Final Report

Effectiveness of Computer-Based Safety Training in Vineyard Workers

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A) Final Progress Report

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List of Terms and Abbreviations

CBT - Computer-based Training
EPA - Environmental Protection Agency
HazCom - Hazard Communication
NIEHS - National Institute of Environmental Health Sciences
NIOSH - National Institute for Occupational Safety and Health
NwETA.com - Northwest Education Training and Assessment
OHSU - Oregon Health and Science University
OJT – On-the-job training
PA - Pesticide Applicator training
PubMedCentral (where publications are filed with the National Institutes of Health)
R2P - Research to Practice
¡Salud! - Tuality HealthCare ¡Salud! Services
STTR - Small Business Technology Transfer grant
WPS - Worker Protection Standard

Conflict of Interest

Drs. Anger and Rohlman are the inventors of the cTRAIN system and 9BUTTON used in this project. This could result in financial benefit for them and OHSU if this study and others like it produce useful results. Drs. Anger and Rohlman also have a company, NwETA, that could benefit if this study and others like it produce useful results. This potential conflict has been reviewed and managed by OHSU and the Integrity Program Oversight Council. If you would like more information, you may contact the OHSU Research Integrity Office at (503) 494-7887.

Abstract
Many agricultural workers have migrated to the US with a limited educational and cultural background to succeed and work safely in the US. While most have completed only 6 years of education, half have less than 6 years and some have not completed any schooling at all. Therefore, industry may utilize on-the-job training (OJT) for these immigrant workers rather than formal training that may be considered to be too challenging. While OJT is preferred for teaching how to adapt specific skills to a workplace, structured formal training provides more consistent expert information than OJT for most topics, especially safety. Therefore, this project sought to test the hypothesis that well-designed computer-based training (CBT) could be used to teach basic safety knowledge, routine skills and skills required for advancement in an agricultural workforce, and teach it as effectively as reported in other better educated populations.

To ensure that the training met the needs of the workforce, community-based participatory research was employed to develop training that melded work skills and safety for Oregon's vineyard industry. The partners were Oregon Health and Science University, Tuality HealthCare ¡Salud! Services and several Oregon vineyards. The project was guided by an Advisory Committee consisting of vineyard executives, vineyard managers, vineyard workers, academics and community partners. The training (a) established basic knowledge (employee orientation, Worker Protection Standard, Hazard Communication), (b) seasonal safety fundamentals and work skills, and (c) improved promotion potential (supervisor skills, pesticide applicator knowledge). Members of the Advisory Committee selected the topics, gave interviews to describe the basic information to develop each topic, and provided the setting and supported volunteers on paid work time for pilot testing of the training and to evaluate the training's effectiveness in the vineyards. Community partner ¡Salud! ensured recruitment participation by supporting the project with the vineyard organizations and their workers. The training content was delivered by cTRAIN, a computer-based training (CBT) system founded on behavioral principles, included a spoken text option, and provided user instructions developed for the target audience, all in Spanish and English.

The participants, who were all experienced vineyard or orchard workers, learned from the training based on improvement pre- to post-training tests, and the majority of both employers and participants rated the training as very good to excellent. Knowledge and work practices in these experienced workers began high and showed improvement. When measured, work practices changed following the training recommendations. These changes were statistically significant and had large effect sizes (d over 0.8) in participants who had a mean of 6 years of education or less.

Turning to the specific topics, training of basic skills and safety showed improvement, though beginning at a high baseline. Based on re-testing at 5 months following initial training on the Worker Protection Standard (WPS), the repeat training required by Environmental Protection Agency (EPA) every 5 years was demonstrated to be too long. Improvement was also seen in learning of complex training topics, including pesticide applicator knowledge (a 1200-screen training program) and behavioral supervisor skills.

After completing the full series of training topics, many participants and all employers requested a continuation of the training. Both the repetition of some topics and the addition of new topics were requested, supporting their ratings and enthusiasm for targeted, well-designed training.

Highlights/Significant Findings

- Agricultural workers with limited education can learn from computer-based training and change their behavior (work practices) based on that knowledge, to work both more effectively and safely.
- Agricultural workers with limited education can learn principles of supervision from computer-based training coupled with a face-to-face workshop.
- Worker Protection Standard (WPS) training provides a base of knowledge, but that base knowledge does not include all critical information, and some information is lost within 5 months after training. This suggests that EPAs current minimum re-training requirement of 5 years is too long a gap between training sessions.
- Agricultural workers with limited or extensive education rate well-designed computer-based training targeted to them very favorably, and request additional training.
- Agricultural workers with limited education react positively to even challenging training on pesticide application information and procedures in a 7-day course of training, remaining on task.

