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Effect of Using Computer - Assisted Instruction
in the Mathematical Practices on achieving the
Behavioural Objectives of a Mathematics Course
and on the College Students'
Attitudes Toward Computer Instruction

Prepared by

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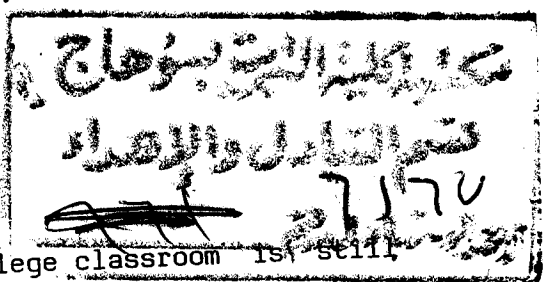
Introduction:

The possibility of using computer to help academic instruction has been known since the early 1960s. With the introduction of the microcomputer since the early 1980s, interest has been renewed in using computers with instruction (12,1).

The computer was considered an additional resource in teaching. Computers were used to assist instruction and as means toward individualized instruction.

The instructional modes of computer - assisted instruction included (6,10):

- (1) Drill and practice mode
- (2) Tutorial mode,
- (3) Simulation mode and
- (4) Problem solving mode.



Mathematics in the college classroom is still taught using only paper and pencil (1,4). This research

tried to recognize the effect of performing the mathematical practices by using computer - assisted instruction on the achievement of the behavioural objectives of math 105 course and on the college students' attitude toward computers.

Significance of the Research :

It has been recently urged that computer instruction (C A I) should take a greater role in education of every level of instruction.

This research aimed at using computer- assisted instruction in doing the mathematical practices the computers' effect on the achievement of math objectives and on the students' attitudes toward computers in math instruction. The research may be of value to instructors and educators in teaching math and using computer - assisted

Questions of the Research:

- 1- What is the effect of using computer - assisted instruction in the mathematical practices on college students' achievement of the behavioural objectives of the math 105 course ?
- 2- What is the effect of using computer - assisted instruction in the mathematical practices on the college students' attitudes toward computer instruction ?
- 3- Is there a correlation between the students'

achievement of the behavioural objectives of the math 105 course and their attitudes toward computer instruction in each of the research groups.

Hypotheses of the Research:

There are no significant differences between the computer group (experimental group -1), the computer - computer group (experimental group-2), and the no - computer group (control group) in the students' achievement of the behavioural objectives of the math 105 course.

There are no significant differences in the students' attitudes toward computer instruction between the three research groups.

There are no significant correlations between the college students' achievement of the behavioural objectives of the math 105 course and their attitudes toward computer instruction in each group.

Objectives of the Research:

This research was structured to achieve the following objectives:

To evaluate the students' achievement of the math 105 course objectives after doing the mathematical practices by using computer - assisted instruction .

To measure differences between the research

groups (Computer group, partial - computer group and no - computer group) in the attitudes toward computer instruction before and after the experimental treatment of the research.

- 3- To find the correlation between the students' achievement of the behavioural objectives of the math 105 course and their attitudes toward computer instruction in each of the research groups.

Sample of the Research:

- 1- The research sample was selected from the math college students, University of Tennessee at Chattanooga, U.S.A.
- 2- All enrolling students in the math 105 course were included in the research. However the students were randomly selected to be members of the experimental and the control groups.
- 3- The research included 40 students, and were divided randomly into three groups as follows:
the computer group (12 students), the partial - computer group (12 students), and the no - computer group (16 students).
- 4- The instructor of the math 105 course taught the three research groups.
- 5- Four demonstrators assisted the researcher in guiding the students of the sample in the computer laboratory.

