

TRACTOR SAFETY CERTIFICATION: A MULTI-CURRICULA APPROACH



Final Report: A Summary of Activities and Findings

**PHS-CDC NIOSH Grant No. R01/CCR514374-01
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TRACTOR SAFETY CERTIFICATION: A MULTI-CURRICULA APPROACH

EXECUTIVE SUMMARY

The primary goal of this project was to develop, test and distribute high quality agricultural tractor and machinery safety curriculum, via interactive CD-ROM, interactive World Wide Web (WWW) programming and interactive paper manual, that would meet part of the requirements for the federally prescribed tractor certification program. The following broad objectives were established:

1. Identify and review agricultural tractor and machinery safety training materials currently available.
2. Develop a curriculum outline of the subject matter that needs to be covered in the tractor and machinery certification program.
3. Develop agricultural tractor and machinery safety educational curriculum in three different formats (*i.e., computer-based CD-ROM multimedia version, computer-based World Wide Web (WWW) multimedia version and an interactive paper manual*).
4. Determine the effectiveness of the educational materials developed.

To ensure the completion of the goal and objectives cited, the following essential methodology components were identified and completed:

1. Identify, review and analyze agricultural tractor and machinery safety training materials currently available.
2. Develop a curriculum outline of the subject matter that should be covered in the tractor and machinery certification program.
3. Develop agricultural tractor and machinery safety educational curriculum in three different formats (*i.e., computer-based CD-ROM multimedia version, computer-based WEB multimedia version and an interactive paper manual version*).
4. Determine the effectiveness of the educational materials developed.
5. Publicize and distribute the findings of the evaluation phase of this project.

The three educational pieces developed (*interactive CD-ROM program, Web-based program and paper manual*) were evaluated in a comparative study to determine the educational effectiveness of each to create a positive gain in knowledge. Results showed that high school aged youth using the interactive CD-ROM based program exhibited an average knowledge gain of 49.8%. Youth using the web-based program gained an average of 24.2% and youth receiving instruction with the paper manual and instructor showed an average knowledge gain of 26.0%. Knowledge was measured using a pre-test/post test strategy.

BACKGROUND

The National Committee for Childhood Agricultural Injury Prevention published a list of objectives in 1996 intended to provide a basis for developing injury intervention programs aimed at the nearly two million children living on, or closely associated with, American farms. One of these objectives is to “use systematic evaluation to ensure that educational materials and methods targeted toward childhood agricultural safety and health have demonstrated positive results.” This project created and evaluated modern, high-tech educational materials for the existing federal agricultural tractor and machinery safety certification programs for youth.

Youths are considered an integral part of many family farms and are perceived to be a viable source of low-cost labor. However, the cost in terms of injuries and loss of life from this practice can be substantial. Children have the highest rate of fatal injuries per hour of work time of any age group and account for as many as one-third of the reported farm work-related fatalities (Purschwitz, 1990). A summary of 460 farm work-related fatalities involving youth indicated that 355 (77%) of those incidents involved tractors and machinery (Sheldon, 1992). Injuries were most commonly associated with tractor and equipment runovers, tractor overturns, and entanglements with machinery.

As an early response to the unacceptable rate of farm work-related injuries involving children, the Congress of the United States passed the Fair Labor Standards Act (FLSA) of 1938. An amendment to the FLSA, Part 1500 of Title 29 of the Code of Federal Regulations, was formulated by the Department of Labor and passed in 1968. Known as the Hazardous Work Occupations in Agriculture Order, this amendment established a specific list of farm work tasks declared particularly hazardous for youth under the age of 16. The regulation states that no child under the age of 16 may be hired to perform any farm task deemed hazardous by the Secretary of Labor. Among these hazardous tasks were the operation of many farm machines, including tractors over 20 horsepower. A special exception was created by the 1968 amendment that permits 14 and 15 year old youths to perform many of those hazardous tasks provided they have successfully completed an approved training course in farm tractor and/or machinery safety and operation (U.S. D.O.L. 1970, 1991).

The primary goal of this project was to develop CAI/Multimedia intervention strategies for teaching principles of safe farm tractor and machinery operation to America’s rural youth population. The information was presented through dynamic interactive computer programs using the latest available technology. Effectiveness of the programs was measured using a comparative study between existing traditional, instructor-led training programs and the newly developed computer-based methods.