Outcomes/Relevance/Impact

Computer-based training is a powerful technology that guarantees consistent and efficient delivery of training. When people are hired in small groups or one-at-a-time, it is prohibitively expensive to employ professional trainers to teach basic knowledge and skills and required training such as Hazard Communication (HazCom) and Worker Protection Standard (WPS). On-the-job training (OJT) can be reliable and effective, but there is no guarantee that OJT is consistent, thorough, or accurate, as there is with professional training. Yet, the limited education of the agricultural and other select occupational workforces, and the lack of knowledge of English, has led agricultural companies to use co-worker OJT as the most expedient approach to teaching critical and required information.

This project demonstrated the effectiveness of consistent computer-based training (CBT) content with agricultural populations through pre- vs. post-tests and observation of work practice changes in the field. The CBT used was cTRAIN. Thus cTRAIN content programs provided a valuable tool for agricultural industries and specifically for the vineyard industry, because they can ensure that knowledge is conveyed consistently and completely. Both cTRAIN and its editing tool, as well as the content programs are available for licensing at a fee. However, the principles in cTRAIN are described in the peer reviewed publications from this cooperative agreement and other grants, so those principles can be applied to other computer- and internet-based training programs to generalize these findings and the technology to other training software and other industries. The primary principles are: (1) self-pacing and interactivity (frequent quizzes, immediate feedback, high accuracy criterion); (2) clear user instructions, developed with the target audience, requiring little coaching for most students including those with no education; (3) icon-based navigation cues always on-screen (e.g., an eye indicating to ‘show’ a movie and the option to speak the text on the screen, recorded in Spanish by a native speaker, represented by an ear); (4) pictures and/or a movie on all screens.

An outcome of this project that could impact regulations is the demonstration of incomplete recall of Worker Protection Standard (WPS) training which should inform EPAs current (2008-2009) efforts to revise the WPS training and to reconsider the current 5-year re-training requirement as too long.

Translation of Findings: Research To Practice (R2P)

While free distribution of the training and the software could result in substantial usage initially, this would not serve to maintain the software or the content over the long haul. The R2P strategy of this project, therefore, is to commercialize the training software and the training content developed in the project. This strategy emerged from the recognition that the software program developed (2001) in the PI's laboratory to train the participants (cTRAIN) and the training content itself will need to evolve in order to remain current and functional over time. We also created an editing tool to allow other developers to create training in cTRAIN (for a fee), and a licensing key function with internet delivery was also developed for efficiency. We therefore formed Northwest Education, Training and Assessment (NwETA.com), a company developed to market the training software and content. The company's home page is shown in Figure 1. Oregon Health & Science University (OHSU) licensed cTRAIN to NwETA in 2006 and the 9BUTTON response unit used for limited-education audiences such as agricultural workers, was licensed in 2007.

Figure 1. NwETA home page.

At each annual Advisory Committee meeting (e.g., Figure 2) of this project, we have referred to this R2P plan and provided updates on the progress of NwETA. We have also committed that all vineyard companies that participated in the Cooperative Agreement would receive license to the training at no cost. This R2P plan was also described to the project technical officer, Janet Ehlers, RN, and to Drs. Max Lum and Pietra Check of NIOSH in 2007. The Advisory Committee and NIOSH representatives have voiced positive support for this approach to R2P. The company website, nweta.com, provides a history and the current status of the company and its products.

No NIOSH cooperative agreement funds were used to support the formation or development of NwETA. A National Institute of Environmental Health Sciences (NIEHS) Small Business Technology Transfer (STTR) grant provided limited startup costs, and contracts won by the company has paid for the additional growth of NwETA. The conflict of interest of the licensing of cTRAIN to NwETA has been declared to NIOSH and a conflict management plan has been put in place by OHSU to oversee the PI's activities in this regard.

Figure 2. Advisory Committee

Research to practice issues were described in Anger et al., 2007:

Anger WK. Hänninen Lecture: Problems and prevention: Research in developing countries and immigrant populations from developing countries. Neurotoxicology 2007, 28: 207-214.

Scientific Report

The overall goal of this project is to test the intervention effectiveness of a computer-based training program in a typical agricultural population, vineyard workers. As such, this population represents an immigrant sample with limited education, largely Latino and from central Mexico. Their mean average years of education completed is approximately 5-6 years, ranging from 0-16 years.

The training program, cTRAIN, is the basic methodology used across all studies.

It is founded on training principles and techniques proven in the laboratory and confirmed in field applications. The primary principles that underlie behavioral education (Edgar and Sulzbacher 1992) and cTRAIN, and the basis for the experiments proposed in Specific Aim 1, are:

1) Fully specify learning objectives.

2) Focus attention on key elements.

3) Carefully sequence training steps to assure competence at each point.

4) Learner-paced progress through training steps.

a) Active, "constructed" response required at each training step. To proceed to the next training step, the learner must make accurate, active choices among alternative answers to demonstrate successful learning.

b) Rapid corrective and motivating feedback based on performance. Once the learner has chosen an alternative in response to a question, it is evaluated for correctness and immediate feedback is given to strengthen correct responding and to redirect the learner who has made an error.

c) Practice until material is mastered. Practice continues at each step until a capable performance is achieved.

