Journal of Agricultural Education
Volume 34, Number 1, pp. 77-83
DOI: 10.5032/jae.1993.01077

Experimental Evaluation of the Effectiveness of a Computer-Assisted Instructional Unit on Sustainable Agriculture

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The 1980s were a time of change in United States agriculture. The environmental consequences of agriculture have also become increasingly important. The protection of natural resources has high priority nationally, within the state, and in local communities. A need exists to educate young people on the proper protection of our natural resources so that they may initiate efforts that will contribute to providing a safer environment in the future.

Three recent studies indicted a void in Iowa's formal education system with regard to instruction about environmental issues related to agriculture. Iowa secondary school agriculture students and teachers were "undecided" about conservation concepts (Whent and Williams, 1988). Iowa farmers expressed the need for more education on conserving natural resources (Andrews, 1988). Soil conservation district commissioners and other farmers in Iowa indicated more precise education concerning agri-chemical management was needed (Bruening, 1989).

Changes in agriculture have made it necessary for teachers to use up-to-date materials in order to provide appropriate learning experiences for students. Agriculture will continue to change in the future, and students will need to master new information to accompany those changes. Teachers will need to continuously search for a variety of instructional materials and references which can be used to supplement their teaching. Learner needs must be identified as concepts instructors should emphasize. Instructional materials must be based on needs of learners, society, and the subject matter (Tyler, 1949).

The development of instructional materials to meet the changing needs of students and society is a continuing process. There is a need for extensive evaluation of instructional materials to guarantee that the actual learning experiences provided are precisely those that are outlined in the learning units (Tyler, 1949). To design instructional materials to meet the rapidity of change in our daily lives and our increased dependence on modern technology is one of the greatest challenges facing agriculture instructors today.

Purpose and Objectives

The purpose of this study was to evaluate the effectiveness of an instructional unit on sustainable agriculture using a computer program as a tool to increase environmental awareness, enhance understanding of environmental problems, and promote the resolution of environmental issues in educational settings. The specific objectives were to:

Determine the educational value of a sustainable agriculture instructional unit as measured by student knowledge of sustainable agriculture.

Determine the effectiveness of a computer-assisted instructional unit as measured by student knowledge of sustainable agriculture.

Procedures

Population and Sample

The population for this study consisted of agriculture students enrolled in Iowa high schools offering programs in agriculture that had adequate computers to allow all students equal access to a computer as they participated in the experiment. Stratified random sampling was used due to the convenience and feasibility of selecting groups of individuals rather than to select individuals from a defined population. From the 97 agriculture departments responding to a survey about computer equipment, 41 indicated having adequate computers to support the experiment. Twenty-one test sites were selected which represented approximately 8 percent of all schools offering agriculture in Iowa. Sixteen schools completed the test with 172 students participating. Five schools declined to participate due to the required time interval.

Data Collection

The Sustainable Agriculture Manager (SAM) instructional unit focused on "best management" practices that have usefulness in managing and conserving natural resources. Two lessons were included in the instructional materials. The instructional unit was designed for approximately 10 periods of instruction. The first day of instruction was used for collecting demographic data and an introduction to sustainable agriculture. A pretest was completed the second and third days using the Sustainable Agriculture Manager computer program in the worksheet mode. Sustainable agriculture components, practices, profitability, energy conservation , and environmental impact were discussed on the fourth, fifth, sixth, and seventh days. During the discussion days, students completed written activities centering on the topics discussed. A follow-up posttest was administered using the SAM computer program in the test mode at the completion of the written instructional materials on the eighth and ninth days. The last day was utilized to summarize and evaluate the instructional unit.

Students and teachers completed written evaluation forms which measured student and teacher ratings of the Sustainable Agriculture Manager materials. The evaluation form contained statements designed to elicit a response for specific items as well as an overall rating of the written materials, computer program, and total package. The SAM computer program automatically calculated scores on sustainable agriculture, energy conservation, and profitability based on students' management decisions. Student responses and scores for both the pretest and posttest use of the computer program were stored on diskette for evaluation. Students had to complete both the pretest and posttest to be included in the study.

Technical accuracy of sustainable agriculture concepts was validated from the Soil Conservation Service, Department of Natural Resources, Iowa State University Extension Service, and other individuals at Iowa State University. Written instrumentation was reviewed by departmental faculty and staff for face validity. Descriptive and inferential statistical procedures were used to analyze the data collected from students who had taken both the pretest and posttest using SPSS/PC+ microcomputer statistical software. A reliability test using Cronbach's procedure resulted in an alpha of .91. The alpha level for testing relational statistics was set at .95.

