

AN ABSTRACT OF THE THESIS OF

Allison Kathleen McNamara for the degree of Honors Baccalaureate of Science in Biology presented on June 2, 2009. Title: The Effectiveness of cTRAIN Computer-Based Programs in Occupational Psychology and its Sociological Implications.

Abstract approved _____
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Pesticides can often be toxic and for this reason their methods and quantities of application are extremely regulated. Pesticide applicators are at risk of permanently damaging their health from exposure to pesticides. In order to ensure that these employees have the proper information to protect themselves, they are required to pass a state certification test. Agriculture, in certain states, relies on a high number of immigrant workers having varying degrees of education, thus making it difficult to efficiently and effectively train each employee in the needed areas.

A computer-based training program for pesticide applicators was developed to be used by agricultural workers preparing for the state certification exam. The training program was designed to be effective for people with varying degrees of knowledge and computer experience. Similarly, its design has allowed for a method of training employees in their native tongue. Agricultural workers from a vineyard completed the computer-based training, in their native language of Mexican Spanish, prior to taking the state certification test. Nine of the sixteen workers passed the training program while none of them passed the state certification test. One participant did not complete either portion of the study, and one participant took the training but

did not take the certification test. Although none of the participants passed the certification test there was a significant increase in the training program scores between the pre-test and post-test. The statistical significances (t-statistics) for packages 1-4, were 0.00132, 0.00015, < 0.001, and 0.0004 in that order. All participants were encouraged to complete basic demographic surveys. The outcome of the training and state tests indicates a need to revise the content of the Pesticide Applicator training to better fit the information required for the certification test and account for the institutional bias that is inherent in the testing system. A follow-up study ran in August 2007 using the modified training.

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The Effectiveness of cTRAIN Computer-Based Programs in Occupational
Psychology and its Sociological Implications

By
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A THESIS

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ABSTRACT:

Pesticides can often be toxic and for this reason their methods and quantities of application are extremely regulated. Pesticide applicators are at risk of permanently damaging their health from exposure to pesticides. In order to ensure that these employees have the proper information to protect themselves, they are required to pass a state certification test. Agriculture, in certain states, relies on a high number of immigrant workers having varying degrees of education, thus making it difficult to efficiently and effectively train each employee in the needed areas.

A computer-based training program for pesticide applicators was developed to be used by agricultural workers preparing for the state certification exam. The training program was designed to be effective for people with varying degrees of knowledge and computer experience. Similarly, its design has allowed for a method of training employees in their native tongue. Agricultural workers from a vineyard completed the computer-based training, in their native language of Mexican Spanish, prior to taking the state certification test. Nine of the sixteen workers passed the training program while none of them passed the state certification test. One participant did not complete either portion of the study, and one participant took the training but did not take the certification test. Although none of the participants passed the certification test there was a significant increase in the training program scores between the pre-test and post-test. The statistical significances (t-statistics) for packages 1-4, were 0.00132, 0.00015, < 0.001, and 0.0004 in that

order. All participants were encouraged to complete basic demographic surveys. The outcome of the training and state tests indicates a need to revise the content of the Pesticide Applicator training to better fit the information required for the certification test and account for the institutional bias that is inherent in the testing system. A follow-up study ran in August 2007 using the modified training.

INTRODUCTION:

Problem Statement

Establish the most effective method of administering job training to immigrant vineyard workers and determine the hindrances and social factors affecting the efficacy of training.

In this study the main questions were: Did the participants gain knowledge from the Pesticide Applicator training program? And was the Pesticide Applicator training program an effective means of preparing employees for the state certification test? What sociological factors may have impacted the results?

Basis for Work

A pesticide is any chemical used to kill, harm, or repel a pest (ODA). Pesticides fall into one of two categories; either general-use pesticides or restricted-use pesticides. In agriculture, restricted-use pesticides are typically utilized, which means that the pesticides may only be used by a licensed pesticide applicator or a person they supervise (ODA). A license is required to buy or apply restricted use pesticides, or to give advice on how to apply pesticides. In the state of Oregon, the Oregon Department of Agriculture (ODA) is responsible for distributing licenses and registration for pesticide application.

Exposure to pesticides has been found to damage the nervous system, and there is some evidence that pesticide exposure may lead to Parkinson's Disease (Ascherio, et al., 2006). People exposed to pesticides often report symptoms such as nausea, dizziness, vomiting, headaches and other health-related issues (McCauley, et al., 2006). It is important to be aware of the harmful effects of pesticide poisoning, especially because it is "commonly under diagnosed in the US" (Alarcon, et al., 2005).