5) Precise record of accomplishments. The path for each learner through the training program is recorded to determine how easily each step was accomplished. This allows evaluation of the individual's training and identifies steps in the program that are too difficult.

cTRAIN provides a training program or delivery platform in which information is presented and competency is documented according to the principles identified above. In addition, cTRAIN provides a "builder" development or editing environment for content experts to create training and test questions, and to load this information into a cTRAIN training program (an automatic step). One specific strength of a behavioral educational approach is its emphasis on learning for each and every individual, not just improving the group average.

cTRAIN is structured as a series of building blocks, termed "information sets" or "info sets" that consist of one or more screens of information followed by one or more "quiz" questions about the information.

1) Information set screens accommodate a limited amount of text and several still digital photos and/or movies and sound recordings (for spoken text).

2) Quiz questions are in multiple choice format with 2-4 possible answers (including yes or no). Correct answers are required to each quiz question in an info set to progress to the following info set. An error returns the trainee to the first screen in the info set that the trainee must step through again and give a correct answer on the same quiz item before proceeding.

3) Each information set screen has: (a) title, (b) a sub-head to describe the content, (c) text, and (d) a representation of the 9 response buttons plus icons depicting the function of each button, on the bottom of every screen (see Figure 3).

4) Each button has specific functions: (a) Buttons 1-4 are for answers to quiz questions; (b) 5 > “show” a movie or enlarge a picture; (c) 6 > “tell” or speak the text; (d) 7 > “more” or supplementary material; (e) 8 > step back one screen; and (f) 9 > step forward to the next screen.

5) The boxes in the lower right of the screen inform the trainee: (a) number of screens completed and to go, and (b) a visual representation of progress.

6) Completion of the content is followed by a Post-test. A pre-test option can present questions prior to beginning training and to provide a test-out option.

Data Reports are generated in a standard spreadsheet, including: (1) **Summary** report that lists totals and percent correct totals, (2) **Detailed** report that includes all trainee responses to track every event during the training, and (3) **Tag** report that lists performance by test question category (e.g., percent correct on questions on labels, questions on storage, questions on transport of hazardous substances).

Figure 3. Navigation bar at the bottom of each cTRAIN screen. Only the words are different on navigation bars in other languages, Spanish and Arabic at present.

Eight studies **(identified as 1-8, below)** are the outputs of this project. They are listed under the 4 aims.

Aim 1) Develop effective computer-based occupational safety & health training (topics from community-based group, owners) to teach optimal work practices, supported by supervisor feedback & reinforcement training.

Eleven **topics** were created, piloted, revised and presented in cTRAIN computer-based training:

- General Orientation to US Industry and Vineyard Work
- Basic Employee Skills
- Worker Protection Standard
- Hazard Communication
- Stretch and Flex
- Supervisor Skills
- Seasonal Skills and safety: Winter, Spring, Summer
- Pesticide Applicator Knowledge and Skills
- Ladder Safety in Orchards

(1) Developing User Instructions. Anger WK, Tamulinas A, Uribe A, Ayala C. Computer-Based Training for Immigrant Latinos with Limited Education. Hispanic Journal of Behavioral Sciences 2004, 26:373-389.

Mexican immigrants working at a wholesale nursery were involved in developing user instructions for the computer-based training system used in this project. It was described in the preliminary research in the cooperative agreement application for this project. Sixty-one Latinos with 0 to 16 years of education completed user instructions delivered on the computer, and all but 3 completed training content about the nursery. Based on objective criteria, program use was rated as "somewhat easy" to "easy" for most participants with more than 3 years of education, whereas 50% of those with 0 to 2 years of education completed content with "difficulty" or "struggled." Participants who completed the computer-based post-test (n = 22) had a mean performance of 96%, which was significantly better than the performance of 87% (n = 18) on an oral pretest (p = .003, d = 1.02). Thus, computer-based instruction can effectively train immigrant Latinos who have very limited education. A typical cTRAIN screen is shown in Figure 4.

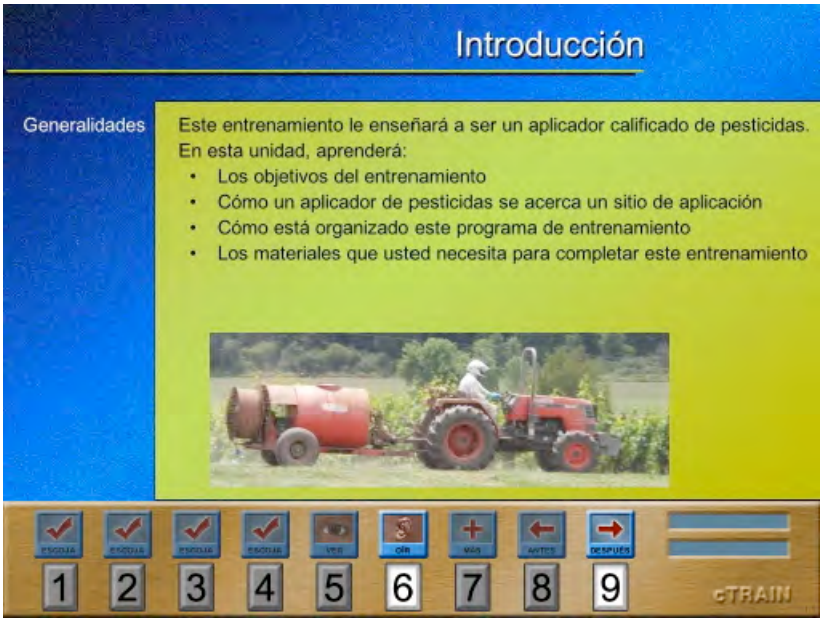


Figure 4. Typical cTRAIN screen (2008)

