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ABSTRACT

The purpose of this series of experiments was to examine two questions related to the effectiveness of computer assisted instruction (CAI). Can microcomputer modules teach effectively, and do they enhance learning when used as a supplement to traditional teaching methods? Part 1 of this report addresses the former question and part 2 addresses the latter. The three microcomputer modules used were Population Growth, Predator Prey, and Mitosis/Meiosis. All three were produced by the author as part of a National Science Foundation (NSF) supported project. Each module was a self-contained teaching medium employing graphics, text, and sound designed expressly for the Apple II microcomputer. Each was interactive, allowing the student to enter answers to multiple-choice questions, parameters for equations, and/or other input. No computer programming background was necessary for the student to execute or make minor modifications to the module programs. Results indicate that learning was achieved to a high degree of significance, but that CAI supplemented with traditional teaching methods did not significantly improve learning. It is indicated that although not a panacea, the microcomputer has proven that it has a solid niche in the educational world, and an ever increasing potential. (Author/JN)

Evaluation of Three Microcomputer Teaching Modules

by Ted Soldan

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SUMIT COURSEWARE DEVELOPMENT PROJECT
DEPARTMENT OF BIOLOGICAL SCIENCES
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Introduction

The purpose of this series of experiments was to test the effectiveness of computer aided instruction (CAI). Can microcomputer modules teach effectively, and do they enhance learning when used as a supplement to traditional teaching methods? Part 1 of this report will address the former question, and part 2 will address the latter. The effectiveness of three microcomputer modules entitled Population Growth, Predator Prey, and Mitosis/Meiosis is tested in this report. All three were produced by the author as part of the NSF supported SUMIT project.

Each module was a self contained teaching medium employing graphics, text, and sound designed expressly for the Apple II microcomputer. Each was interactive, allowing the student to enter answers to multiple choice questions, parameters for equations, and/or other input. No computer programming background was necessary for the student to execute, or make minor modifications to the module programs.

Procedure (Part 1)

The effectiveness of computer aided instruction (CAI) was evaluated using a test given before and after the computer module was examined by a group of students. The pre and posttests were identical, and consisted of seven to nine multiple choice questions, each with five possible answers.

All tests were given on the computer. A program called Quizmaster, developed by Dr. J. D. Spain in conjunction with the SUMIT project, displayed the questions, accepted the user input, and stored the responses. The student's responses to the pretest were accepted without comment by the computer. Following the student's response to the posttest, however, the computer notified the student whether his/her response was correct.

Population Growth and Predator Prey were evaluated in the Animal Ecology course (BL340) fall term, 1981. The laboratory sections were usually small, ranging from seven to fifteen students each. Three sections of different students met each week.

The labs were conducted by Mr. Mark Shaltz, who began each section with a ten to twenty minute lecture, followed by either a field trip or lab work. If a field trip occured that week, the students ran the microcomputer module after returning from the field. If laboratory work was done instead, the students were free to schedule their time, and fit the module into any appropriate time slot. In either case, all students were required to run the module being evaluated that week. In addition to taking the pretest, viewing the module, and taking the posttest, each student filled out a brief evaluation form for each module that was examined.

Population Growth and Mitosis/Meiosis were two of the SUMIT modules evaluated in the General Biology course (BL104) Winter Term, 1981-82. The General Biology sections generally had from twenty to thirty students, and were scheduled for a three hour period. Five lab sections met each week during winter (1981-82) term. In four of the five lab sections, students were required to view a computer module every other week. In the fifth lab section, the modules were available on an optional basis. This arrangement occured because only two of the three Graduate Teaching Assistants (GTAs) were associated with the SUMIT project, so only their four (two each) labs were required to run the modules.

In the General Biology labs, students were given a five to fifteen minute lecture by the GTA at the beginning of the lab period, and then were allowed to schedule their lab time. Those that were not required to run the microcompter module in a given lab period were always allowed the option of running it. Students that ran the microcomputer module in General Biology were required to fill out a brief evaluation form.