Considering the known human health effects of the pesticides used in the vineyard setting, it is not surprising that proper application is a major concern. The state requires that a worker whose job requires any handling of pesticides have a license. For the purposes of agricultural land, the vineyard workers need to pass a private pesticide applicator test to receive their license. The test administered by the state is available in Spanish as well as English due to the large population of agricultural workers who speak Spanish as a first language. Because many agricultural workers are immigrants to the United States, it may be difficult to prepare for the test, and the required score to pass any pesticide test in Oregon is 70% (ODA). These workers may face language barriers or a lack of formal education, which in turn leads to their being unfamiliar with testing procedures.

One method for training groups of people is computer-based training. However, many agricultural workers have little or no experience with computers. The CBT was presented in cTRAIN (NwETA.com; Lake Oswego, Ore.) since it offers: (1) a format based on effective behavioral education principles

(e.g., self-pacing, frequent quizzes, interactive feedback, high accuracy criterion); (2) clear system training instructions, so students do not require coaching on how to use the program; (3) icon-based navigation cues always on-screen, so there are no commands to remember; and (4) Spanish-language and spoken-text options (Anger et al., 2004). In addition, it had been effective in teaching ladder safety information to Latino agricultural workers (Anger et al., 2006), the same population recruited in this study. cTRAIN is a computer-based training program, designed in SuperCard, that provides a means of learning on-the-job information and requirements in a cost-effective manner. The goal of the program is to allow users with widely varying educational levels to learn from training easily. The behavioral training principles selected were used because they were shown to be “effective in training people with limited educational and study skills” (Anger, et al., 2001). The program is also designed to be used with a 9-BUTTON response unit in place of the normal keyboard, making the training program more manageable to participants with very little computer experience. Similarly, the simplicity of the program combined with the 9-BUTTON device allows for easy navigation. The cTRAIN training program is structured as informational topics, which are broken down into a series of information sets. Each information set has information screens followed by quiz screens. At the end of each topic there is a test covering all material presented within that topic. On quiz screens, students receive immediate feedback on their answers. If during a quiz screen, a question is

answered incorrectly, the student is sent back to the beginning of that informational set.

Previous Work in Lab

Recently, various training programs have been designed for Spanish-speaking vineyard workers. A variety of vineyard topics have been created and piloted in the field, including Pesticide Applicator training, Worker Protection Standards, and Supervisor Training. The Pesticide Applicator training program has been piloted on several occasions. It is designed to teach the vineyard workers to be competent applicators and to prepare them for the required state test on this topic. In the previous pilots of the Pesticide Applicator Program, none of the participants were able to pass the state certification exam for Pesticide Applicators.

Similarly, worker training videos have been designed and filmed in Spanish as a more visual method of training, supervisors on how to interact with their employees and improve their skills at conflict resolution.

METHODS:

Subjects:

All of the participants (N= 16) were Spanish-speaking males currently working in a vineyard in the Willamette Valley of Oregon. Two of the men were in supervisor positions, seven were field-workers, six were tractor operators, and one was a mechanic. All of the men except one were preparing to take the Pesticide Applicator state certification test. The participants had 8 months to 26 years of experience working in the vineyard. Nine of the participants had the equivalent of the 6th grade United States education or higher. One participant was already a certified pesticide applicator and completed the training but not the state certification test. One participant did not complete the computer-based training program or the state certification test.

Materials:

The Pesticide Applicator Training was presented in Spanish using the cTRAIN computer-based training software, version 2.0 on laptop computers. A 9-BUTTON response unit was used in place of a keyboard. The Pesticide Applicator training consisted of 1,200 screens of information divided into 18 chapters, and then divided into four packages based on content. Package 1 contained the following topics: Regulations, Pesticide Management, Transport, Storage Disposal, Labels, PPE, Formulations, and Equipment. Package 2

contained training on how to use a calculator, equipment calibration, mixing, loading and application. Package 3 covered risk management and included the following topics: Residues, Spill Response, Records, Liability, health Effects of Pesticides, and First Aid. The 4th package included instructions on how to take the Oregon Pesticide Applicator Exam.

