

DETERMINING CRITICAL SUBJECT MATTER CONTENT FOR A SAFETY CERTIFICATION PROGRAM FOR YOUTH EMPLOYED IN AGRICULTURAL PRODUCTION

Robbie R. Ortega, Graduate Assistant

Roger L. Tormoehlen, Professor

William E. Field, Professor

Mark Balschweid, Assistant Professor

Purdue University

Krisanna L. Machtmes, Assistant Professor

Louisiana State University

Abstract

Purdue University is conducting research to evaluate the effectiveness of an interactive CD-ROM and Internet-based curriculum teaching teenaged youth critical production agricultural safety and health-related information required under the Federal Hazardous Occupations Order. Selected community-based teaching strategies were evaluated and compared for their effectiveness in developing knowledge, changing attitudes and behaviors and improving practices related to the safe operation of agricultural tractors and machinery. This paper summarizes the methodology and outcomes of research conducted to identify and validate the core safety-related competencies upon which the curriculum was based. A preliminary set of competencies was developed using mandated training requirements, past curriculums, and recent youth-related injury data. An expert panel representing various stakeholders independently ranked the preliminary set of competencies and identified additional desired competencies for youth performing farm-related tasks. A sample of high school agricultural educators and youth further reviewed the competencies confirming their significance. The findings showed a high level of consistency between the expert panel, high school agricultural educators and the youth concerning inclusion of the identified competencies into the new curriculum. A set of 170 knowledge and skills-based competencies categorized into 12 units resulted, along with a set of questions designed to assess learner mastery of the competencies.

Introduction

In 1938 the United States Congress passed the Fair Labor Standards Act (FLSA), which included provisions designed to protect youth from hazardous work associated with agricultural production. An amendment to the FLSA, formulated by the United States Department of Labor (U.S.D.O.L.), was passed in 1968. Known as the Hazardous Occupations Order in Agriculture (HOOA), this amendment stated that no child under the age of 16 could be hired to perform any farm task deemed hazardous by the Secretary of Labor. However, the 1968 Act created an exception to the HOOA restrictions which allowed and

still allows, 14 and 15-year-old youth to perform certain hazardous tasks if they have successfully completed approved training in tractor and/or machinery safety and operation (U.S. Department of Labor, 1984). This exception established the basis for development of a national farm tractor and machinery safety certification program for youth.

The HOOA identified two organizations for providing the mandated county-level farm tractor and machinery safety training: one being a course offered through the Cooperative Extension Service's 4-H program, and the other taught through local high school vocational agriculture programs (Fair Labor Standards Act, 1971). The

curriculum content used by both approved sources of training was based on the 4-H Tractor Project curriculum, which was introduced in the early 1960s with support from Standard Oil (National 4-H Council and Standard Oil Company, 1963). This curriculum consisted of four student manuals and a leader's manual containing instructional assistance, sources of additional resources and answers to the questions found at the end of each unit of the student manuals. No documentation of how the subject matter was derived could be found. Silletto and Hull in 1976 combined components of the 4-H curriculum materials specifically identified in the HOOA into a single publication, *Safe Operation of Agricultural Equipment* (Silletto & Hull, 1976, 1998). Though revised on a periodic basis, the core training materials have remained relatively the same and have become out of date both in technical content and general appearance. Furthermore, considerable attention was given to maintenance information in the Silletto and Hull publication that was not directly related to safe operation of agricultural tractors and machinery. This reflected the intent of the earlier 4-H Tractor Project curriculum that included topics such as fuels, lubricants, hardware, and general maintenance tasks. A review of comparable literature during the era when the 4-H material was initially developed suggests that a greater priority was generally placed on proper maintenance of the tractor and machinery rather than operator safety. The function and productivity of the equipment appeared to be of greater importance than the safety of users and bystanders.