(**2) Initial Test of Training Format:** Anger WK, Stupfel J, Ammerman T, Tamulinas A, Bodner T, Rohlman DS. The Suitability of Computer-based Training for Workers with Limited Formal Education: A Case Study from the US Agricultural Sector. International Journal of Training and Development, 2006, 10: 269-284.

The suitability of computer-based training (CBT) for workers with limited education was evaluated in an Hispanic orchard workforce that reported little computer experience and 5.6 mean years of formal education. Ladder safety training was completed by employees who rated the training highly (effect size [d_gain] = 5.68), and their knowledge of ladder safety improved significantly (p=0.01) from 81.8% to 93.8% (d_gain = 1.45). There was also a significant increase (p <0.01) in safe work practices immediately after training (d_gain = 0.70), at 40 days post training (d_gain = 0.87) and at 60 days (d_gain = 1.40), indicating durability of the training. The largest and most important change, maintaining loppers more than 12 inches from the face, is shown in Figure 5. As in mainstream populations, reaction or affective ratings correlated well with utility ratings, but not with behavior change. This demonstrates that an agricultural workforce with limited formal education can learn job safety from CBT and translate the knowledge to work practice changes, and those changes are durable.

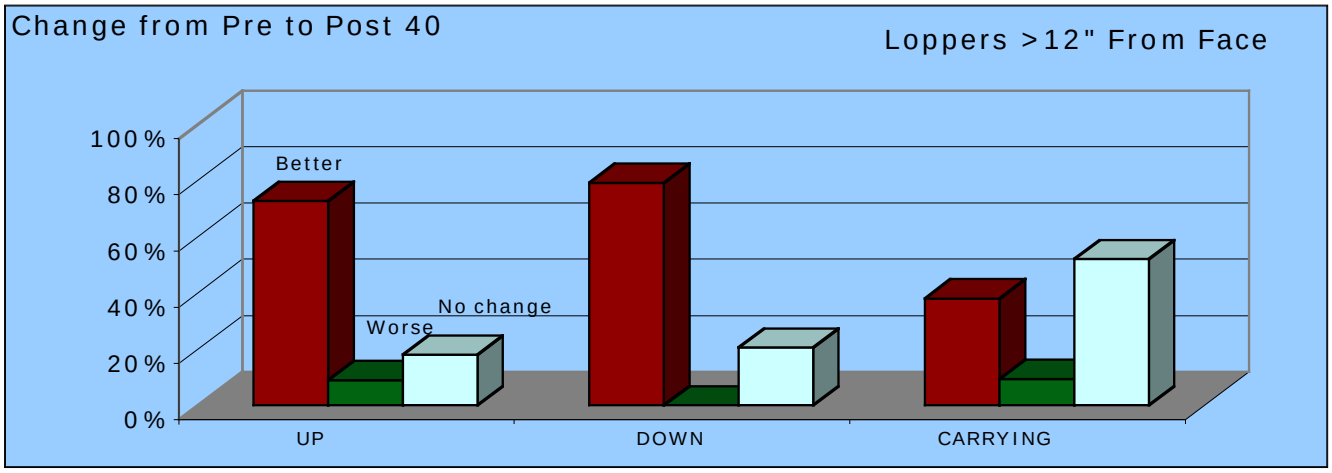


Figure 5. Percent of participants holding loppers *more than 12 inches* from their face more often (better), less often (worse) or not changing at 40 days after training, while climbing up or down a ladder, and while carrying the ladder.

(3) Supervisor Training: Austin J, Alvero AM, Fuchs MM, Patterson L, Anger WK. Pre-training to Improve Workshop Performance in Supervisor Skills: An Exploratory Study in Latino Agricultural Workers. Journal of Agricultural Safety and Health, 2009, 15: 273-281.

