$; $p < .05$). Figure 4 shows the direction of the interaction effect. The attitudinal change of subjects in Experiment 1 was higher, followed by Exp2. There exists significant gender difference in attitude of all the groups in favour the male gender.

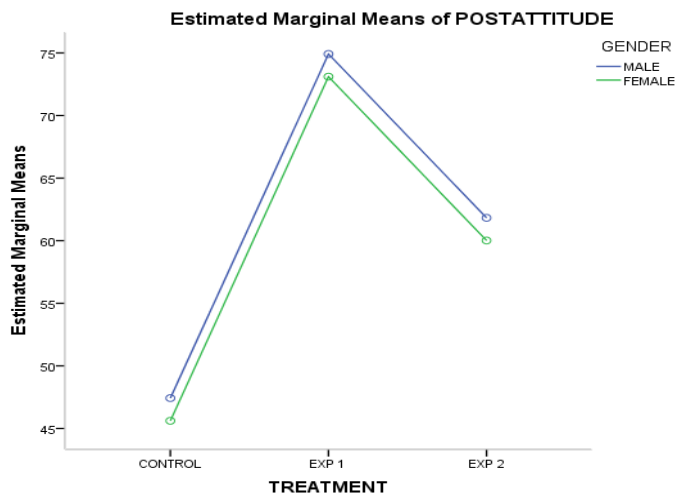


Figure 4. Pictorial representation of interaction of treatment and gender on attitude

Again, Table 1 show that there is no significant interaction effect of gender and computer self-efficacy on students' attitude towards graphs ($F_{(2,295)} = 1.479$; $p < .05$). Figure 5 shows the direction of the interaction effect.

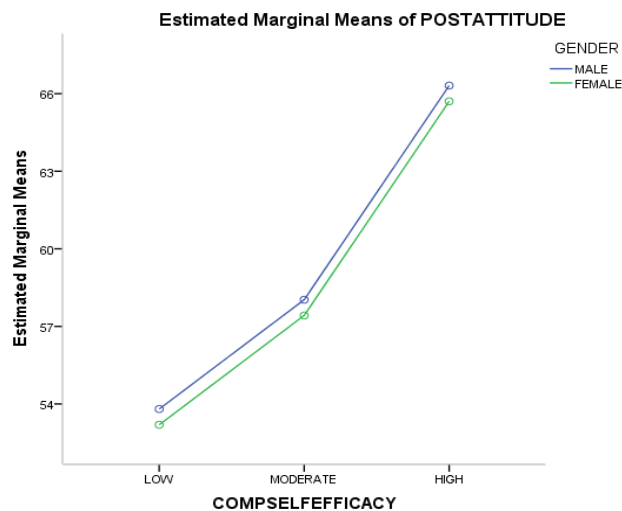


Figure 5. Pictorial Representation of Interaction of Gender and Computer Self-efficacy on attitude.

The last answer, Table 1 reveals that there is significant interaction effect of treatment, gender and computer self-efficacy on students' attitude towards graphs ($F_{(4,295)} = 2.372$; $p < .05$). Figure 6 shows the direction of the interaction effect.

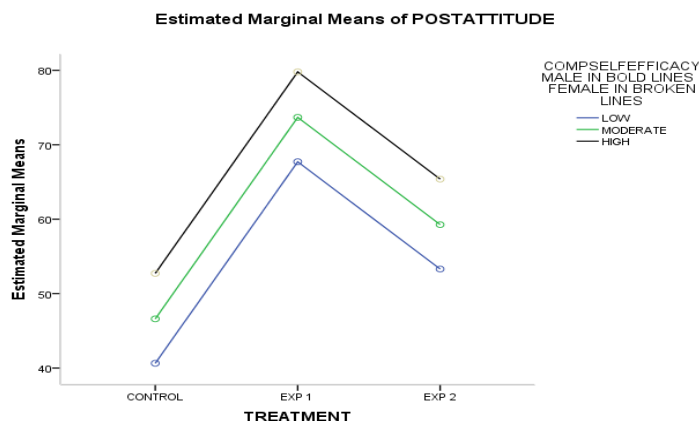


Figure 6. Pictorial representation of interaction of treatment, computer self-efficacy and gender on attitude

Based on the result of the study, the following statements summarize the findings: (1) There is significant main effect of treatment on students' attitude towards graphs. Interactive BASIC programmed package is more effective in enhancing students' attitude towards graphs than graphic organizer and conventional strategy, while graphic organizer is more effective than conventional strategy in boosting students' attitude towards graphs. (2) There is significant main effect of Computer Self Efficacy on students' attitude towards graphs. (3) There is significant main effect of gender on students' attitude towards graphs. (4) There is significant interaction effect of treatment and computer self-efficacy on students' attitude toward graphs. (5) There is significant interaction effect of treatment and gender on students' attitude towards graphs. (6) There is significant interaction effect of gender and computer self-efficacy on students' attitude towards graphs. (7) There is significant interaction effect of treatment, gender and computer self-efficacy on students' attitude towards graphs.

The result obtained from this study shows that students exposed to interactive BASIC program package had higher attitude mean score than those that were taught using graphic organizer and conventional strategy; whereas those that were taught using graphic organizer had higher mean attitude mean than those exposed to conventional strategy. The interactive BASIC program package strategy was more effective in effecting positive attitudinal change in learners than the graphic organizer and conventional method of instruction; while the graphic organizer proved to be better than the conventional method in effecting change in learners' attitude towards graph. This could have been due to the fact that the students were favourably disposed to interactive BASIC program package haven offered the opportunity to learn with the computer. It gives them the opportunity to learn at their pace as well as interact with the graphs that are similar to the one drawn in the book.