Procedures:

Before designing the training, a member of the research team took the pesticide applicator certification test and the training program was designed based on the information that was tested on the exam. After informed consent was first obtained the participants completed the study over 4 days. The training was divided into four packages and the participants were given a day to complete each package. If more time was needed to complete a package the participants were to complete it the following day. Another two days were scheduled for participants to review the material, complete unfinished training, and ask questions. During the training, several members of the research staff were available to answer any questions or help the participants. A chapter was added on how to properly fill out a Scantron test form and one chapter utilized pesticide labels to teach the participants how to analyze what information is important on a pesticide label. Each participant was also asked to fill out a demographic survey prior to completing the training. The training portion of the study took place at Elk Cove Vineyards and the state

certification test was carried out at the Viticulture Center at Chemeketa Community College in Salem, Oregon.

On the 7th day, after completing the 4 day training and the two day study period, the State of Oregon Pesticide Applicator Certification Test was administered. The participants then took the Pesticide Applicator certification Scantron test required by the state. Each participant who completed the training was paid 50 dollars. The state certification test cost \$15 for those who took it. The participants' test scores on the certification exam were obtained with the permission of the employees and compared with the Pesticide Applicator training program test scores.

RESULTS:

Figure 1 shows a comparison of the average scores of the Pre-Test and Post-test for each package of the Pesticide Applicator training. These averages do not include the scores of the participants who did not take the pre-test or post-test. Table 1 shows the percent difference between the pre-test and post-test while table 2 shows the t-test significance comparing the scores of the pre-test and post-test for each package. In each package, there was a highly significant improvement on the post-test.

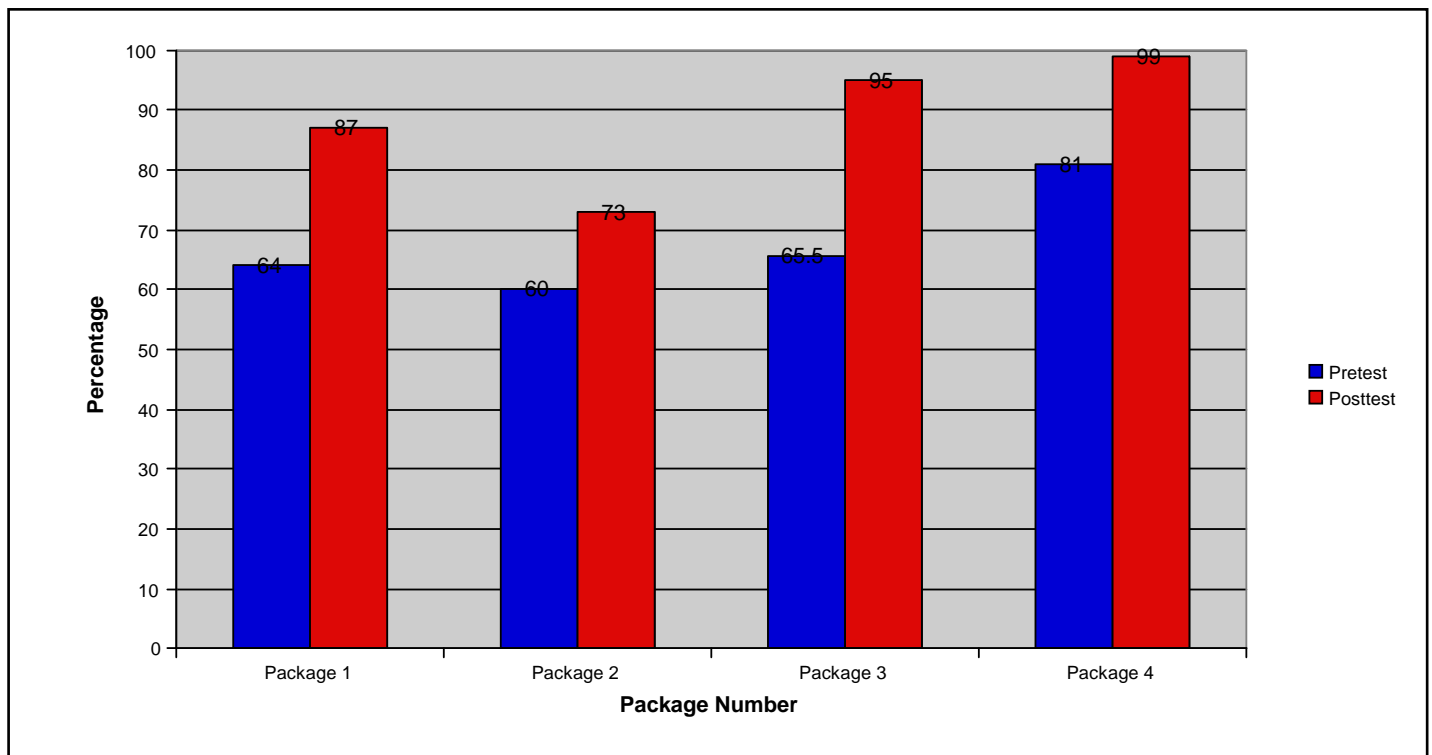


Figure 1: Average Scores for Pre-Test and Post-Test or Packages 1-4.