Participation in the federally prescribed farm tractor and machinery safety certification program has dramatically declined since the peak enrollment periods in the 1960's and '70's (Carrabba, 2000). This decline was largely attributed to the substantial reduction in the farm population, the changing role of youth on many farms, a lack of qualified instructors, and a lack of appropriate and up-to-date training materials. Issues such as these have led to some states discontinuing the training making compliance for eligible youth with the HOOA requirements near to impossible

to achieve. This dilemma, though affecting a relatively small number of youth, is significant considering the disproportionate share of farm-related injuries involving youth. Carrabba concluded that new educational materials readily developed to meet federal training for youth requirements should focus on the "big ticket" items causing the most fatalities and severe injuries and employ current educational methodologies and new delivery strategies.

As part of a research effort sponsored by CDC/NIOSH, Purdue's Departments of Youth Development and Agricultural Education, and Agricultural and Biological Engineering have collaborated on exploring the effectiveness of interactive CD-ROM and World Wide Web based educational programs to teach youth critical production agricultural safety and health related topics that contribute toward meeting the HOOA requirements. The first step of the project was to identify the core competencies that the computer-based programs should incorporate. This article summarizes the process used to identify and validate these competencies.

Significance of Appropriate Curriculum Component Selection

The most significant agent contributing to farm-related fatalities involving youth has historically been and continues to be tractors. Forty-five percent of all unintentional farm work deaths involving youth relate to exposure to or operation of farm tractors (Sutherlin, 2001). When equipment is included, the percentage increases to approximately 75% (Sutherlin, 2001). Even though the number of farm-related fatalities is on the decline, especially among youth, the problem of tractor-related injuries is such a significant part of the problem that it must be addressed if further reductions in the number of children and adolescents involved in farm workplace deaths are to occur. Furthermore, much has been learned about the causative factors involved in other types of farm and ranch-related injuries involving youth and new forms of technology. New production methods have been introduced since the original curriculum material was developed resulting in the need to add new subject

matter content to those previously used. All of this type of information needs to be incorporated into new instructional materials if it is to remain relevant and effective.

A review of the literature identified no published effort to narrow in on the most critical cognitive and skills-related competencies that youth need to acquire in order to be safe farm workers and operators of agricultural tractors and machinery. Work by the National Children's Center for Rural and Agricultural Health and Safety explored age appropriateness of certain farm-related tasks but did not identify needed skills and knowledge (Marshfield Medical Research and Education Foundation, 1999). Each of the presently available curricula and those curricula now out-of-print appear to have been based upon a common set of core topics, but no documentation was provided on how these topics were selected or how they could effectively impact the safety of workers. For example, some materials gave considerable attention to how spark plugs function and the selection of the proper weight motor oil. Knowledge related to either of these activities, however, would not likely cause or prevent an injury even if the learner was unable to correctly perform the related competencies such as adjusting the spark plug air gap. It appears that the heavy emphasis on maintenance activities was a strategy used to motivate students through the safety components of the curriculum.

Regardless of whether the curriculum is paper-based or computer-based, the success of the curriculum depends, largely, on the appropriateness of the subject matter content. It is critical, especially when unmastered knowledge can lead to injury, that the most pertinent subject matter be identified and clearly communicated. Identifying the topics that are most important for the student to learn or the "big ideas" within a content area facilitates the greatest amount of knowledge acquisition and makes it possible for students to learn in the most effective manner. Organizing instruction using "big ideas" enables instructional designers to reduce the memory load for students and to promote more conceptual understanding (Stein & Carnine, 1998).

The diversity of the potential student population participating in the trainings, including the level of prior knowledge, breadth of educational skills, scattered distribution of the target population, geographical and cultural differences, and limited local resources such as time, instructional staff and supplemental materials (i.e. access to videos, etc.) also had to be considered in the development of curriculum components. Each of these issues had the potential of presenting complex barriers to the effective delivery of whatever curriculum was designed. Consequently, it was determined that the contents needed to be more focused than prior curricula, targeting topics that develop, reinforce and encourage the most critical safe behaviors of the participating youth. The format needed to provide considerable flexibility without compromising academic quality (Smith, 1993).

