The Microcomputer as an Instructional Tool

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The microcomputer is the most significant advancement in educational technology in decades. Sturdevant (1982) noted that 25% of the public schools had some type of computer in 1981, and that this total would double during 1982. Lipsitz, (1983) reported that 68% of all schools and 86% of all high schools now have computers. Further, there are now 325,000 microcomputers in schools, with an average of eleven in each high school. Beer (1981) reported that 700 county extension offices were equipped with computer terminals or microcomputers.

Computer technology is here, and microcomputers are invading the classroom. Agricultural educators must now be prepared to use their full potential.

The microcomputer as an educational tool holds great promise for agricultural education. A major advantage is the increased efficiency in the use of the educator's time. For example, one microcomputer and one program can perform unlimited hours of instruction; and a microcomputer does not tire and can teach the same lesson repetitively, without deviation of content or presentation; and a well-written program requires only a minimum of teacher management.

As microcomputers become less expensive and more prevalent in educational settings, the potential of such equipment to present technical information must be explored and developed. With many microcomputers in a price range of $150 to $3,000 and with diskettes costing three dollars or less each, the microcomputer is a cost-effective method of disseminating technical information.

Program Development

The authors developed a microcomputer program *Communicating for Safe Tractor Operations* on the Radio Shack TRS-80 microcomputer. This content was selected for two reasons. First, the subject matter is important in tractor and machinery safety. Secondly, the authors wanted to demonstrate the capability of a microcomputer program to display animated graphics. Graphics that are embedded in instructional content contribute to the learning process by presenting a visual model of the information to be learned (Cohen, 1983).

The developed software package focuses on the magnitude of agricultural and tractor accidents, identifies the types of tractor ac-

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cidents, and illustrates the methods of communications used between tractor operators and others. The slow-moving vehicle (SMV) emblem, the eleven ASAE-adopted agricultural signals and the three arm and hand signals (right turn, left turn, and slow down - stop) are included in the program.

The computer program has 20 concepts. They are:

- Magnitude of tractor accidents (1),
- Types of tractor accidents (1),
- Communicating to prevent tractor accidents (3),
- Slow-moving vehicle (SMV) emblem (1),
- Common arm and hand signals (3), and
- Agricultural arm and hand signals (11).

Graphics were developed for the 14 arm and hand signals and for the slow-moving vehicle emblem. Ten of the graphics required motion while three required only two-dimensional graphics without animation.

Because machine memory is less than diskette memory, the program was divided into two components. The first component included the first nine concepts listed above. The second component of the program covers the 11 agricultural hand signals. Each of the signals is defined, as in "Hand Signals for Use in Agriculture" (ASAE Standard S 276.3) (Baxter & Hahn, 1983), followed by an animated graphic of that signal.

Content information was provided for each of the 20 concepts, as well as a four choice - multiple choice question for each concept. The interactive aspect of the program allows a student to either select a response or return to the content information for further study. When a correct response is selected, a "reward" response of "Great," "You got it right," or similar word response is given, along with reinforcing information. If an incorrect answer is given, additional information is provided and the student is asked to select another response. This process continues until the correct response is selected.

Additional information on technical aspects of the program development is available from the authors.

Objectives

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Objectives

The overall objective of this study was to determine the effectiveness of the microcomputer program *Communicating for Safe Tractor Operations* with both high school and college students.

The following null hypotheses were formulated and tested at the one-tailed .05 alpha point:

> Ho_1: There is no significant difference in the pretest and posttest means of students who completed the *Communicating for Safe Tractor Operations* microcomputer program.
>
> Ho_2: There is no significant difference in the pretest and posttest means between high school youth and college youth who completed the *Communications for Safe Tractor Operations* microcomputer program.

Methodology

Pre and posttests were developed to parallel the 20 concepts of the program. The 20 questions on the pre- and posttests were identical, but the choice of answers differs. There are five word questions for the first five concepts and 15 pictures for the 14 hand signals and for the slow-moving vehicle emblem.

The program and the pre- and posttests were field-tested with 20 students. No significant problems were uncovered. The Kuder-Richardson 20 coefficient for reliability was run on both the pre- and posttests with coefficients of .94 and .90, determined, respectively.

The pretest, program, and posttest were then administered to a total of 210 students; consisting of 145 high school vocational agriculture or 4-H youth and 65 college students enrolled in courses within the College of Agriculture at the University of Florida.

The high school youth were from four high schools and one statewide group of 4-H youth. The college students were enrolled in several College of Agriculture programs, but all were taking some courses in the Department of Agricultural Engineering.

Students were given the pretest and upon completion, without the pretest being scored or discussed, were given a maximum of thirty minutes at the microcomputer to study the *Communicating for Safe Tractor Operations* program. This was followed immediately with the posttest.

Findings

As shown in Table 1, the respondents took between 5.0 to 11.5 minutes to complete the pretest, with a mean of 8.0 minutes. Then

Table 1

Respondents' Time in Minutes to Complete the Program Communicating for Safe Tractor Operations

Program phase	Range	Mean
Pre-test	5.0 - 11.5	8.0
Computer program	18.0 - 30.0	28.0
Post-test	5.0 - 10.5	7.5
Total	28.5 - 52.0	43.5

Table 2

Comparison of Respondents' Mean Pre- and Post-test Scores

Group	N	Pre-test	Post-test	Percent increase	T-Ratio
High school	145	56.8	85.6	50.1	-21.2*
College	65	68.9	95.8	39.0	-14.5*
Total	210	60.5	88.8	46.8	-19.1*

Note. *Significant at $p < .01$ point.

they were immediately given a maximum of 30 minutes to study the *Communicating for Safe Tractor Operations program.* Forty-eight percent of the respondents took 30 minutes; the range was from 18 to 30 minutes, with a mean of 28 minutes. The posttest was administered immediately after the 30-minute time frame to study the program. Five to 10.5 minutes were required to complete the posttest, the mean time being 7.5 minutes.