Employees with limited education may be excluded from advanced training due to assumptions that they might not learn rapidly. However, preparatory training may be able to overcome missing experience in education. The purpose of this study was to test the hypothesis that computer-based training of supervisor skills in Latino agricultural workers with limited education would improve subsequent performance in a workshop designed to teach supervisor skills. Ten men born and educated in Mexico participated in the study; all spoke Spanish, the language of the training. CBT training on behaviorally-based supervisor skills was developed (filming for the movies in the training is pictured in Figure 6, showing a simulated observation of a supervisor coaching an employee). The training was pilot tested in Latino supervisors. Five participants

(mean 6.4 years of education) completed computer-based supervisor skills training, and five participants (mean 8.2 years of education) completed computer-based hazard communication (hazcom) training as a control condition. Following the computer-based training, a consultant experienced in behavior management conducted a two-day supervisory skills training workshop face-to-face. Although the groups did not differ on knowledge scores on a multiple-choice test before the face-to-face workshop, after the workshop the HazCom group had a mean test score of 51.2% (SD=8.7) while the Supervisor group had a higher mean test score of 65.2% (SD=14.3). The difference was marginally significant by a *t*-test (p = 0.052), and the effect size was large (*d* = 1.16). The results suggest that computer-based training in supervisor skills can be effective in preparing participants with limited education to learn supervisor skills from a face-to-face workshop. This result suggests that a lack of education is not a barrier to learning complex skills, that pre-training may improve learning in a workshop format and that successful pre-training may be presented in a computer-based format to employees with limited education.

Figure 6. Simulated observation showing distance of observer to workers.

(4) Year-Long Training Program: Anger WK, Will LL, Patterson L, Fuchs M, Rohlman DS, Bodner T, Garside L. Community-Based Participatory Research for Prevention: A Training Initiative focused on Vineyard Skills and Safety in Oregon (USA) (unpublished).

The purpose of this study was to determine if repeated training in one format would change each of Kirkpatrick's four main levels of training evaluation: (a) reaction: the training would be accepted by agricultural workers regardless of educational attainment, (b) knowledge: post-test performance would improve by comparison with pre-test performance and the speed of completing training (viz., mean time per screen) would also improve as a measure of increased facility with the training format, (c) behavior: improve work practices, and (d) results: improve management perceptions of the workers' safety and job skills (the baseline measures of accidents and workers compensation claims were too low to demonstrate measurable changes).

Community-based participatory research (CBPR) on training that melded vineyard work skills and safety was conducted in Oregon's vineyard industry, with special emphasis on training that melded skills and safety and would improve the participants' promotion potential (employee basics, supervisor skills, pesticide applicator skills). The partners were Oregon Health and Science University, Tuality HealthCare ¡Salud! Services and Oregon vineyards, and the project was guided by an advisory committee consisting of vineyard executives, vineyard managers, vineyard workers, academics and community partners. The Advisory Committee guided and supported this development by selecting topics, providing the basic information to develop each topic and arranging for the piloting to take place at their vineyards during work time. The community partner ensured recruitment for the piloting and participation by the vineyard organizations.

Two female and 37 male participants were recruited from 4 vineyards. Their mean age was

37.6 years. All were born in Mexico, they had lived in the US a mean of 12.1 years and their mean years of education was 6.6. Participants identified their job titles as workers, tractor drivers, or supervisors/foremen, and the mean number of years worked at this position was 7.4.

Three vineyard managers, 1 female and 2 male, who oversaw these workers were also recruited to complete a safety climate survey and evaluation of the training program. Their mean time in this position was 6.3 years. Their mean age was 39 years and the mean years of education was 11.3. Eight worker and tractor driver participants were recruited as "new Employees" or controls at the end of the project, to take the non-seasonal training and the reaction questionnaires. Their demographics were similar to those of the other employees, although they were a little younger, had slightly more education and had lived in the US fewer years than the other participants.

Targeted training was provided seasonally, in winter, spring and summer. In addition, Hazard Communication (HazCom) and Worker Protection Standard (WPS) were also administered to participants at the end of the season. Figure 7 is a picture from the training.

Speed of performance: The amount of time per screen reveals that the amount of time spent per screen was approximately 38 seconds in the initial Winter training and then declined to 22-24 seconds per screen in the summer skills and safety topic. Time-per-screen increased on the final topic, Worker Protection Standard (WPS), which increased to over 40 seconds per screen (this topic had a very extensive pre- and post-test and may not have been representative).

Reaction: Participants rated the training as excellent (92.9%) or Good (7.1%). No participant rated the training OK, Not very good or poor.

Knowledge: Mean correct performance on the pretests was 77.6%, increasing to 92.2% on the post-tests after the training.

Behavior: There were trends to increased wearing of proper clothes and proper work practices after the training.

Results: From the survey at the end of the study completed by the vineyard managers, following is the percent of the three managers who evaluated the training as having a positive impact on: 1) job safety (100%), 2) job skills (67%), 3) attitude or comments toward work (67%), 4) attitude toward supervision/management (67%), 5) attitude towards the company (67%), and 6) intangible ways (33%). None of the three selected "no impact I could observe," or "NEGATIVE impacts."

Figure 7. Dropping leaves during summer training.

(5) Pesticide Applicator Training: Anger WK, Patterson L. Pesticide Applicator Training. The primary request of the project's community partner was to provide training in pesticide application to help vineyard workers in the community to pass the Oregon state licensure test. Oregon's Department of Agriculture reports that 78.5% of people taking the state certification test in English pass while only 9.7% of people taking the test in Spanish pass the test.

