# The Effect of Computer-Assisted Instruction on Achievement and Attitudes Toward Fundamentals of Algebra among College Freshmen

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## The Problem

The use of computers in education began in 1960 at the University of Illinois (Allen & Trolip, 1991). The Computer-based instruction integrated text and graphics, and provided institutions with one of the first programming environments for computer instructions.

In 1972, the Mitre Corporation (Meril, Schneider and Fletcher, 1991) introduced computer-based instruction on microcomputers and in 1981 the International Business Machine (IBM) released personal computers.

In the following years, more coursewares for computer-assisted instruction (CAI) were prepared by different companies; and several schools, colleges and universities made use of them.

Several studies were made in an attempt to evaluate the effectiveness of Computer-Assisted Instruction (CAI) as the number of educational users increased. Results of the studies were conflicting; for example, the Deborah Meems Johnson (1980), Rossel Davis (1991), Barbara Baxter (1988), Susan Partridge (1986), Sue Milne (1990), M. Zock (1989) and Frank Christ (1982) reported that computer-assisted instruction enhanced learning. On the contrary, Vivian Taylor Baker (1980), Deborah Rosencrans (1986), Victoria Dixon (1989), Kulik & Kulik (1985) and Bangart & Brown claimed that computer-assisted instruction could not have made a significant contribution to the enhance-

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ment of learning.

It is important to remember that computer-assisted instruction is a new approach and is fast evolving, and there is still much to be learned about the vast ways to use computers.

## Statement of the Problem

This study will compare the college freshmen performance in Algebra at Morgan State University, a predominately Black University. The two groups compared were those taught through computer-assisted instruction and those with the conventional method by a qualified college professor. Specifically, this study attempted to answer the following problems:

1. Is there a significant difference in the achievement between students taught through a computer-assisted instruction program (CAI) and those taught by conventional instructional method (CIM)?

2. Is there a significant association between instructional methods (CAI or CIM) and attitudes towards algebra?

Null hypotheses served as guide in seeking answers to the stated problems.

## Importance of the Study

Many educators share perception that computer technology and computer-assisted instruction will enhance learning. One of those who strongly advise educators and teachers about the use of computers in education is Dr. Wilson (1992) of Tula, Tennessee when he said:

> *... I don't think anyone can miss the reality that technology can take a wide variety of learning abilities and meet the individual learner's needs. Technology is just essential.*

The advice of Dr. Wilson was based on his observation about the enthusiasm of the students to study when a computer laboratory was established. Wilson further said:

> *We have found that students respond so well to the computers we have made available during the day that we've created a lab center, and that the teachers have access to it.*

By the year 2000, computers will become a major tool in education. Computers will cut across the whole complex educational program. Chin-Lin Kulik and James Kulik (1985) said:

> *Social commentators predicted that computer technology will change education in the years about as completely as the invention of writing and printing in centuries past. Computers can work in schools as drill masters, tutors, testers, and diagnosticians of educational problems. Recently, the cost of computer-based teaching systems stood in the way of wide-scale use. With the development of small, quick, inexpensive microcomputers during the last decade, computing costs have dropped dramatically, and so computer revolution in education becomes a real possibility.*

In Morgan State University, like any other learning institution for higher education, computer technology and computer-assisted instruction had been in place since 1985. Morgan State University (MSU) is an historically black University (HBCU). Its mission included service to African Americans and other cultural minorities. The mission of MSU is to develop all students; it means that the programs are made available to the intellectually advanced students for their quest of excellence, and to the slow performers so that they can reach the desired standards. This study is focused on the performance of the slow learners.

## Methodology

The topics discussed are the following: research methods used, subjects studied, brief description of the course covered in this study, (Fundamentals of Mathematics) methods in gathering the data, discussion about the tests, the questionnaire, and a brief discussion of the statistical tools used.

### Research Method Used

This study used a quasi-experimental design. Part one of the study used an experimental design. A pretest-posttest approach was applied. The pretest was needed to determine the entering capability and the posttest to determine the difference of the academic performance of the subjects.

Part two of the study used a descriptive method. It made use of a list of questions which the students responded. Problem two was classified as part two of the study and the Likert Scale was used to measure the variables.