Limitations of the Research:

- 1- This research was administered in the Faculty of Math, University of Tennessee at Chattanooga, U.S.A.
- 2- The mathematical practices were performed in the Faculty computer laboratory.
- 3- The experimental treatment in this research lasted about 15 weeks in the spring semester 1991 (from Jan. 2 to Apr. 24. Two weeks were excluded for the spring break).
- 4- The two experimental groups used computer software to perform the mathematical practices according to the experimental treatment in each group.
- 5- The researcher and the demonstrators guided the students who needed help in doing the mathematical practices in the computer laboratory.

Procedures:

- 1- Analysing the content of the math 105 course to recognize the content of each chapter in the course.
- 2- Defining the behavioural objectives of the math 105 course on the comprehension level according to the content analysis and Bloom's cognitive objectives, and examining it by the jury members.
- 3- Checking the computer software to know its relevance to the topics of math 105 course, and to the students' workbook.

- 4- Designing a pre - achievement test of the multiple choice type, which was examined by the jury members.
- 5- Applying the pre - test to the students who participated in the research groups before teaching the math 105 course.
- 6- Preparing an attitude scale to measure the students' attitudes toward computer instruction . It was examined by the jury members.
- 7- Administering the attitude scale to the three research groups before studying the math 105 course.
- 8- Carrying out the research experiment by teaching the math 105 course to the three research groups, and doing the mathematical practices according to the experimental treatment of each group.
- 9- Applying the post - test which consisted of open question, multiple choice, and true - false types after completing the research experiment to measure the behavioural objectives of the math 105 course.
- 10- Applying the attitude scale after completing the research experiment to measure the students ' attitudes toward computer instruction.
- 11- Correcting the pre - test, the post - test, and the attitude scale before and after the research experiment.

- 12- Analysing and explaining the results, and presenting some recommendations.

Definition of Terms:

Computer - Assisted Instruction (CAI): is the method of instruction utilizing a computer. CAI is basically divided into some categories such as drill and practice, tutorial, and problem solving.

Mathematical Practices by CAI: include the mathematical problems which are presented to the students after each topic of the math 105 course, and the students' solutions which are evaluated by the computer in the form of drill and practice with little or no researcher intervention.

The Objective : is an intent communicated by a statement describing a proposed change in a learner - a statement of what the learner is to be like when he has successfully completed a learning experience (5,57).

Math 105 : is the title of the math course which is used in the present research experiment.

Hardware: refers to the devices that physically enter, process, store, retrieve, and deliver data (13, 114),

Software: refers to the computer programmes that direct information processing operations performed by hardware (13,115). This research used applications software type.

Math comprehension: is the ability to connect mathematical symbolism and notation with appropriate rules and ideas.

Three Kinds of behaviour, which may be taken as evidence of math comprehension, are: translation , interpretation, and extrapolation (7.65).

Feedback: is an internal condition of learning which occurs when the student observes the correctness or appropriateness of his responses while engaged in the mathematical practices by computer.

Attitudes: include two types of components affective and cognitive. The affective components is basically an emotional perception of something. The cognitive component includes Knowledge, opinion, and belief. While an attitude is originally formed in the context of the affective and cognitive components, it can be influenced by behaviour related to the given attitude (9,11).

Behavioural Objectives:

The behavioural objectives of the math 105 were defined on the comprehension level according to the content analysis and Bloom's cognitive objectives . A question of the post - test was asked to measure one of these objectives. Some of these objectives were.

The students should be able to :

- 1- use the terms in ordering the arithmetic operations.

- 2- estimate the fractions by using whole numbers.
- 3- subtract the different square roots.
- 4- translate the verbal expressions into math expressions for finding the unknown in the problem.
- 5- find the vertical line equation through knowing a point on it.
- 6- analyse the third degree equations in one variable.
- 7- calculate the geometrical shape area from the drawing.