Using a theoretical framework developed by Tyler (1949), four fundamental questions were considered when developing the revised curriculum:

1. What is the purpose of the curriculum? "If an educational program is to be planned and if efforts for continued improvement are to be made, it is very necessary to have some conception of the goals that are being aimed at. These educational objectives become the criteria by which materials are selected, content is outlined, instructional procedures are developed and tests and examinations prepared" (Tyler, 1949). The purpose of this curriculum being the reduction of deaths and injuries to adolescent farm workers through safety training.
2. What educational experiences can be provided to attain this purpose? "Essentially, learning takes place through the experiences which the learner has; that is, through the reactions he/she makes to the environment in which he/she is placed" (Tyler, 1949). In other words, what are the essential competencies that youth need to

acquire prior to being able to safely operate agricultural tractors and machinery and perform other hazardous farm-related tasks?

3. How can these educational experiences be organized effectively? "Since learning experiences must be put together to form some kind of coherent program, it is necessary for us to consider the procedures for organizing learning experiences into units, courses, and programs" (Tyler, 1949). How should a safety certification program for youth employed in agricultural production be organized to present a logical flow of relevant information that builds upon prior knowledge and competencies? The existing HOOA training is based upon the assumption of prior knowledge in agricultural production practices. The training was not designed to train an individual with no prior experience in agriculture to become an efficient and safe worker.
4. How can it be determined whether or not the desired purposes are being attained? "Evaluation is an important operation in curriculum development. It should be clear that evaluation then becomes a process for finding out how far the learning experiences as developed and organized are actually producing the desired results. As a result of evaluation, it is possible to note in what respects the curriculum is effective and in what respects it needs improvement" (Tyler, 1949). Do youth who participate in safety training actually experience a lower rate and severity of farm work-related injuries?

Tyler's approach, confirmed by other researchers responsible for a revival of interest in curriculum design (Harden, 1986; Pratt, 1980), has provided an established and tested approach to use in identifying the essential components of a new safety training program for youth employed in agricultural production.

An additional approach to curriculum development as emphasized by Pratt (1980) is the use of an advisory committee or curriculum team. Pratt looked at the formation of a curriculum team using individuals with expertise in at least six areas. Pratt stated that three of the expertise areas are critical to the development of a comprehensive curriculum while three are important to curriculum development. Subject matter, pedagogy, and curriculum design were critical while measurement, organization, and writing skills were important. Pratt also stated that it is necessary to include representatives from many constituencies including the potential users of the curriculum. "A more creative and broader interplay of ideas is possible than any member of the team could achieve autonomously" (Pratt, 1980).

Kingman, Yoder, Sutherlin, and Field (2001) also looked at utilizing expert panels, specifically in agricultural safety and health research. Kingman stated that constant assessment and evaluation of the progress of the expert panel is needed to accomplish the group's goals. Kingman also stated that flexibility is key to successfully working with expert panels. "Without the use and input from a panel of experts, the outcomes and development of the critical competencies would be deficient in scope and relevancy" (Kingman, et al.).

Project Goal and Objectives

Using Tyler's approach, a process was designed to identify the essential or core knowledge and skills-based competencies that should be incorporated into a training curriculum for youth prior to their employment on farms and ranches where it would be expected that they would be exposed to or engaged in work activities recognized as hazardous by federal law or by recently published injury data.

The specific short-term objectives were to:

1. Identify potential and mandated competencies deemed necessary by:
 - a. Developers of prior tractor and machinery safety curriculums

- b. Federal and state regulations applicable to youth employed in agricultural production
2. Identify competencies that could potentially address the primary causes of farm-related injuries to youth based upon suggestions of a panel of experts and the most recently published injury data.
3. Validate and prioritize the competencies utilizing a panel of experts, educators, and potential users of the revised instructional materials.
4. Organize the competencies into coherent categories that could provide the basis for the instructional components of a training program for youth employed in agriculture.