**The Groups**

Two groups were formed. Group one consisted of half the 8 to 9 class and a half of the 9 to 10 class. This group was the experimental group; and was assigned to the students lab for the computer assisted instruction. A total of 34 students were assigned to this group. Group two, the control group consisted of the other half of the 8 to 9 class and the other half of the 9 to 10 class. Thirty four students composed this group. This group was assigned to stay in the classroom and received the conventional instruction in learning the course from a qualified faculty of Morgan State University.

**Subjects of the study**

The faculty of the Mathematics Departments were invited to participate in this experiment before the end of December, 1993. One faculty responded to this invitation and it was very good because she had two sections in one course entitled "Fundamentals of Mathematics". All students from the two classes came from the Freshmen Studies Program. The Student Advisement Office classifies students from this group as low performers, having low grade-point average (GPA). Suffice to say that all students of the two classes are homogeneously grouped.

**Sampling**

Although the subjects of the study belong to a homogeneous group, being classified under the student advisement program, sampling procedure in grouping was faithfully observed. As such, a systematic random sampling was employed in the process of grouping. First, the students were asked to count off. In this case, all those in the odd numbers, like 1,3,5 and so on belong to the RED group. They wrote their names on a sheet of paper. Students bearing the even number, like 2,4,6 and so on and were sitting alternately signed their names and the paper was labelled as BLUE. When all the students had signed their names, a representative of each group was asked to pick up a sheet from two equally folded papers, one containing a statement "go to the students' lab" and the other "stay with you teacher". This process was done in the 8 to 9 class and was repeated in the 9 to 10 class. Thus, the two groups were formed randomly.

The software used in the study in Algebra I. Algebra I is one of the items in the IBM advanced Mathematics Programs. A thorough review of the syllabus used by the faculty in Algebra was done by the researchers. The purpose of the review was to match the topics included in the syllabus with those found in the computer-assisted instruction software. Inasmuch as there were discrepancies in the topics covered between the syllabus and CAI program, final matching was

done by including topics for discussion in the CIM group with the topics found in the software. The result of the matching led to the uniformity of the topics taught by the teacher and those of the CAI. The following topics were included.

Syllabus for Math 106
Fundamentals of Mathematics

**Course Description**

This is a beginning Algebra course. This course is designed to help students with limited methematical background and who wish to major in an area where mathematics is a cognate. Math cognate includes Computer Science and Engineering. Topics in Math 106 include numbers, expressions, polynomials, exponents, radicals, linear equations and quadratic equations.

**Course Objectives**

The objectives of the course are to teach students the fundamentals of Algebra, to increase students' self confidence and self awareness about mathematics by reducing mathematics anxieties while also increasing mathematics competencies. This course offers a solid mathematical presentation of basic Algebra for students who have never studied Algebra and/or need a detailed review before attempting college level mathematics.

- *Constant and Variables*
  Symbols of Operations and Groupinig
  Algebraic Expressions
  Equations and Literal Expressions

- *Signed Numbers*
  Meaning of Signed Numbers
  Rules of Combining Signed Numbers
  Combing like terms

- *Equations*
  Types of Equations: conditional, identity and equivalent

  Solving Equations using division rule, substraction rule, addition rule and multiplication rule

Applications: problems solving linear equations

- *Solving Word Problems*
  From words to Algebra
  Solving word problems
  Number related problems
  Distance-rate-time problems
  Mixture problems

- *Systems of Equations and Inequalities*

  Points on a plane
  Graphing linear equations in two variables

  The slope of a line
  Graphing inequalities in two variables
  Solving a system of linear equations

  Graphical method
  Substitution method
  Addition method

- *Graphing linear equalities in two variables*
  Standard form of linear equation
  Solving word problems in two variables

## Results

To recall, three tests were administered to the student respondents in the study. The pretest was given before the study started; the midtest was conducted three weeks after the instruction and finally, the posttest was administered six weeks later. At this time, the total number of respondents was reduced to 67 from 68 because one of the CAI group withdrew from the class. The results of the three tests are shown in Table 1.