The finding of this study is in line with that of Acalajado (2011) who observed that teaching with computer assisted instruction(CAI) package was capable of increasing attitude of learners. It also contradicts the finding of Downs (2003) and Ragasa (2008) who claimed that they did not observe any significant difference in the attitude of learners taught with CAI and those taught with conventional strategy. The result might have been due to poor design of the instruction. Similarly, graphic organizer is also found to be more effective than the conventional strategy in boosting attitudinal change in learners. In this study students who learned with the help of graphic organizer are observed to acquire high positive attitude towards graphs than those taught with conventional strategy. Therefore the finding of the study confirmed that of Irvine

(2020) and Tella (2013) who observed that graphic organizer have the capability of enhancing development of positive attitude towards mathematics.

Three categories of computer self-efficacy, high, moderate and low were used in the study. There is significant main effect of computer self-efficacy on students' attitude towards graphs. The mean attitude scores of students with high, moderate and low computer self-efficacy is significantly different. Students with high computer self-efficacy have higher attitude score than those with moderate and low computer self-efficacy, while those with moderate computer self-efficacy have higher mean attitude score than those with low computer self-efficacy score.

The findings of this study support that of Ozden, Aktay, Yilmaz, & Ozdemir (2007), Ersoy & Akbulut (2014), as well as Kalemoglu Varol (2014) who affirmed that there exist a high correlation between computer self-efficacy and attitudinal change. Stanley & Pollard (2013), Sure (2009) and Brown (2008) also support that self-efficacy relates positively to attitude.

The study equally revealed that there is significant main effect of gender on students' attitude towards graphs. The result shows that the estimated mean scores of male and female students on attitude towards graphs are different. The male had mean score of 60.163 and female 58.210 giving F ratio of $F(1,295) = 15.835; p < .05$. This shows that there is a significant difference in achievement of male and female students, with scoring higher. This implies that the male developed higher positive attitude towards graphs than the females after the treatment.

The finding of this study on the effect of gender on attitude towards graphs is supported by Singh & Imam (2013), Mahanta & Islam (2012), Bassey, Joshua, & Asim (2008), Oswald (2009), Opolot-Okurut (2005), and Wood, Wood, Boyd, Bracey-Lorenzo, & Lambright (2011) who asserted that there is significant gender difference in attitude towards mathematics among students in favour of male. The male always dominates over female in terms of their attitude scores.

The result shows that there is significant interaction effect of treatment and computer self-efficacy, treatment and gender, on students' attitude towards graphs. However, there is no significant interaction effect of gender and computer self-efficacy on students' attitude towards graphs. This implies that computer self-efficacy has significant influence on the attitude of male female and students towards graphs but do not affect achievement significantly on gender basis.

4. CONCLUSION

The study demonstrated that interactive BASIC program package as well as graphic organizer teaching strategies are both effective in improving students' achievement and attitude towards graphs. This is due to the fact that both teaching strategies enable learners to develop self-confidence in terms of their ability and self-effort. The inbuilt drill and interactive exercises in the interactive help the learners understand faster while the sequential presentation facts in graphic organizer is aid the students to learn with ease. Though significant improvement in attitude was observed it was also noted that there still exists gender difference in attitude of learners in all the groups. The use of interactive packages and graphic organizer in teachings mathematics is capable resuscitating attitude towards mathematics and should be used by the teachers.

Based on the results of this study, the following recommendations are made. Interactive computer packages written in acceptable computer language are recommended for use in teaching mathematics. The packages should be used in teaching different topics in mathematics which conventional method cannot adequately address. Instructional programming should be introduced into mathematics teacher education curriculum. Under this mathematics teachers

should be equipped on how to write simple computer program that can be used in teaching some mathematics topics that involves graphics, two dimensional and three dimensional shapes.

Mathematics teachers should be trained on how to write instructional program in BASIC, Lisp, python and other programming languages. This should be to enable them produce their instructional packages when needs arise. Mathematics teachers, who cannot write computer based instructional program, should design the instruction and sit side by side with a computer programmer to develop the package. This is because it is difficult for a programmer who is not a teacher to be able to develop a package that can sufficiently address learners' needs.

Interactive packages should be developed from good note of lessons for it to be effective. The teacher or the programmer should ensure that every component of the instruction is captured in the package. For the purpose of effective teaching mathematics and other subjects each school should have computer laboratory well equipped with at least 50 to 100 microcomputers. There should also be computer operators, technicians and programmers employed to maintain the laboratories and make them useful for the purpose of teaching and learning. It is important to note that it is only where the conventional strategy is not adequate that the use of computer should be employed in teaching and learning. Topics that can be taught effectively with conventional strategy do not require the use of computer because of the cost of effectively employing computer in teaching and learning.

Graphic organizer is also another strategy which is observed to be capable of enhancing achievement and attitude towards graphs. Mathematics teachers should employ graphic organizer either as advance organizer, post organizer or both in teaching so as to boost achievement and attitude towards mathematics. Mathematics teachers should be trained and retrained in the used of good strategies such as computer assisted instruction and graphic organizer in teaching.

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