Methodology

Using Silletto and Hull's (1998) *Safe Operation of Agricultural Equipment* and other available tractor and machinery safety resources from both the U.S. and Canada, an initial list of desired competencies for tractor and machinery operators and farm workers was identified. Silletto and Hull's book is the only remaining nationally distributed student manual for use in training youth to meet the Federal requirements under the HOOA. It is distributed by HOBAR Publications of St. Paul, Minnesota. This list was complimented with an additional set of competencies that was generated by reviewing data and recommendations published on the issue of child and adolescent injuries in agricultural workplaces (Lee, Gallager, Marlenger, & Hard, 2002). This set of competencies reflected new findings on causes of farm-related injuries to this population and changes in agricultural production practices that have occurred since much of the original training material was produced over 35 years ago. For example, none of the existing material addressed skid steer loaders, ATV's or utility vehicles, common sources of recently documented injuries.

All federal laws relating to farm and ranch employee training were reviewed and specific training requirements noted. The review included the training components

required by the HOOA, OSHA and EPA. It was concluded that an effective training program should be responsive to all federal regulations and incorporate, to the extent possible, mandated training. Where the law included specific age restrictions, such as relating to fork lift operation or pesticide application, this information was translated into corresponding competencies. From this review came additional competencies that also incorporated, for example, the annual employee training requirements under OSHA and personal protective equipment training required by EPA. A list of 68 specific, measurable competencies was drafted from this preliminary review of existing curricula and federal regulations ranging from tractor and farm machinery topics to first-aid and emergencies.

An expert panel of individuals representing agricultural safety specialists, agricultural equipment manufacturers, 4-H tractor leaders, high school agricultural educators, agricultural news media, the Hispanic/migrant worker population, and youth were identified and invited to participate in the project as an expert panel of curriculum reviewers. Panel members were chosen based upon their expertise in several relevant fields and personal interest in agricultural safety issues. Agricultural safety specialists from both the public and private sector provided the technical background needed while the 4-H tractor leaders, high school agricultural educators, and agricultural news media gave insight on instructional format, presentation and delivery. Those representing the Hispanic/migrant worker population and youth were chosen to help determine if the curriculum would be effective at reaching Hispanic/Spanish speaking audiences. The final panel was comprised of 15 individuals who met on three occasions for 2-day work sessions over a 2 ½ year period.

A questionnaire was developed using the initial 68 critical competencies and mailed to members of the expert panel. Using the questionnaire, the panel was invited to independently weigh the importance of each competency using a Likert-type scale. Responses were coded as Absolutely Non-essential=1, Non-essential=2, Unsure=3, Essential=4, and Absolutely Essential=5.

Members of the expert panel were also encouraged to include any additional competencies they felt were necessary for youth to safely operate tractors and equipment and perform other typical farm work. There was a 100% return rate of the questionnaire. The feedback was analyzed and competencies prioritized using the weighted averages of the scores given by the panel members. A face-to-face meeting with the expert panel was then held to expand, refine, and prioritize the list of desired competencies. Using a group consensus process, the panel, with the summarized data gathered from the returned surveys, was instructed to come to a consensus on the

importance of each competency and determine whether or not each should be included in the new curriculum.

A revised set of 72 competencies was prepared with additional emphasis given to drafting each as a measurable skill or knowledge. To categorize the competencies, 12 major headings were developed and by using a consensus process, each competency was placed within one of the 12 categories, with all performance based competencies grouped into category 12. The categories are listed in Table 1. The revised set of categorized competencies in outline form was redistributed to the panel of experts for review and comment.

Table 1
Subject Headings for Curriculum Competencies

1.	General Safety Overview
2.	Tractor Basics
3.	Tractor Pre-operational Procedures
4.	Tractor Operation
5.	Tractor Powered Implements
6.	Other Self-propelled Agricultural Equipment
7.	Operating Tractors and Equipment on Public Roads
8.	Safely Maintaining and Repairing Agricultural Equipment
9.	ATV/Utility Vehicle Safety
10.	General Farm and Ranch Hazards
11.	First Aid and Emergencies
12.	Tractor Operation Performance Skills