The pretest shows that the means of the computer-assisted instruction group of CAI and the Conventional Instruction Method of CIM are almost equal. The mean of the CAI group is 58.4167 while that of the CIM is 56. The slight difference which is 2.4167 is not significant; it is only due to chance. It can be claimed statistically that both groups performed equally in the pretest.

*Table 1. Pretest, Midtest and Posttest Results*

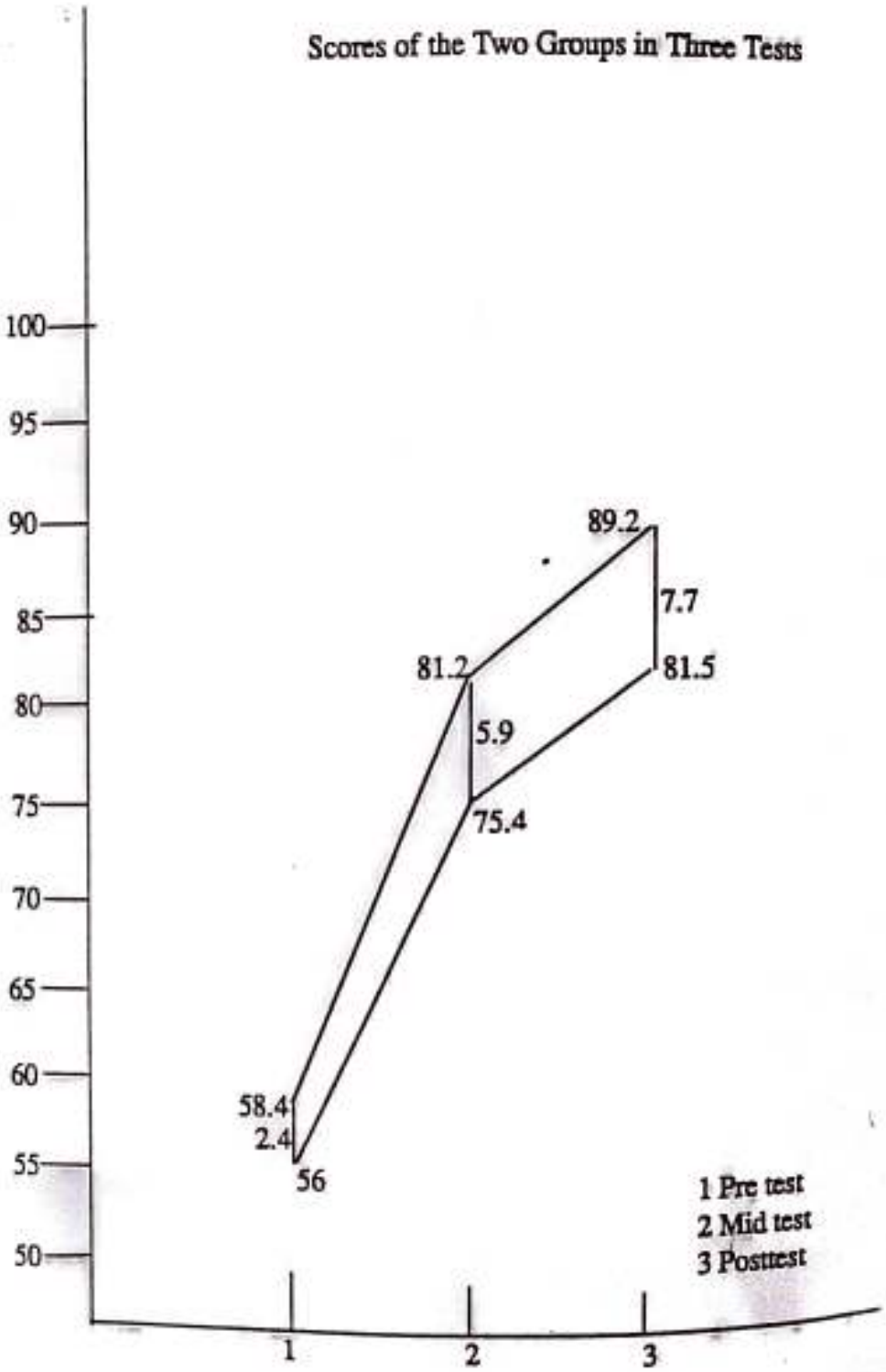
| Test | Mean | SD | SE of Means |
|---|---|---|---|
| **Pretest** | | | |
| CAI | 58.4167 | 18.298 | 5.282 |
| CIM | 56.0000 | 16.056 | 4.842 |
| | Levene's Test for Equality of Variance 2.98 T-test for Equality of Means .34 < .05 | | |
| **Midtest** | | | |
| CAI | 81.2353 | 12.980 | 2.226 |
| CIM | 75.3824 | 14.735 | 2.537 |
| | Levene's Test for Equality of Variance 2.57 T-test for Equality of Means 1.74 > .05 | | |
| **Posttest** | | | |
| CAI | 89.2258 | 7.852 | 1.410 |
| CIM | 81.4571 | 12.123 | 2.049 |
| | Levene's Test for Equality of Variance 0.14 T-test for Equality of Means [illegible] .05 | | |