The effectiveness of CAI/Multimedia as a teaching medium in agricultural and technological fields has been demonstrated by other studies. Poe compared electrical wiring tasks using high school and college students. Subject mastery was found to be higher for students receiving computer-based instruction than for students taught with traditional laboratory instruction. Results were: 68% mastery with CAI/Multimedia versus 52% mastery with instructor-based instruction for complex wiring tasks; 83% mastery with CAI/Multimedia versus 72% mastery with instructor-based instruction for simple wiring tasks. Poe concluded that CAI/Multimedia was more effective than traditional laboratory instruction in teaching hands-on wiring techniques to high school agricultural education students and to university students in basic agricultural mechanization classes (Poe, et al, 1987).

Using CAI/Multimedia to teach basic hydraulics, Blank concluded that this method just as effective as instructor-based education. The author suggested that instructors should be able to increase the average student's comprehension by using CAI/Multimedia and supplying additional or supplemental information without an increase in instructional staff. Assuming Blank was correct, computer-based training materials for safe farm tractor and machinery operation could alleviate the problem of the shortage of qualified instructors for teaching the certification courses (Blank, 1991).

A program for teaching principles of agricultural economics to university freshmen was tested by comparing three instructional groups. One group received only CAI/Multimedia instruction; one group received only traditional classroom instruction; and one group received traditional instruction followed by the computer instruction. Although no significant difference was detected in posttest scores, the time of instruction was 32% less with CAI/Multimedia group (Marrison and Frick, 1993).

One of the primary advantages of CAI/Multimedia instruction is that the individual student is permitted to progress at his/her own pace (Hazari, 1992). Students who are more comfortable learning at a quicker pace are less likely to become disinterested due to the slower pace dictated by traditional teaching methods. Students who find it difficult to keep up in the classroom can take as much time as they need to master a subject and the program can be designed to provide topic reviews whenever a deficiency is detected.

The advantages of computer assisted instruction were detailed by Lehman and Kidd (1992). Those applicable to this project include:

1. **Interactively** --The computer requires active learning by the student. It can present information, elicit the learner's response, evaluate the response, and provide immediate feedback.
2. **Individualization** --The computer's branching capabilities permit instruction to be tailored to the individual.
3. **Consistency** --Computer-based training provides replaceable instruction and a consistency often lacking in classroom instruction and independent study programs using printed materials.
4. **Motivation** --Computer simulations provide challenging scenarios for the student. Motivation is a key element in learning.
5. **Personalization** --Learners can proceed at their own pace without fear of appearing inept to their peer or instructors.
6. **Administration** --Computer-based training packages can be designed for stand-alone use; no instructor is required. Automatic record keeping is possible, permitting a trainer to track each individual student's progress despite flexible scheduling and use.
7. **Learner control** --Learners perceive the ability to control CAI to be a positive attribute.
8. **Cost effectiveness** --Although more expensive to develop than traditional instructor-based instruction, CAI is much less expensive to maintain and deliver. Computer disks are inexpensive and easy to duplicate and distribute, and microcomputers are widespread.

SIGNIFICANCE

Participation in the federally prescribed Farm Tractor and Machinery Safety Certification program has been low in most states. In 1993 only 5,783 youth of the estimated 346,000 ages 15 to 19 participated in the farm tractor safety certification program. This low participation could be due, in part, to a lack of qualified instructors and a lack of appropriate training materials. This project addressed potential solutions to those limitations through a three-pronged approach to develop accessible, up-to-date, training materials that could be used for the required classroom portion of the certification programs. These materials may also be used in the national 4-H Farm Tractor and Lawn and Garden Tractor projects, agricultural education classes, state and local highway departments and as a resource for refresher courses for farm machinery operators of any age.

One prong of the project was the development, testing, and distribution of an interactive multimedia CD-ROM for providing a portion of the required classroom instruction of the certification program. The CD-ROM utilized high-resolution graphics, video, animation, digital audio, and interactive learning activities in a hypertext format. The program is arranged in a series of independent units suitable for individual, as well as sequential, use.

The second prong of the project consisted of the development, testing, and posting of a World Wide Web site that provided similar instructional materials to the CD-ROM. The continuing exponential growth and accessibility of the WWW is providing a dynamic information base soon to be as common as the personal home computer. The educational power inherent with the ability of instant access to unlimited archives of knowledge is somewhat like an untamed frontier. Considering its recent history, one can only guess where web technology will be in two to three years. However, it appears certain that the boundaries of both formal and informal education will continue expanding and pushing deeper into that frontier. It is essential that any educational training materials presented in the WWW format be carefully scrutinized for accuracy and dependability before posting.