The Pesticide Applicator (PA) training was based on information in a state-funded training manual and converted to a computer-based format (worker taking PA training is shown in Figure 8) through reorganization, and a series of pilot studies on small groups of topics. The training package consisted of ~1200 screens of training on:

Regulations
Pesticide Management
Transport
Storage Disposal
Labels
PPE
Formulations
Equipment
Using a calculator, Equipment Calibration
Mixing, Loading, Application
Residues
Spill Response
Records
Liability
Health Effects of Pesticides
First Aid
How to Take the Oregon Pesticide Applicator Exam
Practice Test for the Oregon Pesticide Applicator Exam

Figure 8. Pesticide Applicator training on computer with 9BUTTON response unit.

The entire PA package was then administered to a group of participants, revised and then administered to a second group of participants. Fourteen workers who sought to pass the state certification test participated in the pilot studies (Figure 9). Their mean age was 31.7 (range 22-46) and mean education was 6.5 years (range 0-12 years) in the first pilot and the mean age was 31.5 (range 21-47) and mean education was 7.1 years (range 0-11) in the second pilot.

Following the first pilot of the full package, group discussions formed spontaneously in the 'open availability' days, and flash cards were developed during our second full pilot. In each case, the initiative came from the community members from Salud or the employees taking the training. Virtually all topics were modified following data collection and participant feedback. The practice test developed for the second pilot of the full training package proved accurate in predicting how people would fare on the state test. No trainee passed the 100-question state licensure exam following the pilot studies, but virtually all participants completed the training expressing the opinion that they understood the information. Although the state test was in Spanish, it focused on reading and applying information on labels; the labels were in English. Those who had taken the licensure exam previously improved their score on the second exam. The primary conclusion was that participants needed and extended period of learning, rather than concentrating the training in a week-long class.

The Pesticide Applicator training, at the recommendation of the project Advisory Committee, was therefore modified to be taken over a period of weeks for distribution to several vineyards. Thus, the classroom event was turned into an individual study program to be distributed to the vineyards in 2009.

Figure 9. Participants in week-long Pesticide Applicator training class.

Aim 2) Determine the feasibility of teaching a population with diverse education and computer experience to learn from internet-based training provided in a structured work setting.

The software was identified and tested and two content programs have been developed for both computer-based and internet-based delivery, to compare these two options. The internet-based training has been pilot tested, as has the computer-based training. However the study has not yet conducted because the participants were required for harvest and then left on vacation until January, 2009, when the study will be completed using the PI's discretionary funds. As a complement to this study, we evaluated the durability of Worker Protection Standard (WPS) training over a 5-month period.

(6) Recall of WPS: Anger WK, Patterson L, Fuchs M, Will LL, Rohlman DS. Learning and Recall of Worker Protection Standard (WPS) Training in Vineyard Workers. Journal of Agromedicine, 2009, 14: 336-344.

Worker Protection Standard (WPS) training is one of the US Environmental Protection Agency's primary methods for preventing pesticide exposure in agricultural workers. Retention of the knowledge from the training may occasionally be tested by state Occupational Safety and Health Administrations (OSHAs) during a site visit, but anecdotal evidence suggests that there is no consistent testing of knowledge after WPS training and the retraining requirements are at 5 year intervals, meaning the knowledge must be retained that long.

Vineyard workers completed a test of their baseline WPS knowledge, computer-based training on WPS, a post-test immediately after training and a re-test 5 months later. Pre-test performance suggested that there was a relatively high level of baseline knowledge of WPS information on two-answer multiple choice tests (74-75%) prior to training. Training increased the knowledge to 85% on the post-test of the same questions, a significant increase ($p < 0.001$, 1-tailed) and a large effect size (d) of 0.90. Re-test performance (78%) at 5 months revealed a return towards but not back to the pre-test levels. Better test performance was significantly correlated with higher education and to a lesser extent with younger ages. Whether this level of

knowledge is sufficient to protect agricultural workers remains an open question, although an increase in the proportion of people in a work group who know the critical WPS information may be the most important impact of training.

Aim 3) Evaluate the influence of education and related experience on training effectiveness.

(7) Age and education: The relationship between age, education and knowledge test results was assessed in two of the studies described here: The study Anger et al. study (Learning and Recall of Worker Protection Standard (WPS) Training in Vineyard Workers) in which the WPS training was administered two times 5 months apart (N = 52) reported under Aim 2 and the Observational Study under Anger et al. study (Community-Based Participatory Research for Prevention: A Training Initiative focused on Vineyard Skills) in which participants completed three training titles (N= 39) reported under Aim 1. Results are in those publications but brought out here for this Scientific Report (unpublished).