The midtest results are shown in Table 1 under the subtitle "Midtest". The means of the CAI and CIM groups are 81.2353 and 75.3824, respectively. The difference of the means is 5.8529, greater at .05 level of significance. This finding shows that the CAI group obtained a higher score that the CIM group.

In the posttest, the CAI group obtained a mean of 89.2258 and the CIM 81.4571, or a difference of 7.825, greater than the critical value at .05 level of significance. In fact, the difference of the means in the posttest is wider than that of the midtest. Once again, it is seen that the CAI group obtained a higher score than the CIM group in the posttest, concluding that CAI group performed better than the CIM group in the two examinations.

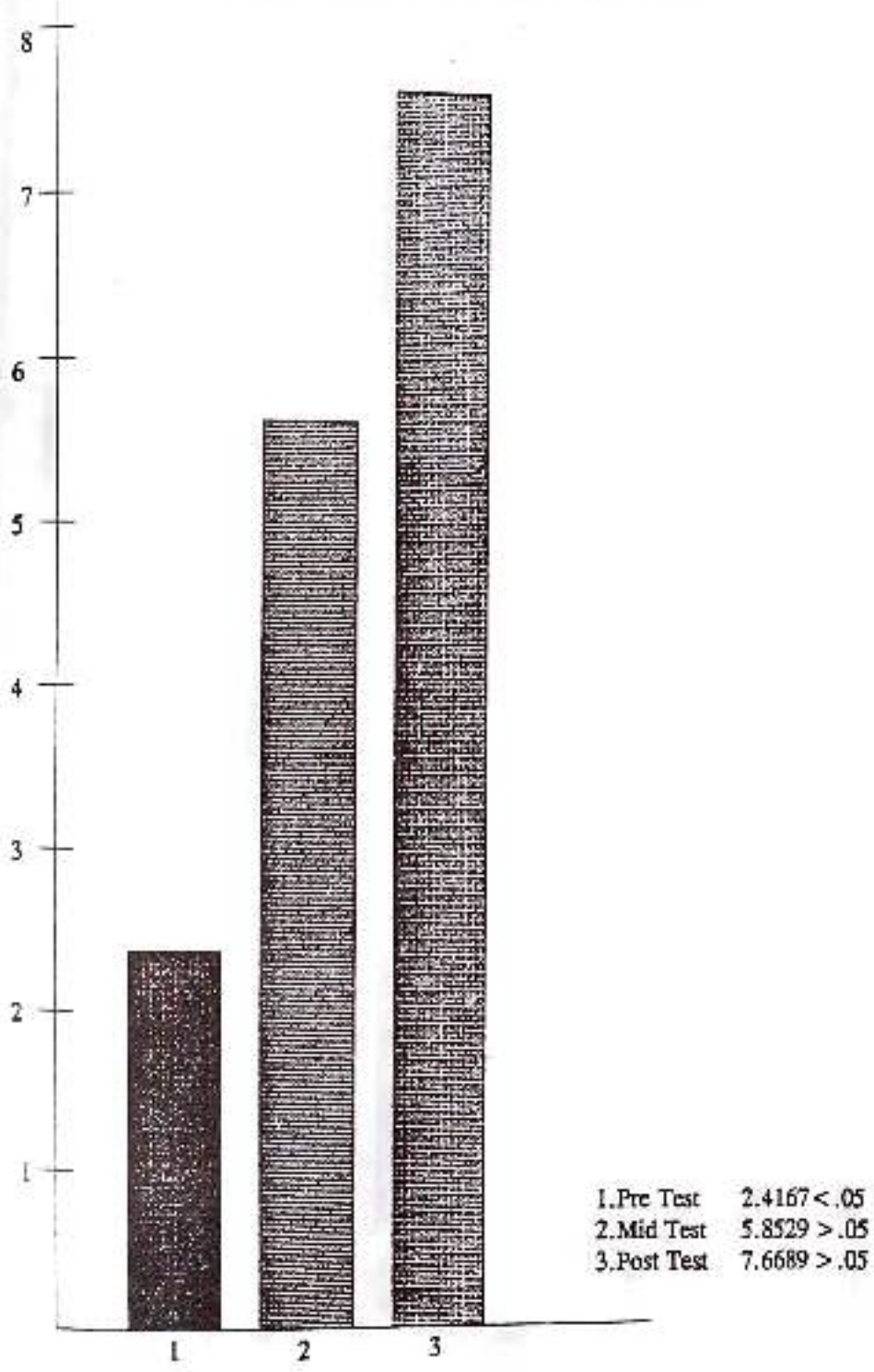
To illustrate the position of the scores from the pretest, midtest and the posttest, graphs are presented on the succeeding pages.