Design of the Research:

The research was designed as follows:

- 1- The three research groups received the pre - test and the attitude scale before studying the math 105 course.
- 2- The students did not use computers during any test, and computations were performed by using paper and pencil. Calculators were permitted to all participants during the mathematical practices and the tests.
- 3- The students in the experimental and control groups were instructed the math 105 course in the same way, and they solved the same mathematical problems on each chapter using either computer software or workbook.
- 4- The experimental groups received instruction on how to use the computer's hardware and software in the computer laboratory.

5- After finishing the mathematical practices of the math 105 course, the research groups received the post - test and the same attitude scale.

6- The research groups were:

a) Experimental group one (computer group):

This group practised to solve all mathematical problems on each chapter using the computer's software and the calculator. Each student worked individually on the computer. The computer group received feedback from the computer.

b) Experimental group two (partial - computer group):

Students of this group chose 50 percent of the mathematical problems on each chapter, and practised to solve them by using the computer and the calculator. They solved the other 50 percent of the mathematical problems on each chapter from the workbook by using paper, pencil and calculator. Each student worked individually while using the computer. This partial-computer group received feedback from the computer.

c) Control group (no - computer group):

This group attempted to solve all mathematical problems on each chapter from the workbook by using paper, pencil and calculator. This group did not receive any computer training or feedback from the computer.

Materials of the Research:

- (1) The pre - test was prepared by the researcher.
- (2) The attitude scale toward computer instruction (the first version) was prepared by the researcher.
- (3) The attitude scale toward computer instruction (the final version) was prepared by the researcher.
- (4) The computer software was prepared by the math department. It was checked by the researcher.
- (5) The post - test was prepared by the researcher.

The Pre - Test:

The objective of the pre - test was to make sure that there was no difference in the mathematical comprehension level between the research groups before performing the research treatments.

The pre - test consisted of 24 multiple choice items. The reliability coefficient of the pre - test was calculated as 0.83. The validity of the pre-test was known after examining it by the jury members. The maximum score of the test was 24 points.

The Attitude Scale toward Computer Instruction:

The objective of the attitude scale was to measure the students' attitudes toward computer instruction.

The first version of the attitude scale consisted of 36 items. It was checked by the jury members to make sure of its validity. The final version of the attitude scale consisted of 20 items. The reliability coefficient was calculated as 0.81. The attitude scale was prepared on Likert model which consisted of five levels. The maximum score of the scale was 100 points.

The Post - Test:

The objective of the post - test was to measure the achievement of the behavioural objectives of the math 105 course on the comprehension level after performing the research experiment, where each question was put to measure one objective.

The post - test consisted of : 8 open questions, 8 multiple choice, and 8 true or false items. The student took one point for each correct answer in multiple choice, and true or false items, and took five points for each correct answer in open question items. The maximum score of the test was 56 points.

The post - test was applied on a pilot sample to calculate :

- a) a time of applying the test. It lasted 72 minutes.
- b) a reliability coefficient. It equalled 0.78.
- c) an easiness coefficient. It was between 38%,84%.
- d) a recognition coefficient. It was bwtween 0.34 , 0.76.

The post - test was examined by the jury members to make sure of its validity.

After these steps, the post - test was applied on the research sample.

Summary of the Results:

The results were indicated by answering the following research questions:

The First Question:

What is the effect of using computer - assisted instruction in the mathematical practices on the college students' achievement of the behavioural objectives of the math 105 course ?.

To answer the first research question, the researcher calculated the mean and the standard deviation of the pre - test and the post - test in each group to perform the variance analysis between the three research groups before and after the experimental treatments of the research as follows:

Table (1)

The variance analysis and F - values of pre - test and post - test

The subject	Pre - test		Post - test	
	inside groups	between groups	inside groups	between groups
Free scores	37	2	37	2
Squares sum	135	5	927	957
Variance	3.7	2.6	25.1	478.5
F - value	1.42		19.06	
The tabular-F	2.23 at 0.05 level, and 5.18 at 0.01 level			

Table (1) indicated that F-value=1.42, but the tabular -F= 3.23 at 0.05 level. This showed that there was no significant difference between the three research groups in the mathematical comprehension level before the experimental treatment of the research.