The mean test scores for both the high school and college students are shown in Table 2. For the high school students, the mean score on the pretest was 56.8% correct answers. The posttest mean was 85.6% correct. There was a mean score increase of 28.8 points, or a 50.1% increase, over the pretest mean.

The college youth scored better on both the pre- and posttests. Their mean on the pretest was 68.9%; on the posttest it was 95.8%. The mean score increase was 26.9 points, or a 39.0% increase, over the pretest mean.

The combined group (N = 210) had means of 60.5% on the pretest and 88.8% on the posttest. The mean score increase was 28.3 points, or a 46.8% increase, over the pretest mean.

There was a significant increase in the posttest scores of both the high school and college groups and also in the scores of the two groups combined, resulting in a significant difference using a one-tailed *t*-test at $p<.01$. Therefore the null hypothesis (Ho_1) was rejected.

Table 3

Comparison Between High School and College Groups' Pre- and Post-test Mean Scores

Test	Groups: High school N = 145	Groups: College N = 65	Difference	Standard error	Z-Score
Pre-test mean	56.8	68.9	12.1	2.24	5.40*
Post-test mean	85.6	95.8	10.2	1.37	7.45*

Note. *Significant at $p < .01$.

Differences in both the pretest and posttest means of the two groups were analyzed using a one-tailed test for uncorrelated data. The data in Table 3 indicate a significant difference between the two groups at $p<.01$ for both the pre- and posttest. The null hypothesis (Ho_2) was rejected. The college group did significantly better on both the pre- and posttests.

A chi-square analysis of the twenty test items in the pre- and posttests was conducted. These results are summarized in Table 4.

There was a significant increase in the number of correct answers on 17 of the 20 test items from the pretest to the posttest. Fifteen of the test items proved to be significant at the .01 alpha level.

While the posttest scores were higher than the pretest scores on all twenty items, three test items showed no significant increase. Respondents knew that tractors operating on public roads during hours of dusk, dawn or at night should be equipped with lights: 96.6% had this test item correct on the pretest. The respondents also knew that communications could reduce serious tractor accidents; 80% had this answer correct on the pretest.

Table 4

Analysis of the Twenty Questions in the Pre- and Post-tests for the Program Communicating for Safe Tractor Operations

Test item	Percent correct answers Pre-test	Post-test	Increase
No. killed in accidents	37.9	97.2	59.3**
Types of accidents	77.9	94.5	16.6**
Types of communication	80.0	87.6	7.6
How to best communicate	72.4	97.9	25.5**
Use of lights	96.6	97.2	.6
SMV emblem	53.8	90.0	36.2**
Right turn	72.4	84.1	11.7**
Left turn	63.4	82.8	19.4**
Slow down - stop	64.8	76.6	11.8*
ASAE HAND SIGNALS			
This far to go	76.6	97.9	21.3**
Come to me	11.0	60.7	49.7**
Move toward me	53.8	61.4	7.6
Move out -	58.6	80.0	21.4**
Stop	71.0	82.1	11.1*
Speed it up -	38.6	83.4	44.8**
Slow it down -	46.9	81.4	34.5**
Start the engine	34.8	90.3	55.5**
Stop the engine	62.8	91.7	28.9**
Lower equipment	51.7	89.7	38.0**
Raise equipment	23.4	85.5	62.1**

Note. *Significant at $p < .05$, ** significant at $p < .01$.

One hand signal appeared to give the respondents some difficulty. The signal "Move Toward Me, Follow Me" was consistently confused with the "Come to Me" hand signal. There was insufficient improvement in this test item mean 53.8% to 61.4% to result in a significant difference.

Conclusions

1. The microcomputer program has the capacity to teach. Both high school and college youth had significantly increased scores on a posttest after completing the program.

2. College youth had significantly higher scores on both the pre- and posttests than did the high school group. The level of intelligence, ability to comprehend concepts, reading ability, and maturity in the former group probably account for the difference.

3. There was a significant increase in scores on 17 of the 20 concepts presented in the program.

Recommendations

1. The program should be modified for use on other microcomputers.

2. Additional microcomputer programs need to be developed in agriculture to warrant the investment in microcomputers as an instructional instrument.

3. Further study should be conducted to compare the effectiveness of more traditional instructional methods with instruction via the microcomputer.

Summary

Microcomputers can have a significant role in agricultural education. However, if their potential is to be reached, two major thrusts must be developed. First, agricultural educators must be exposed to microcomputers, become comfortable with them, and become familiar with their potential. This thrust has begun (Bowen, Mincemayer, & Parmley, 1983) but must be accelerated.

The second thrust is the development of quality software. Commercial sources cannot be expected to develop the variety of needed agricultural programs. Educators in all the agricultural disciplines must become involved in this important effort.

As Camp (1983) stated it, "if agricultural education is to keep pace with these changes, we must move now and rapidly!" (pp. 13-14).

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