**Graph 1**



Graph 2

Bar Graph showing the Difference of Means



After the tests, the students were now free to use the computer as much as they like regardless of their group. The use of the computer was no longer limited to the computer-assisted instruction and was not specifically supervised. In about two weeks before the close of the semester, a questionnaire was administered to them, but they were still asked which group they belonged in the earlier part of the study. The purpose of the questions were to find out if grouping them in the CAI and CIM has changed their attitudes towards Algebra.

Eight items were finally chosen for this evaluation, and out of the eight, four yielded strong association. Chi-square was used in testing this hypothesis. Table 2 is presented.

Item one indicates that there is a strong association between the variable

*Table 2. Items having Strong Association*

| Items | Chi-Square Test | | Significance Level |
|---|---|---|---|
| Grp. with "Algebra is difficult subject" | Pearson<br>Phi | 5.7005<br>30481 | .695>.5<br>.672>.5 |
| Grp. with "I had fun learning the concepts of Algebra" | Peason<br>Phi | 4.33158<br>.26432 | .82604>.5<br>.82604>.5 |
| Grp. with "Broadly, I like Algebra" | Pearson<br>Phi | 3.25153<br>.22901 | .77668>.5<br>.77668>.5 |
| Grp. with "CAI can enhance grades" | Pearson<br>Phi | 6.50179<br>.32383 | .59121>.5<br>.59121>.5 |

"groups" as CAI and CIM, and the perception that Algebra is a difficult subject. The strength of the association is revealed through the computed values (Pearson 5.7605 and Phi .304781), whose significance levels are placed at .694 in Pearson and .672 in Phi respectively, and both are higher then the .5 level of significance. Raw data shows that respondents from the CAI group do not think that Algebra is a difficult subject as the respondents from the CIM group do. In effect, there is a significant discrimination in the responses of the two groups.

The next item informs that the variable "group" is also strongly associated with the item "I had fun learning the concepts of Algebra". This claim is

evidenced by the computed values (Pearson 4.33158 and Phi .26432), both of which yielded a significance level of .82604, greater than .5. Again, from the raw data, it is seen that the CAI group shows a more positive attitude towards algebra by partly enjoying their study of the course than the students from the CIM group.

The third item also exhibited an association that is acceptable at .5 level of significance. Here, the item "groups" is paired with "Broadly, I like Algebra". The strength of the association is seen when the computed values (Pearson 3.25153 and Phi .22901) are greater at .5 level of significance. Raw data also reveals that, like the previous items, the CAI group seem to "like" Algebra more than the CIM group.