Since pre and posttest scores were available for most students (scores were discarded for those lacking either test score), a paired t-test was used to analyze the data.

Results and Discussion (Part 1)

The main assumption of the paired t-test is data independence. Data independence can be assumed in both the Animal Ecology and General Biology sections, since no attempt was made to single out students to run the module. In the Animal Ecology labs, everyone was required to run the modules, and in General Biology, a student's requirement to run the module was independent of his/her ability to achieve at quizzes.

Regular paired t-tests were run on the data (see Appendix 1) from Population Growth in General Biology, Population Growth in Animal Ecology, Predator Prey in Animal Ecology, and Mitosis/Meiosis in General Biology. The t-scores calculated were 6.691**, 4.258**, 5.186**, and 4.107** respectively (see Table 1). Since the t-scores are all positive, this shows significant increases in posttest scores when compared to pretest scores.

Procedure (Part 2)

Students in the General Biology class were quizzed during recitation over the material covered in lab the previous week. The students were always asked on the quiz whether they had run the previous week's computer module in lab. When quiz scores were graded, it was noted whether the student had run the computer module the previous week in lab. Thus, two groups of quiz scores were avialable, one group with students that ran the module, and the second with those that did not.

The Mitosis/Meiosis module lent itself well to comparison of these two sets of scores, since it covered material directly applicable to the recitation quiz. Mitosis/Meiosis was run during week three of lab (prior to Christmas break), and the students were quizzed over this material during week four in recitation (following Christmas break). Approximately thirty percent of the recitation quiz was taken directly from the module. Two recitation sections were evaluated in this manner, and their quiz scores were pooled (see Appendix 1). The scores of those that ran the module in section four were pooled with the scores of those that ran the module in section five, and likewise for those that did not run the modules in both sections.

The t-test for two sample means was chosen to analyse the data.

Results and Discussion (Part 2)

The assumptions for the two sample t-test are data independence and variance homogeneity. The variance for the two samples was tested, and found homogeneous. The calculated F value was 1.98 for 18 and 23 degrees of freedom.

Data independence was harder to prove in this case. If those students required to run the modules had been the only ones to do so, data independence would be nearly assured. However, since any student had the option to run the module, it could be argued that the better students chose to run the module, thus artificially raising the quiz scores.

This problem was minimized during week three since the labs were held near the end of the week just prior to Christmas break. Students were highly motivated to finish lab work quickly and leave, and therefore avioded any extra work. Using the data collected from two recitation section's tests, it was found that over the entire term, the modules were run by 67% of the students. During week three however, the modules were run by only 53% of the students.

The t-calculated from this data is 1.268 with 41 degrees of freedom. This is not significant at the 95% confidence level (see Table 2).

Conclusion (Parts 1 and 2)

The results indicate that learning was achieved to a high degree of significance, but that CAI supplemented with traditional teaching methods did not significantly improve learning. These results are comparable to those of other investigators (Tsai and Pohl 1978, 1981).

The mean recitation scores for the group that ran the module, versus the group that didn't run the module are different (see Table 2), but not enough to make the difference significant. If learning is enhanced by CAI supplemented with traditional teaching methods, then one or more factors must have masked the numbers. One such factor may have been the students' desire for a good grade. Since quiz scores were part of the students' grade, the good students probably studied and received a good score with or without the use of the microcompuuter module. The average, and below average students probably put forth their normal effort, but thanks to the use of the module, may have been able to do better.

If learning could be tested in a controlled environment where sufficient motivation existed for all students to do their best work, but not a disproportionate amount of work, real differences may be evident between traditional teaching methods alone versus traditional teaching methods supplemented with computer aided instruction.