The same table showed that F-value = 19.06 in the post - test, but the tabular - F = 5.18 at 0.01 level . This indicated that there were significant differences between the three research groups in achieving the behavioural objectives of the math 105 course. To recognize the differences between the groups, the researcher used T - test. The results of T - test indicated that the differences between the computer group and the partial - computer group were significant

at 0.05 level for the computer group whereas T-value equalled 2.64 . The differences between the partial - computer group and the no - computer group were significant at 0.01 level for the partial - computer group whereas T-value equalled 3.17. The differences between the computer group and the no - computer group were significant at 0.01 level for the computer group whereas T-value equalled 7.16.

These results proved that doing the mathematical practices by using computer - assisted instruction was more effective than using paper and pencil in achieving the behavioural objectives of the math 105 course.

To recognize the achievement of each behavioural objective of the math 105 course, the researcher calculated the percentage of achievement of each objective. The results indicated that the percentage range of achieving the behavioural objectives was different in each group. It was between : 92 & 50 in the computer group, 83 & 42 in the partial - computer group, and 75 & 32 in the no - computer group. The best objective's achievement in each group was about using the terms in ordering the arithmetic operations. The worst objective's achievement in each group was about calculating the geometrical shape area from the drawing. These results agreed with the results of studies by Hodges (8) , Burns & Bozeman (2) , and Kulik & Others (10) .

The Second Question:

What is the effect of using computer-assisted instruction in the mathematical practices on the college students' attitudes toward computer instruction?.

To answer the second research question, the researcher calculated the mean and the standard deviation of the attitude scale in each group before and after performing the research treatments to do the variance analysis between the three research groups as follows:

Table (2)

The variance analysis and F - values of the attitude scale pre - and post - research treatments

The subject	Pre- treatment		Post-treatment	
	inside groups	between groups	inside groups	between groups
Free scores	37	2	37	2
Squares sum	2205	73	5008	891
Variance	60	36.5	135.4	445.5
F - value	1.31		3.29	
The tabular-F	2.23 at 0.05 level, and 5.18 at 0.01 level			

Table (2) indicated that there was no significant difference between the three research groups in the attitudes toward computer instruction before performing the research treatment where F - value equalled 1.31,

but the tabular - F equalled 3.23 at 0.05 level.

The same table showed that F - value equalled 3.29 between the research groups on the attitude scale after performing the experimental treatment, while the tabular - F equalled 5.18 at 0.01 level and 3.23 at 0.05 level. This indicated that there were significant differences between the research groups. To recognize the differences between the three groups, the researcher used T - test. The results of T - test indicated that there was no significant difference between the computer group and the partial - computer group where T - value equalled 0.67 for the computer group, while the tabular - T equalled 1.96 at 0.05 level. Also the difference between the partial - computer group and the no - computer group was not significant at 0.05 level where T - value equalled 1.91 for the partial - computer group. But the difference between the computer group and the no - computer group was significant at 0.05 level for the computer group where T-value equalled 2.41.

These results proved that using computer-assisted instruction in doing the mathematical practices was effective to improve the students' attitudes toward computer instruction.

The percentage distribution of the students' respondents on the attitude scale after the research treatments were as follows:

66.67% of the computer group, 58.33% of the partial -

computer group, and 37.50% of the no-computer group expressed positive attitudes toward computer instruction, while 25% of the computer group, 25 % of the partial - computer group, and 43.75 % of the no - computer group exhibited negative attitudes toward computer instruction . In summary, the experimental groups' students possessed more favourable attitudes than the control group's students as a result of using computer-assisted instruction during the mathematical practices. These results agreed with the results of Gross & others (4), and Mathis & others (11) studies, but the results disagreed with those of Vernette (14).