Using the revised set of competencies, a second questionnaire was developed and administered to high school agricultural educators ($n = 34$) attending an in-service training and a group of 4-H youth ($n = 79$) attending an agricultural engineering event, both held at Purdue University. The purpose of the survey was to further validate the findings of the expert panel concerning core competencies content and to determine if there were differences in the perceptions of the youths and teachers as to what should and should not be included in the curriculum. High school agricultural educators were used in the determination of the critical competencies to obtain the perspective of the educator while youth were

used to gain their perspective as prescribed by Tyler (1949). "Education is an active process. It involves the active efforts of the learner himself. Hence it is essential to see that education provides opportunities for the student to enter actively into, and deal wholeheartedly with, the things which interest him." The following section presents the findings of this survey.

Findings From Preliminary Assessment of Competencies

The following analysis is based on a comparison of data from a subset of the teachers and students pulled from the original 113 subjects who indicated that they

used a tractor on a monthly, weekly, or daily basis ($n = 80$). Demographics of the respondents are listed in Table 2. The youth group was comprised of 71% males and 29% females whereas the agricultural educators were all male. A majority of the youth responders (> 80%) lived on a farm and were not members of a 4-H Tractor club (> 70%). Because of the small sample size and ordinal data, a Mann-Whitney U Test was used to test for statistical significance. The Mann-Whitney U -test ranks the scores from two groups together from the lowest to the highest value (while retaining a label to indicate from which group each score

came). The value of U reflects the number of times scores for one group precedes scores for the other group in the distribution. After the whole distribution is examined, the total value of U is found. A probability value is then determined that indicates the probability that a value of U of this magnitude or smaller could occur under the terms of the null hypothesis. A Mann-Whitney U allows researchers to examine the data to see if the values from one population are significantly higher or lower than the values from another population (Hinkle, Wiersma, & Jurs, 1994). This test is equivalent to the t -test.

Table 2
Background Characteristics of Youth and Agricultural Educators ($N = 80$)

Variables		Age		% of Total
		Youth 14-18	Ag. Educators 22-57	
Gender	Male	37	25	80.5
	Female	15		19.5
Live on Farm	Yes	48	18	83.5
	No	6	7	16.5
Member of 4-H Tractor Club	Yes	19	2	27.0
	No	35	22	73.0

Note. Not all totals equal 80 due to non-responders in each category

Statistically significant differences between the two populations, youth and teachers, occurred on 50% of the critical competencies. Analysis further revealed that the teachers always ranked or prioritized the competencies higher than the youth. Competencies that youth ranked significantly lower than the agricultural educators are listed in Table 3. It should be noted that while youth ranked the importance of these tasks lower than the agricultural educators they still felt, in most

cases, that the competencies should be included in the curriculum.

Table 3 lists only the critical competencies in which there were statistically significant differences between the two populations. The table shows the number of responses for the youth and high school agricultural educators, the mean rank of responses, and the calculated value from the Mann-Whitney U procedure. The column headed "Mann-Whitney U " shows the significant difference level between the two populations.

Table 3
Competencies That Youth Ranked Significantly Lower Than Agricultural Educators

Critical Competency	Respondent	N	u	
			Rank	p
Replace shields and guards	Youth	54	34.82	.001
	Ag. Educators	25	51.18	
	Total	79		
Charge a battery with charger	Youth	53	33.28	.000
	Ag. Educators	22	51.63	
	Total	77		
Jump start a tractor with a low battery	Youth	54	32.92	.000
	Ag. Educators	25	55.30	
	Total	79		
Replace damaged/missing guards	Youth	53	33.96	.001
	Ag. Educators	25	51.24	
	Total	78		
Adjust operator's seat and steering wheel	Youth	50	31.61	.000
	Ag. Educators	25	50.78	
	Total	75		
Adjust rear view mirror	Youth	47	29.89	.000
	Ag. Educators	25	48.92	
	Total	72		
Locate, identify, and describe the function of the charge indicator	Youth	51	33.33	.002
	Ag. Educators	25	49.04	
	Total	76		
Explain use of SMV emblem and other retro-reflective material used on equipment	Youth	51	32.42	.000
	Ag. Educators	25	50.90	
	Total	76		
Demonstrate the standard arm signals for use on public roads	Youth	51	33.15	.001
	Ag. Educators	25	49.42	
	Total	76		
Describe how to contact local emergency services	Youth	50	32.59	.000
	Ag. Educators	25	48.82	
	Total	75		