	Package 1	Package 2	Package 3	Package 4
% Difference	26.4%	17.8%	31.0%	18.2%

Table 1: . Percent Difference for Pre-test and Post-test of Packages 1-4

	Package 1	Package 2	Package 3	Package 4
Significance (t-statistic)	0.001	0.0002	<0.0001	0.0004

Table 2: t-test significance for Pre-test and Post-test of Packages 1-4

Figure 2 shows the results of the Pesticide Applicator Training program Final Test for each participant. Nine of the sixteen participants received a score of 70% or higher, which is the score required to pass the state certification exam. The mean score for those who completed the training was 69.73%. Data from the state revealed that the poorest scores were on label comprehension and pest characteristics.

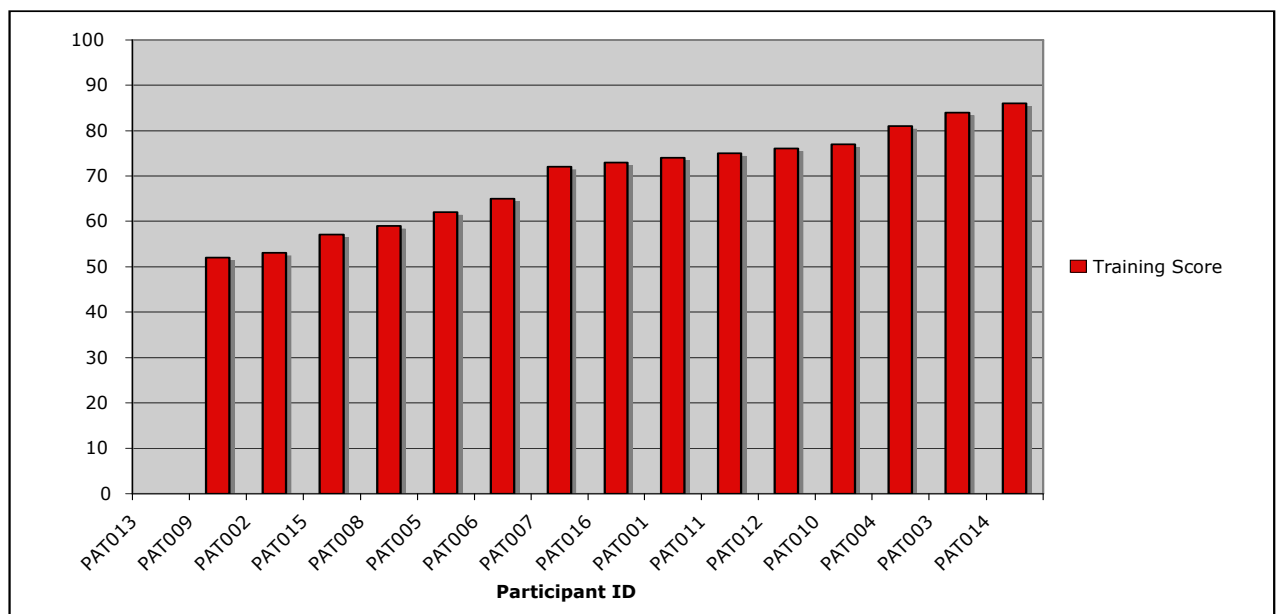


Figure 2: Pesticide Applicator Final Training Scores

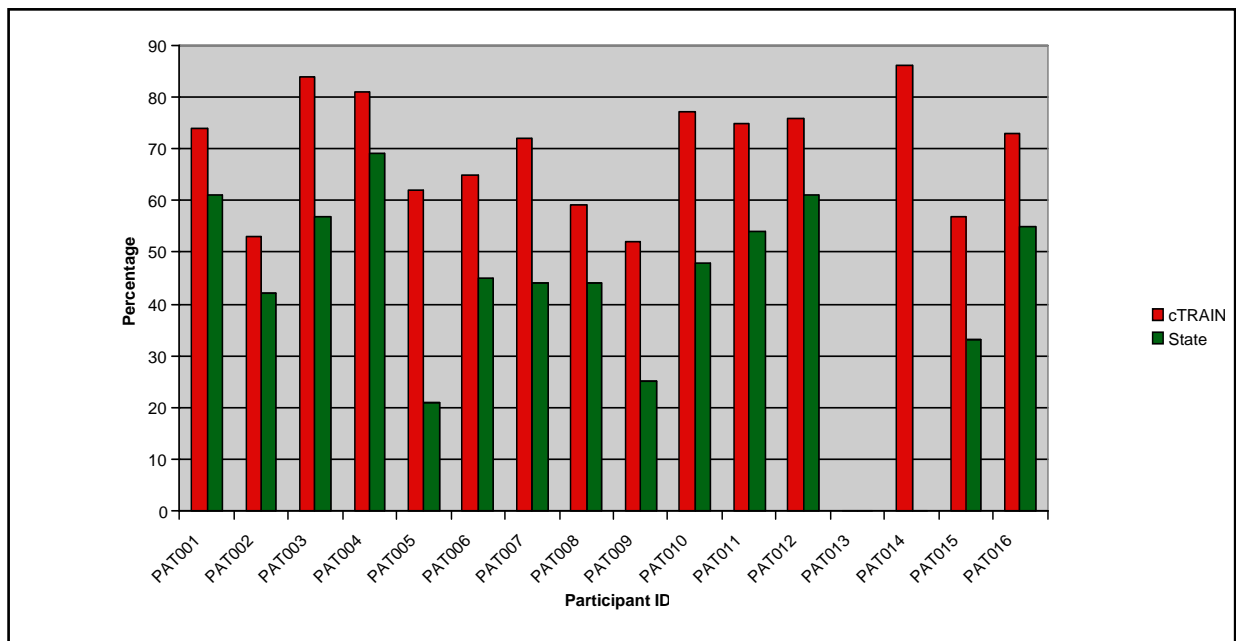


Figure 3: Test Scores-State Certification vs cTRAIN

Figure 3 shows the results of the Pesticide Applicator state certification test and Pesticide Applicator Training side by side. Participant PAT 014 was already a certified pesticide applicator and did not need the state certification test a second time. None of the fourteen participants who took the test received the passing score of 70%. The average score for those who took the test was 47.57%.

The demographic information collected is provided in Table 3, Table 4, and Table 5. Some information has been left out due to its redundant nature or uniform responses from all participants. As indicated by data in Table 3, the average school grade completed by the participants is 6.5. In Table 4, some activities were grouped together based on commonalities. Reading activities include reading books and magazines, while computer activities include using a computer, playing video games, and using the internet.