Based in the data presented in this paper, and the author's personal experience with microcomputers several conclusions may be drawn. Microcomputers are not a panacea for eductaion. Like many other tools currently in use in the field of eductaion, the microcomputer has its strengths and weaknesses. It is a constant temptation to produce educational software that could be implemented as well or better with the use of film loops, film strips, books, tapes, or other educational materials.

One of the greatest strengths of the microcomputer is its ability to perform mathematical operations. This strength, plus the graphics capabilities of the machine, make possible unique situations in the computer environment in which objects can be made to move about the screen based on user input. Many popular games are based on this capability, and the potential for educational use of the microcomputer in this area is enormous.

Utilizing the microcomputer's mathematical abilities, graphs and histograms can also be displayed. When graphs are keyed to user input in the microcomputer environment, a learning tool is available that is unmatched in current educational technology.

The computer can also be programmed to make sounds, and display text, both of which can be mixed with the graphics to make a truly versatile educational tool. The increasing availability of the microcomputer in the academic environment coupled with its current popularity among students is also a plus for the micro.

Teachers will probably never be replaced by the computer, although programmed learning is gaining in popularity at many universities. The computer, however, is a tool that must be reckoned with by modern academicians. Those that fail to develop some computer literacy may find themselves replaced by more progressive faculty that perceive the need for this remarkable tool.

While not a panacea, the computer has proven to the author, as well as to others active in the field, that it has both a solid niche in the educational world, and an ever increasing potential.

References

Tsai,S and N. F. Pohl. 1978. Student achievement in computer programming: lecture vs. computer-aided instruction. Journal of Experimental Education, 46(2): 66-70.

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Table 1.

Paired T scores for three modules in two classe (Animal Ecology - BL340, and General Biology - BL104).

Module	Class	N	T	df
Population Growth	BL104	46	6.691	90
Population Growth	BL340	25	4.258	48
Predator Prey	BL340	12	5.186	22
Mitosis/Meiosis	BL104	23	4.107	44

Table 2.

Two sample T scores for Recitation sections four and five (pooled) Data was recorded from General Biology.

Group	N	Mean	df	T
Ran Module	24	15.250	41	1.268 ns
Didn't Run Module	19	13.526		

Appendix 1a

Pre and post test scores from Animal Ecology laboratories

Population Growth
(in percent)

Pretest	Posttest
75	88
38	63
75	100
63	100
88	88
25	0
50	75
50	100
75	83
13	63
25	100
50	63
88	88
88	100
75	75
63	50
63	75
38	88
88	88
63	75
25	88
38	63
88	100
67	75
75	100

Predator Prey
(in percent)

Pretest	Posttest
67	89
33	56
22	100
56	78
56	89
22	89
33	89
67	89
67	89
33	56
56	89
33	33

Appendix 1b

Pre and post test scores from General Biology laboratory

Population Growth (in percent)

Pretest	Posttest
13	88
50	25
13	38
13	50
0	38
25	75
3	63
38	88
38	75
13	75
38	75
25	63
38	88
50	50
50	75
50	25
25	25
38	100
25	13
38	75
38	75
75	100
38	63
38	63
38	63
50	75
13	50
25	63
38	88
38	50
25	13
50	38
38	75
13	25
25	88
30	75
13	88
38	13
38	50
13	50
13	4
50	75
63	38
38	63
38	50
25	100

Mitosis/Meiosis (in percent)

Pretest	Posttest
57	57
71	86
57	71
57	43
29	29
29	57
71	86
43	57
29	57
71	71
57	57
29	43
57	71
29	43
0	71
43	43
14	29
57	86
43	57
29	43
71	71
29	49
43	71

Appendix 1c.

Raw scores (out of 20 possible) on recitation sections four and five (pooled) quizes.

Ran Module	Didn't Run Module
20	7
12	20
18	17
16	14
8	13
17	18
12	15
16	10
20	14
11	18
8	20
19	4
14	11
15	15
18	19
14	18
20	14
15	5
20	5
16	
17	
9	
16	
15	