The third prong involved the development, testing and distribution of an interactive student-training manual. The manual was developed using high quality illustrations, photographs and hands-on educational activities.

Completion of this project and the three resulting educational pieces has resulted in the following benefits, benefits currently not available in the tractor safety certification program:

1. Provide high quality educational training materials for a portion of the federally mandated tractor and machinery safety certification program. The current materials are 20 plus years old and as such use educational theory that is no longer on the cutting edge. The new materials developed involve the user in the learning process through interactive educational hands-on activities. Likewise, the CD-ROM and WWW program use cutting edge technologies (i.e., digital video, high quality graphics, audio and interactive activities) to aide the user in the learning process.
2. The new interactive educational materials have been developed so that the youth can learn in a self-directed, self-study situation, reducing the tremendous demands placed upon the volunteer instructor.

3. Develop high quality educational materials on tractor and machinery safety that may be used in other educational settings such as the 4-H tractor program and high school agricultural educational classes.
4. Farm parents have an educational tool that would aide them in teaching tractor and machinery safety to their children, children who may not enroll in the tractor safety certification program.

RESULTS/EVALUATION

This project consisted of 8 major components and 29 action steps. Following is a listing of the 8 major components and 29 action steps with a report on what was accomplished for each.

Component	Action Steps	Accomplishment
1. Hire project staff	1.1 Hire staff as identified in this proposal.	This project was effectively and efficiently completed using student labor from Purdue's Department of Technical Graphics.
2. Form and work with an advisory committee	2.1 The advisory committee for this Project has already been established.	Twelve individuals representing agricultural safety experts, 4-H volunteers, high school vocational agriculture instructors and agricultural machinery representatives were selected to serve on the advisory committee (<i>listing of committee is attached</i>).
	2.2 Meet with advisory committee via phone at least twice during this Project	An initial phone conference was held with the advisory committee to discuss the scope of the project and the proposed subject matter outline. Additional correspondence was via email and US mail.
3. Develop a detailed outline of subject matter topics and subtopics	3.1 The Project teams will develop a detailed outline of subject matter content to be included in all three versions of the curriculum pieces to be developed.	Done
	3.2 Advisory Committee members along with Project staff will meet via a phone conference to thoroughly discuss and refine the detailed outline.	Done
	3.3 The subject matter outline will be revised based on input from the advisory committee.	Done (<i>copy is attached</i>)
4. Develop an interactive paper	4.1 The Project Director, team leaders and writer will meet to develop a plan and procedure to ensure that all three	Accomplished

<p>manual, interactive CD-ROM and interactive WWW (World Wide Web) versions of high quality agricultural tractor and machinery safety educational materials</p>	<p>curriculum pieces will follow the subject matter outline developed.</p> <p>4.2 The project teams (team leader, writer and computer programmers) will identify and produce, as needed, multimedia resources such as video, audio, pictures, animation sequences, and interactive activities.</p> <p>4.3 Each project team for the three curriculum pieces will develop an initial draft version of their curriculum piece.</p> <p>4.4 Professors Reeder, Sheldon and Tormoehlen, team leaders for the three curriculum pieces, will correspond weekly, via phone or e-mail, to ensure that the materials being developed are consistent.</p> <p>4.5 Following completion of the initial draft of the three curriculum pieces, the advisory committee will be asked to review them.</p> <p>4.6 The project teams for each of the curriculum pieces will revise the draft version based on the feedback from the advisory committee.</p>	<p>Accomplished. Graphics and 3-D animations were both developed and acquired from other sources.</p> <p>Accomplished</p> <p>Accomplished</p> <p>The CD-ROM and paper manual were mailed to the advisory for their input. The mailing also included the URL for the web site.</p> <p>Accomplished.</p>
<p>5. Validate the educational materials developed.</p>	<p>5.1 Appoint members of the advisory committee to one of the three subgroups (review committees).</p> <p>5.2 Each project team will design a short evaluation instrument to be distributed to the review committee along with the draft copy of the curriculum pieces.</p> <p>5.3 Following feedback from the review committees, the team leaders for each of the three curriculum pieces will meet to discuss how the feedback will be incorporated across all three curriculum pieces where appropriate.</p>	<p>This process was modified to include all advisory committee members reviewing all three curriculum pieces for accuracy and correctness.</p> <p>An instrument was not developed. The advisory committee was asked to review the materials for accuracy and for completeness based on the subject matter outline developed.</p> <p>Accomplished</p>