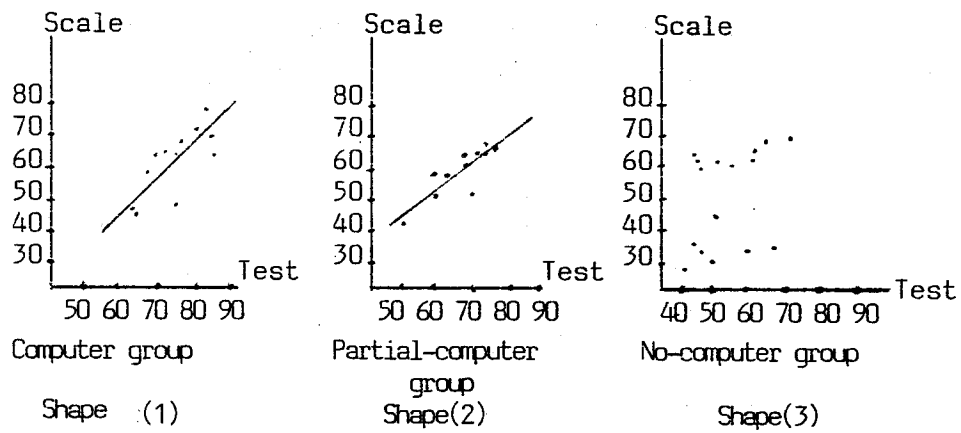
The Third Question:

Is there a correlation between the students' achievement of the behavioural objectives of the math 105 course and their attitudes toward computer instruction in each group of the research groups.

To answer the third research question, the researcher recorded each student's score on the post - test and on the attitude scale in the three groups after performing the experimental treatments of the research. Pearson's correlation coefficient was used to compare the students' scores on the post - test and the same students' scores on the attitude scale in each research group.

The results indicated that the correlatin coefficient in the computer group equalled 0.55, 0.48 in the

partial - computer group, and 0.12 in the no-computer group. These results showed that there was a positive correlation (but not significant at 0.05 Level)between the students' scores on the post_test and the attitude scale in the computer group, and in the partial-computer group. Also it showed that there was no correlation between the students' scores on the post - test and the attitude scale in the no - computer group.



The shapes (1) & (2) & (3) indicated that there were positive correlations in the computer, and the partial - computer groups, but there was no correlation in the no - computer group between the students' achievement of the behavioural objectives of the math 105 course and their attitudes toward computer instruction.

These results agreed with the results of Cavin's study (3).

Recommendations of the Research:

The results of this research let the investigator formulate the following recommendations:

- 1- Using computer - assisted instruction should be taken into consideration when improving the students' achievement of the math courses objectives.
- 2- Computer - assisted instruction should be used during the mathematical practices because it is a good help to students in solving the mathematical problems.
- 3- It is worthwhile to give the students some computer background and training before doing mathematical practices to become more familiar with computers.
- 4- Different computer software should be available in the computer laboratory or in the math department to use it in the mathematical practices.
- 5- The instructors in the computer laboratory should ensure that the students have completed the mathematical practices during the assigned time because the length of the practices time is an effective variable.
- 6- Students' attitudes toward computer - assisted instruction may be improved by using computers during doing the mathematical practices.

- 7- The instructors' attitudes toward computer instruction should be examined along with the students' attitudes because they can be an important variable for successful implementation.

Recommendations for Future Researches:

- 1- This research should be replicated in other branches of math courses, and other instructional stages.
- 2- This research should be replicated with more accurate measurements of time spent in the computer laboratory and time spent using the computer.
- 3- Researches should be designed to see if using the computer as a practice tool could help students in achieving other courses' objectives.
- 4- Researches should be conducted at different regions and on varied student populations to ensure that the results remain valid.
- 5- Larger sample size should be chosen to determine that the final conclusions remain the same.
- 6- Research can be designed about the effect of the mathematical practices with computer-assisted instruction on achievement and attitudes toward mathematics.

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