Results

Sample Characteristics

Of the 172 students involved, 42 percent were in the tenth grade, 30 percent eleventh grade, 15 percent ninth grade, and 13 percent twelfth grade. Male students comprised the largest group of students (84%). Thirty-seven percent of students had been enrolled in three to four semesters of agriculture. Approximately one-half of the students (49%) lived on farms and, of those students, over one-half (66%) lived on farms less than 480 acres in size.

Of the 16 teachers participating in the study, ten teachers (63%) with 94 students (55%) utilized the Apple II software and six teachers (37%) with 78 students (45%) utilized the MS-DOS software. Both groups utilized the same written support materials.

Effectiveness of the Instructional Unit

Students and teachers were asked to rate the overall educational value of the instructional materials using a Likert-type scale with ratings of 1 (low), 25 (below average), 50 (average), 75 (above average), and 99 (high). When both teachers and students evaluated the entire instructional unit, the overall means revealed that both groups rated the materials above average in educational content. Table 1 revealed that students rated the materials lower than did teachers and that both students and teachers rated the computer program higher than the written materials.

Tabel 1. Means and Standard Deviations for Student and Teacher Overall Educational Value Ratings of Sustainable Agriculture Manager Materials.

Program components		Student scores	Teacher scores	t-value	t-prob.
		N=172	N=16		
Overall educational value of the written materials	M[a]	68.88	74.94	-1.53	.140
	SD[b]	19.61	14.61		
Overall educational value of the computer program		77.33	82.50	-1.65	.112
		19.06	11.08		
Overall educational value of the total package		77.96	80.81	-0.89	.383
		19.39	11.37		
Mean		74.72	79.42	-2.32	.023
		19.35	12.35		

[a]M=Mean

[b]SD=Standard Deviation

Students completed a pretest and posttest using the Sustainable Agriculture Manager computer program. Students' scores were based on their responses to various situations presented in the program. Sustainable agriculture (SA) scores measured how well the student utilizated crop and livestock system and agricultural inputs. The computer checked for

activities which supported and maintained the economic and social viability while preserving the high productivity and quality of natural resources. Energy conservation (E) scores measured how well the student conserved energy usage. Profitability (P) scores measured how well the student maintained long-term profit.

Table 2 presents the scores from the computer pretest and posttest. All posttest mean scores were significantly higher than pretest mean scores. Table 3 revealed a significant difference existed in the posttest mean scores of male and female students, whereas the pretest mean scores were similar.

Table 2. Means and Standard Deviations for Student Pretest and Posttest Sustainable Agriculture Knowledge Scores Materials

Sustainable agriculture components		Pretest scores	Posttest scores	t-value	t-prob.
		N=172	N=172		
Sustainable practices[a]	M[b]	40.45	54.34	-12.21	.001
	SD[c]	17.04	15.77		
Energy conservation[d]		12.85	20.32	-9.08	.001
		10.60	9.92		
Profitability[e]		38.46	38.88	-3.74	.001
		11.35	12.37		
Mean		30.46	38.88	-11.87	.001
		13.00	12.69		

[a]Highest known scale value obtained pre-field testing was 80.

[b]M=Mean

[c]SD=Standard deviation

[d]Highest known scale value obtained pre-field testing was 65.

[e]Highest known obtainable scale value obtained pre-field testing was 50.

General written comments from students indicated that the computer program was fun, made learning easy, and that the written materials and computer program was easy to understand and use. One student expressed that it would be a good idea to have farmers use the computer program since the student felt that many farmers have no idea how much they are hurting the land. Several students indicated that they could go through the computer program many times and learn something new each time. Students indicated that competition became widespread to see who could improve their scores from the pretest.

Written teacher comments concerning the instructional unit indicated that the unit was well received by all teachers. Teachers reported that they had good discussions with students about sustainable agriculture concepts. The interest approaches, visual masters, and student activities kept the students interested. Teachers indicated that the repeat function in the worksheet (pretest) mode of the computer program increased learning on some of the harder concepts presented. Overall, teachers enjoyed teaching the unit and indicated that the computer program was an excellent way to review sustainable agriculture concepts.