The correlation of age and education with pre-test and post-test performance is shown in Table 1. In both of the studies, there was virtually no correlation between age and either pre-test (r = -0.086-0.203) or post-test (r = 0.01-0.022) performance. The correlations with education were mixed in the two studies (r = 0.365 and 0.075), but they were more consistent and medium for post-test performance (r = 0.302 for the repeat WPS testing study and r = 0.372 for the 3 titles study). This would suggest that prior education has a medium impact on post-test performance and presumably learning but not a dominant effect that would prevent those with limited education from learning from CBT such as used here.

Table 1. Correlation of Age and Education with Pre-test and Post-test Performance.

Demographic	Pre-test – WPS	Pre-test 3 titles	Post-Test WPS	Post-test 3 titles
Age	-0.086	0.203	0.011	0.022
Education	0.365	0.075	0.302	0.372

Aim 4) Provide the training, software and hardware for a community-based organization to implement training, rigorously evaluate its integrity and effectiveness, and publish the result in a peer-reviewed journal.

The training, software and hardware have been provided to our community-based partner organization. Unfortunately, our partner who has a huge clinic to run and over 200 vineyards to serve each year, was not been able to complete the training she had planned due to her workload and a business reversal in her selected partners who were not able to provide the degree of support needed to complete the training.

In lieu of this aim, resources were devoted to an evaluation of an agricultural community-developed (Oregon State University, Washington State Department of Agriculture) face-to-face training class in pesticide applicator skills, based on a program developed by the University of California at Davis. Study results:

(8) Workshop effectiveness on donning/removal of PPE without contamination: Stock T, Patterson L, Fuchs M, Anger WK. Effects of a Training Workshop on PPE Selection and Donning in Latino Pesticide Handlers (manuscript in preparation).

The problem of providing effective communication across language barriers was tackled by a targeted, hands-on curriculum adapted by the Washington State Department of Agriculture (WSDA 2002). This study examined the effectiveness of the WSDA Hands-On Pesticide Handler Training Program. The aim was to identify retention of knowledge in Hispanic pesticide handlers over a six-month period of time following WSDA instruction. Pesticide handlers (n=23; mean age 39.8 years; mean 6.3 years of education in Mexico) working the area of Hood River, Oregon, were interviewed in January 2008. They were asked to demonstrate their knowledge of chemical work safety practices. Personal protection equipment (PPE) and applicator equipment were displayed (Figure 10) and participants were asked to don and remove the PPE and show their skill in cleaning the application equipment. In early February, the handlers attended the WSDA Hands-On Pesticide Handler Training Program, and in August 2008, the handlers were interviewed again and the same questions were repeated with the same PPE and equipment displayed. Their performance was reevaluated using the initial criteria, and performance before and after training was compared.

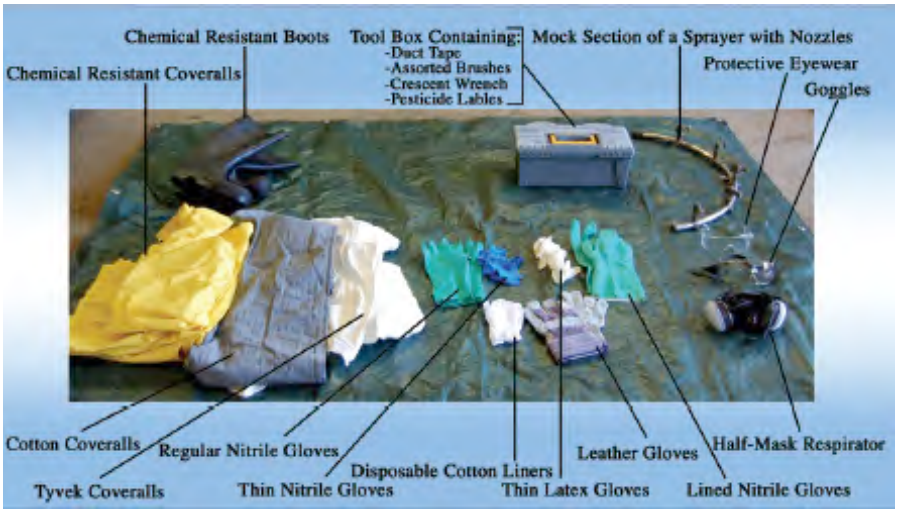


Figure 10. Clothes and equipment as presented to participants.

Overall improvement in knowledge and safety practices was found in 8 of 9 response categories, two of which changed significantly (binomial test $p<0.05$). As shown in Figure 11, participants identified the routes of exposure and steps for heat prevention more effectively 5 months after training than they did prior to the training. The WSDA curriculum is thus supported as being an effective and retentive method of instruction.