	5.4 Each curriculum piece will be revised based on the feedback from the review committee.	Accomplished
6. Pilot test all three versions (paper manual, interactive CD-ROM, and WWW based) of the tractor and machinery safety educational materials developed.	<p>6.1 The project teams will develop an evaluation tool to be distributed to individuals participating in the pilot testing phase.</p> <p>6.2 Each project team/leader will identify 3 to 5 youth for pilot testing of their materials.</p> <p>6.3 Each curriculum piece will be pilot tested.</p> <p>6.4 The team leaders for each of the three curriculum pieces will meet to discuss how the feedback will be incorporated across all three curriculum pieces where appropriate.</p> <p>6.5 The curriculum pieces will be revised based on feedback from the pilot testing.</p>	All three instruments used in the final testing of the products (i.e., multimedia perception questionnaire, participant questionnaire and pretest/post test) were developed and evaluated using youth attending the National 4-H Tractor, Small Engines and Lawn Tractor Events. Total of 36 youth. The evaluation instruments were revised based on the feedback gathered.
7. Field test all three versions of the educational materials developed using 12 to 15 year old youth.	<p>7.1 Identify and select the field test sites.</p> <p>7.2 Develop the evaluation tools (i.e., pretest, posttest, and perception questionnaire).</p> <p>7.3 Field-test the curriculum pieces using youth 12 to 15 years of age.</p> <p>7.4 Tabulate, analyze and summarize the data gathered.</p> <p>7.5 Revise, update and produce the curriculum pieces as identified in the field testing phase. The American Society of Agricultural Engineers in St. Joseph, MI</p>	<p>Evaluation of the CD-ROM and Web based programs was conducted at Clinton Prairie High School in Indiana using 8th to 10th graders. The paper manual was evaluated using freshman and sophomore aged youth in a vocational agricultural classroom in Ohio.</p> <p>The evaluation instruments as revised in the pilot testing phase were used for the final evaluation phase of this project.</p> <p>Accomplished with the two test population mentioned above.</p> <p>Partially done. Some of the data is still being analyzed.</p> <p>Accomplished.</p>

	will do the page layout, illustrations and printing of the interactive paper manual.	
8. Disseminate results from the field testing	<p>8.1 The team leaders will prepare articles on the findings of the Project.</p> <p>8.2 Submit articles for publication in refereed injury prevention journals, both nationally and internationally, professional agricultural health and safety journals and education journals.</p> <p>8.3 Make presentations at national and international injury prevention conferences such as ASAE (American Society of Agricultural Engineers) and NIFS (National Institute for Farm Safety).</p>	<p>This stage of the project is in process.</p> <p>An article will be submitted to a referred journal such as the Journal of Agricultural Safety and Health or the Journal of Safety Research.</p> <p>Proposals for presentation of the findings have been submitted to the National Institute for Farm Safety and the American Society of Agricultural Engineers.</p>

Reports and papers on the project were presented at:

- 1998 National Extension Technology Conference, St. Louis, MO
- 1998 American Society of Agricultural Engineers International Meeting, Orlando, FL
- 1998 National Institute for Farm Safety Conference, Canada
- 1998 National Safety Congress, Los Angeles, CA

FINDINGS

A comparative evaluation of the interactive CD-ROM based program and the web-based program was conducted using 63 eighth and tenth graders at Clinton Prairie High School in Frankfort, IN. A pretest/post test evaluation was used to determine the effectiveness of each educational strategy at causing a positive gain in knowledge.

To insure a random test population and to eliminate biases each class was randomly divided into three groups using the following procedure:

1. Youth drew a number (1, 2 or 3) from a hat. This process was done to break the class into three randomly divided groups.
2. To determine which group was assigned to the CD-ROM, Web and traditional classroom instructional group a number 1, 2 and 3 were placed in a hat. The first number drawn was the number of the group assigned to use the CD-ROM educational strategy. This process was repeated to assign the Web-based group and the control group (*traditional classroom setting with instructor and manual*).