The last item is "group" and CAI can enhance my grades. It can be seen that the computed values in both Pearson and Phi are greater at .5 level of significance; and indicate further that respondents from the CAI group believe that CAI enhanced their grades.

Three items have weak association. Table 3 is shown below.

All the items in Table 3 do not show a significant association with Algebra as a subject or course. The scores between the two groups do not discriminate from

*Table 3. Items Having Weak Association with Algebra*

| Items | Chi-Square Test | Significance Level |
|---|---|---|
| Grp. with "I like to solve problems in Algebra" | Pearson 10.2351<br>Phi .40540 | .42 < .5<br>.42 < .5 |
| Grp. with "I plan to choose algebra as my area of concentration" | Pearson 6.2911<br>Phi .31867 | .17810 < .5<br>.17810 < .5 |
| Grp. with "Algebra-confidence" | Pearson 13.551<br>Phi .46757 | .0944 < .5<br>.0944 < .5 |

each other because both groups share similar level of responses. The differences in the scores of both groups are found below the significance level and are therefore attributed only to chance. The raw data suggest that both groups "do not like to solve problems in Algebra", although CAI group seem to "like to study the concepts of Algebra". Both groups do not consider Algebra as an area of concentration" when they will choose their major subjects later. Both groups think

they are not confident in this field of discipline

## Summary of Findings

1. Students performed better in *Fundamentals of Algebra* with the use of Computer-assisted Instruction (CAI) than students (CIM group) who used the conventional (teacher-lecture) method

2. The variable "groups" as CAI and CIM is associated with the contention that Algebra is a difficult subject. Respondents from the CAI group perceived that Algebra is not as difficult as what the CIM group perceived it to be.

3. "Groups" is also associated with "fun" in studying algebra. CAI group had more fun studying the concepts of Algebra that the CIM group.

4. "Groups" is also associated with the perceptions that CAI can enhance grades. Respondents from the CAI group perceived that their grades can be enhanced with the help of computer-assisted instruction, however the CIM group do not seem to agree with them

5. No significant association is seen between the variable "groups" and the perception that respondents like to solve the problems in Algebra. Both the CAI and the CIM groups do not like to solve the problems in Algebra despite the fact that the CAI group likes to study the concepts of this discipline. It maybe recalled that this study was done for six weeks only

6. No significant association is seen between "groups" and the plan of the respondents to choose Algebra as a major field of study some years later. Both groups do not plan to choose Algebra as a major field of concentration when the time for them to decide their major field of study

## Conclusions

The null hypothesis stating that no significant difference exists in the performance between the CAI and CIM groups is rejected, because the findings show otherwise.

The null hypothesis stating that there is no significant association between the "groups" as CAI and CIM and the contention that Algebra is a difficult

subject is also rejected. Facts show that a significant association do exists and a discrimination between the scores of the two groups is established.

The null hypothesis which states that "groups" is associated with the item "I had fun learning the concepts of Algebra" is also rejected. A discrimination is seen between the scores of the two groups and that the CAI group had more fun in studying Algebra than the CIM group.

Inasmuch as the variable "groups" is associated with the item "that CAI can enhance their grades", the null hypothesis is also rejected. However, the variable "groups" is not associated with the item "I like to solve problems in Algebra", thus the null hypothesis is accepted. Similarly, no association was seen between the item "groups" and "I plan to choose Algebra as my concentration of study", therefore, the null hypothesis is also accepted.

## Recommendations

Inasmuch as the use of computer-assisted instruction helped in the performance of the students, this study recommends that teachers and students shall use this tool in their classes, specifically in algebra.

Teachers, especially in algebra shall get involved in evaluating and or choosing coursewares in computer-assisted instructional programs. Ultimately, they are the users of the program and are din the better position to identify the needs of their students and of the course, and therefore can choose the best software.

Further research is needed to find out if the findings of this study will also hold true in other disciplines and in other surrounding circumstances, and in a longer period of time.

Since this study found that students have low preference for Algebra, further research is needed to find out the positive motivational factors that will make Algebra an attractive field.

Administrators shall lead in the use of computer-assisted instruction and educational technology, inasmuch as the findings of this study show potential contribution to the learning level of the students.

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