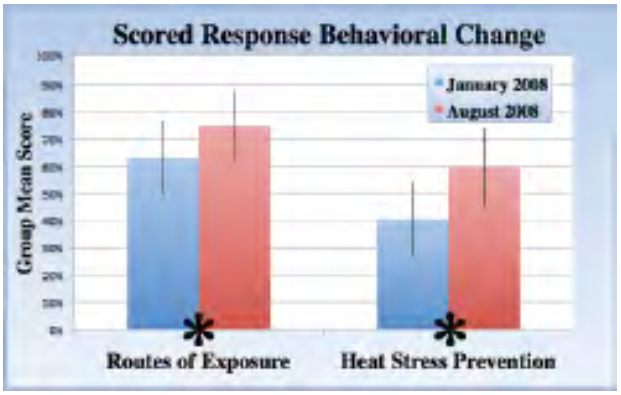
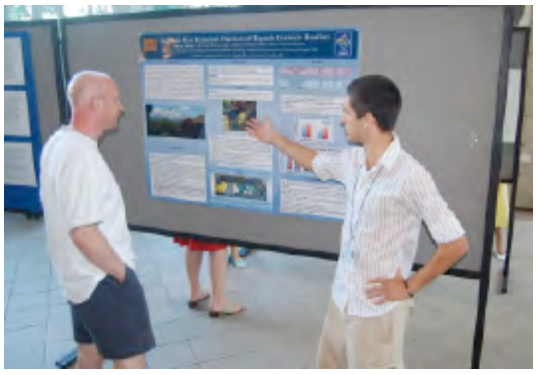


Figure 11. Correct responses in 2 categories.



The results of this study were presented in a poster by a student in summer OHSU's summer intern program in August, 2008. The intern conducted duplicate observations of the participants and used those data to develop the poster shown in Figure 12.

Manuscript in preparation.

Figure 12. Summer intern poster (2008).

Overall Conclusions

A Community-Based Participatory Research project with the goal of evaluating the utility of computer-based training (CBT) for training a typical agricultural population in the US focused on four specific aims. Based on the research proposal/application, the training titles we proposed were accomplished, but the number of screens in that training were more than triple expectations due to the huge amount of training required to teach the Pesticide Applicator topic.

As listed in the Significant Findings section, we conclude that there were five significant findings:

- Agricultural workers with limited education can learn from computer-based training and change their behavior (work practices) based on that knowledge, to work both more effectively and safely.
- Agricultural workers with limited education can learn principles of supervision from computer-based training coupled with a face-to-face workshop.
- Worker Protection Standard (WPS) training provides a base of knowledge, but that base knowledge does not include all critical information, and some information is lost within 5 months suggesting that EPAs current minimum re-training requirement of 5 years is too long a gap between training sessions.
- Agricultural workers with limited or extensive education react very favorably to well-designed computer-based training targeted to them, and request additional training.
- Agricultural workers with limited education react positively to even challenging training on pesticide application information and procedures in a 7-day course of training, remaining on task.

Publications

Anger WK, Stupfel J, Ammerman T, Tamulinas A, Bodner T, Rohlman DS. The Suitability of Computer-based Training for Workers with Limited Formal Education: A Case Study from the US Agricultural Sector. International Journal of Training and Development, 2006, 10: 269-284.

Anger WK. Hänninen Lecture: Problems and prevention: Research in developing countries and immigrant populations from developing countries. Neurotoxicology 2007, 28: 207-214.

J. Austin, A.M. Alvero, M.M. Fuchs, L. Patterson, W.K. Anger. Computer-Based Supervisor Skills Pre-training Improves Workshop Performance in Latino Agricultural Workers. Journal of Agricultural Safety and Health, 2009; 15:273-281.

Anger WK, Patterson L, Fuchs M, Will LL, Rohlman DS. Learning and Recall of Worker Protection Standard (WPS) Training in Vineyard Workers. Journal of Agromedicine, 2009, 14:336–344.

Manuscripts in preparation

Anger WK, Will LL, Patterson L, Fuchs M, Rohlman DS, Bodner T, Garside L. Community-Based Participatory Research for Prevention: A Training Initiative focused on Vineyard Skills and Safety in Oregon (USA).

Stock T, Patterson L, Fuchs M, Anger WK. Effects of a Training Workshop on PPE Selection and Donning in Latino Pesticide Handlers.

Inclusion of Gender and Minority Study Participants

Ethnic Category	Sex/Gender			
	Female	**Male**	**Unknown**	**Total**
Hispanic or Latino	6	182	3	**191**
Not Hispanic or Latino	0	1	0	**1**
Unknown	0	0	0	**0**
Total	**6**	**183**	**3**	**192**

Racial Category	**Female**	**Male**	**Unknown**	**Total**
American Indian or Alaskan Native	0	0	0	**0**
Asian	0	0	0	**0**
Black or African American	0	0	0	**0**
Native Hawaiian or other Pacific Islander	0	0	0	**0**
White	6	183	3	**192**
More than one race	0	0	0	**0**
Unknown	0	0	0	**0**
Total	**6**	**183**	**3**	**192**

Note: An additional 27 male Latino participants were included in the Oregon State University (OSU) substudy (8. Workshop effectiveness on donning/removal of PPE without contamination), but not included in the above table as they were reported through OSU's IRB.

Inclusion of Children

Children are not employed in the vineyard or orchard industry where this research was conducted.

Materials available for other investigators

Publication(s) are and will be available at PubMedCentral within 12 months of publication. Training content programs are available at NwETA.com.