Table 3. Student Pre- and Posttest Differences in Sustainable Agriculture by Sex

Sustainable agriculture component	Pretest scores Male[a]	Female[b]	t-value	t-value	Posttest scores Male[a]	Female[b]	t-value	t-value
Sustainable practices[d]	40.52[c] 17.63[e]	40.07 13.68	0.15	0.88	55.54[c] 15.99[e]	47.93 13.01	2.69	0.01
Energy conservation[f]	12.71 11.03	13.59 8.02	-0.49	0.63	20.66 10.23	18.52 8.01	1.21	0.23
Profitability[g]	38.14 11.55	37.74 10.39	0.18	0.86	42.73 12.76	38.00 9.15	2.30	0.03
Mean	30.46 13.40	30.47 10.70	-0.01	1.00	39.64 10.53	34.82 7.94.	2.74	0.01

[a]N for both male groups was 145

[b]N for both female groups was 27

[c]Mean

[d]Highest known scale value obtained pre-field testing was 80.

[e]Standard deviation

[f]Highest known scale value obtained pre-field testing was 65.

[g]Highest known scale value obtained pre-field testing was 50

Conclusions

Based on the findings of this study, the following conclusions concerning the Sustainable Agriculture Manager instructional unit tested in agriculture departments in Iowa were drawn.

The high percent of students living on farms or in rural areas provides an excellent audience for instructional materials on sustainable agriculture. It is anticipated that many of these students will share their knowledge of sustainable agriculture with their parents and/or that they will become farmers of tomorrow. Those not living on farms will also benefit from their sustainable agriculture knowledge, as more emphasis is placed on conservation of energy and natural resources. All students must be part of this needed effort.

Only 16 percent of the student population were female. Instruction on sustainable agriculture concepts is reaching only a limited number of female students through agriculture classes.

The sustainable agriculture instructional unit was developed at an instructional level for students to understand the content of the materials being taught. The materials can be taught as a complete unit or as a supplemental unit in a variety of courses.

The sustainable agriculture instructional unit was successful in improving student knowledge of sustainable agriculture concepts.

The use of computers in teaching about sustainable was well received by both students and teachers. The mean for the overall educational value of the total package for students was 77.96 and for teachers the mean was 80.81.

Recommendations

Instructional materials about sustainable agriculture should address the needs of all students (rural and urban) enrolled in agriculture classes. New instructional materials must be concerned with stimulating teacher interest and increasing the teacher's knowledge as well as the student's knowledge.

Instruction about conservation of energy and natural resources is a growing concern and must be addressed in our public education system to ensure these resources will be available for future use. By developing an awareness on the local level, the wisdom and experience of experienced farmers can be used to help facilitate the succession of knowledge to our students.

New teaching strategies should be included in the agriculture curriculum when feasible to stimulate interest and increase student awareness of topics being taught. Materials incorporating problem solving, decision making, or critical thinking skills should be injected into the agriculture curriculum where feasible.

Teachers should be encouraged to seek additional training on how to use computers in the classroom and additional knowledge of sustainable agriculture concepts. Teachers should be encouraged to use computers in all agriculture subjects to facilitate learning at the student's pace. Software utilizing problem solving should be emphasized. Schools should be encourage to purchase new computers and teaching materials that include the use of computers or update existing computer hardware and software.

Experimental procedures should be used when feasible in curriculum evaluation prior to general dissemination. Similar studies in other states should be conducted to compare the effectiveness of the instructional unit. Studies should be conducted to determine the effects of instructional units containing software programs on subject matter learned and thinking skills developed. Student motivation to work with software as well as the educational benefits of the software should be studied.

This study did not attempt to determine the most effective instructional strategies or techniques necessary to teach sustainable agriculture concepts. It is conceivable that other strategies or techniques could be just as effective as those used in this study. The Sustainable Agriculture Manager (SAM) instructional unit and computer program were successful in increasing student knowledge of sustainable agriculture concepts and in teaching management and conservation of natural resources to students in agriculture.

Availability

The instructional unit, "Sustainable Agriculture Manager: A Computer Program for Agriculture Education in Secondary Schools" (SAM) was developed as part of a Resource Enhancement and Protection Education Board (REAP) research project. Currently 150 Iowa agriculture instructors are using SAM which has the potential of reaching 1,980 high school students annually. The Soil Conservation Service in Iowa is utilizing SAM to train employees on sustainable agriculture concepts.

The Sustainable Agriculture Manager computer program is designed to operate with Apple II, MS-DOS, and Macintosh computers. For additional information and availability of the instructional unit, contact the Department of Agriculture Education and Studies, 201 Curtiss Hall, Iowa State University, Ames, Iowa 50011.

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