This process was done for all three classes.

The evaluation process was conducted over a three-day period. The activities conducted by day follow:

- **Day 1:** Provided a brief overview of the project, stating the goals and purpose. Following the pretest and participant questionnaire were administered.
- **Day 2:** Youth, in their respective groups, were taught tractor safety. In the CD-ROM and Web-based instructional groups the youth did not receive any instruction other than that provided by the computer-based programs. Dr. Tormoehlen and Dr. Sheldon, project directors, were in the room only to observe. In the traditional classroom setting youth used HOBAR's *Safe Operation of Agricultural Equipment* and received instruction from a veteran agricultural education instructor.
- **Day 3:** The post test and multimedia perception questionnaires were administered to the youth.

	INSTRUCTIONAL STRATEGY		
	CD-ROM	Web-based	Traditional classroom instruction (control group)
Number of test subjects	21	22	20
Average pre-test score	9.8	10.5	10.0
Average post test score	14.6	13.0	12.6
Average gain	4.9	2.5	2.6
Percent knowledge gained	49.8	24.2	26.0

General Observations

Youth who used CD-ROM based program were excited about the program. Comments such as "WOW", "Awesome", "Did you see that?" were comment place as the students reacted to the interactive graphics and activities in the program.

SUMMARY

A comparative test of the three educational strategies employed (*interactive CD-ROM, Web-based program and traditional classroom instruction with instructor*) found that the interactive CD-ROM was the most effective at creating a positive change in knowledge. While the goal of this study was meet, that being to develop, test and distribute high quality agricultural tractor and machinery safety curriculum, via interactive CD-ROM, interactive World Wide Web (WWW) programming and interactive paper manual a lot of questions remain to be answered concerning the use of electronic technology as an educational tool in the agricultural safety field.

Research questions that need to be addressed include:

1. Is there a different in the amount of knowledge retained between the three educational strategies? This study only evaluated short-term knowledge retention. What about long term knowledge retention? Research needs to be conducted to see if the differences observed in this study are maintained over a three to six month period.
2. Is one educational strategy more effective than the others at creating a positive change in safety and health attitudes?
3. What about behavioral changes? This study only looked at knowledge change. A more important question is "Is one educational strategy more effective than the others in creating a permanent behavioral change?"

This study demonstrated that knowledge on health and safety issues can be imparted to the learner effectively using electronic medium such as CD-ROM technology and web based programs.



Memorandum

Date: May 23, 2001

From: Roy M. Fleming, Sc.D., Director, Research Grants Program RMF
Office of Extramural Programs, NIOSH, D30

Subject: Final Report Submitted for Entry into NTIS for Grant 1 R01 CC514374-01.

To: William D. Bennett
Data Systems Team, Information Resources Branch, EID, NIOSH, P03/C18

The attached final report has been received from the principal investigator on the subject NIOSH grant. If this document is forwarded to the National Technical Information Service, please let us know when a document number is known so that we can inform anyone who inquires about this final report.

Any publications that are included with this report are highlighted on the list below.

Attachment

cc: Sherri Diana, EID, P03/C13

List of Publications *None*

NIOSH Extramural Award Final Report Summary

Title: Tractor Safety Certification: A Multi-Curricula Approach
Investigator: Roger L. Tormoehlen, Ph.D.
Affiliation: Purdue University
City & State: West Lafayette, IN
Telephone: (765) 494-8429
Award Number: 1 R01 CC514374-01
Start & End Date: 9/30/1997–11/30/1998
Total Project Cost: \$120,000
Program Area: Special Populations
Key Words:

Abstract:

The primary goal of this project was to develop, test and distribute high quality agricultural tractor and machinery safety curriculum, via interactive CD-ROM, interactive World Wide Web (WWW) programming and interactive paper manual, that would meet part of the requirements for the federally prescribed tractor certification program. The three educational pieces developed (interactive CD-ROM program, Web-based program and paper manual) were evaluated in a comparative study to determine the educational effectiveness of each to create a positive gain in knowledge. Results showed that high school aged youth using the interactive CD-ROM based program exhibited an average knowledge gain of 49.8%. Youth using the web-based program gained an average of 24.2% and youth receiving instruction with the paper manual and instructor showed an average knowledge gain of 26.0%. Knowledge was measured using a pre-test/post test strategy.

Publications

No publications to date.