The questionnaire distributed to the youth and agricultural educators was also used for a cross tabulation showing what critical competencies these two groups felt should and should not be included within the curriculum. These competencies were prioritized using a frequency percentage. The analysis showed that the youth and agricultural educators prioritized the competencies similarly with the teachers

ranking the competencies higher than the youth.

Table 4 lists the critical competencies that both the youth and agricultural educators felt should not be included in the tractor safety certification curriculum. Shown are only those competencies that 50% or more of the youth and teachers felt should not be included.

Table 4
*Competencies Youth and Agricultural Educators Felt Should Not Be Included**

Critical Competency	Youth	Ag. Educators
	%	%
Adjust fan tension	51.9	--
Adjust the operator's seat & steering wheel	54	--
Adjust the rear view mirror	57.5	--
Check antifreeze with hydrometer	72.5	76
Check battery electrolyte levels & change	67.9	72
Clean battery terminals	55.6	--
Locate, identify, and describe the function of the hour meter	55.1	52
Identify the different types of fire extinguishers	54.9	--
Jump start a tractor with a low battery	51.9	--
Replace light bulbs	69.8	--
Replace overload clutches as required	51.9	64
Replace wiper blades	79.6	52

* - 50% or more youth and teachers felt should not be included.

Table 5 includes a sample of the critical competencies that 50% or more of the youth and agricultural educators felt should be included in the curriculum.

Table 5
*Competencies Youth and Agricultural Educators Felt Should Be Included**

Critical Competency	Youth	Ag. Educators
	%	%
Check for fuel or oil leaks.	92.6	76
Describe the steps to take in the event of an injury or emergency.	92	100
Identify, describe, and demonstrate the function of the engine throttle.	87.5	100
Explain the dangers of hydraulic oil under pressure.	90.9	95.8
Explain the role of ROPS and seatbelts in preventing injuries in the event of a rollover.	89.9	95.9
Identify, describe, and demonstrate the function of the gear shift lever.	87.5	100
Identify environmental hazards to tractor operation including overhead power lines, ditch banks, holes, and low branches.	90	100
Implement (farm equipment) hazards (i.e. pinch points, crush points, shear points).	86.8	100
Locate, describe, and identify the function of the oil pressure indicator.	88.2	100
Identify, describe, and demonstrate the function of the PTO control lever.	87.6	100

* - 50% or more youth and teachers felt should be included

Expanded Set of Competencies

Using the collective feedback gathered from two additional meetings of the expert panel, the data from the survey of teachers and youth, and review by three external reviewers, a further substantial revision to the set of competencies was completed including a significant expansion of the list in order to include new competencies or breakdown preliminary competencies into more specific and measurable competencies. In addition, the panel was used to identify a set of hands-on or skills based competencies

that were considered essential for the safe performance of high risk tasks. This revised set was distributed and reviewed at a third meeting of the expert panel with attention given to combining comparable competencies, enhancing clarity of text, ensuring comprehensiveness of competencies selected and categorizing the competencies into logical and somewhat balanced groupings. The groupings eventually became the primary sections or chapters of the final curriculum. The final set of 170 competencies, organized into 12

units, was used as the basis for developing the contents of the new safety curriculum for training youth to work on farms and ranches. The curriculum has been developed as a CD-based program with adaptability for use on the web and eventual publication in a paper version for use in traditional settings. The competencies form the core for both the student component of the curriculum and supportive material for instructors.

Evaluation Component

In order to assess student learning resulting from exposure to the newly developed curriculum a set of questions directly relating to the core competencies was developed. Learning associated with each competency was measured through a response to a corresponding question. In some cases, where the expert panel placed a very high priority on the competency, more than one question was used to ensure student mastery of the subject matter. A total of 254 questions were designed and reviewed by the expert panel. The questions were field tested by seven high school agricultural educators and administered to 127 students enrolled in Purdue's Agricultural Safety class. Revisions were made to enhance clarity and reduce the level of reading difficulty to approximately the ninth grade. A reading specialist was employed to review both the competencies and the evaluation questions to ensure appropriateness for the target audiences. The revised questions were then inserted as review questions at the end of each unit of the CD-ROM based curriculum and are being used to provide instructors a data base of questions for student testing.

Since the existing Federal Hazardous Occupations Order does not specify the level of student performance required to become certified, even with respect to the specific competencies, additional work is needed to determine whether or not the questions can be used to screen or eliminate program participants who may be at greater risk of injury. If the 170 validated competencies have been determined to be essential or critical for the youth to master prior to participating in work deemed to be hazardous, it is only logical that the student should score correctly on a relatively high

number of questions designed to test mastery of the competencies. Without an effective evaluation component, it will be impossible to ascertain the impact the curriculum has in instilling the desired competencies.

Conclusions

The process utilized to develop a set of critical competencies for the federal tractor and machinery safety certification program utilized four key steps. Step #1 was the use of a sound theoretical framework as defined by Tyler in 1949. The four questions asked by Tyler aided in the approach and development of the newly revised curriculum. The second step was to critically review existing materials and previous farm-related injury data to devise an initial list of competencies. Curricula developed by the 4-H Youth Tractor program, HOBAR publications, and Deere and Company were the primary sources used when developing the list of competencies. The use of an expert panel as emphasized by Pratt (1980) and Kingman, et al. (2001) was the third key step. Without the use and input from the panel of experts, the outcomes and development of the critical competencies would have been deficient in scope and relevancy. The final, and fourth key step, was the use of end users, in this case high school agricultural educators and high school aged youth to validate the competencies developed. This four-step approach provided a sound scientific method for the development of a comprehensive list of key competencies for use in curriculum design. It is believed that the set of competencies developed through this process provides a valid foundation for completion of a safety curriculum that not only meets the present federal training requirements but also addresses hazards associated with present production practices.

Recommendations

Based on the findings and conclusions of this study, the following recommendations for the continuation of the development of a new interactive multimedia tractor and

agricultural machinery safety curriculum are as follows:

1. Additional validation of the 170 core competencies using potential employers of youth involved in production agriculture would further confirm their applicability to real world settings. The employers would be used to concur that the youth involved in production agriculture, in fact, are exposed to the hazards addressed in the set of competencies.
2. Further testing of the materials should to take place outside of the Midwest to ensure that the curriculum can be used nationally rather than regionally and that the contents are culturally sensitive.
3. Additional teaching materials need to be developed aside from the new CAI/Multimedia curriculum. These new materials would integrate the latest teaching technologies with more traditional means of instruction creating a total package for high school agricultural educators and 4-H tractor leaders to disseminate agricultural safety and health information.

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ROBBIE R. ORTEGA is a graduate student in the Department of Curriculum and Instruction at Purdue University, West Lafayette, IN 47907-2098.

ROGER L. TORMOEHLEN is a Professor in the Department of Youth Development and Agricultural Education at Purdue University, 615 W. State Street, West Lafayette, IN 47907-2053. E-mail: torm@purdue.edu

WILLIAM E. FIELD is a Professor Department of Agricultural and Biological Engineering at Purdue University, 225 S. University Street, West Lafayette, IN 47907-2093. E-mail: field@ecn.purdue.edu

MARK A. BALSCHWEID is an Assistant Professor in the Department of Youth Development and Agricultural Education at Purdue University, 615 W. State Street, West Lafayette, IN 47907-2053. Email: markb@purdue.edu

KRISANNA L. MACHTMES is an Assistant Professor in the School of Human Resource Education and Workforce Development at Louisiana State University, 142 Old Forestry Building, Baton Rouge, LA 70803-5477. E-mail: machtmes@lsu.edu