The information that all participants had in common was as follows: all participants were right handed, all participants were of Latin ethnicity, and all participants spoke some form of Spanish as a first language. Pearson r correlations were run for variables that were considered to be of importance against both the cTRAIN training score and the state certification test, in order to determine the strength of the relationship between the two variables.

These values can be found in table 5.

ID	Age	Place of Birth	Years in the U.S.	School Grade Completed
PAT001	44	Michoacan, MX	27	7
PAT002	46	Michoacan, MX	20	6
PAT003	22	Michoacan, MX	8	12
PAT004	33	Puebla, MX	12.5	6
PAT005	48	Michoacan, MX	26	3
PAT006	34	Veracruz, MX	8	2
PAT007	30	Veracruz, MX	4.5	8
PAT008	25	Ignacio de Llaveiver	5	6
PAT009	27	Michoacan, MX	7	0
PAT010	22	Michoacan, MX	4	0
PAT011	26	Guanajuato, MX	4	8
PAT012	26	Guanajuato, MX	6	9
PAT013	35	Michoacan, MX	18	9
PAT014	28	Guanajuato, MX	13	12
PAT015	28	Mexico	10	5
PAT016	33	Guerrero, MX	7	11

Table 3: General Demographic Information.

ID	Other language	Hours of reading per day	Hours of computer activities per day	Computer in home	Use a computer at work
PAT001	None	2	3	No	No
PAT002	None	1	1	Yes	No
PAT003	English	2	3	Yes	No
PAT004	None	2	3	No	No
PAT005	English	3	3	Yes	No
PAT006	None	0	0	No	No
PAT007	English	4	10	Yes	Yes
PAT008	English	2	3	Yes	No
PAT009	English	5	3	Yes	No
PAT010	None	0	0	No	No
PAT011	None	2	3	No	No
PAT012	English	3	5	Yes	No
PAT013	English	2	3	No	No
PAT014	English	2	3	No	No
PAT015	English	2	3	No	No
PAT016	None	1	0	Yes	No

Table 4: Participant skills and activities.

	Age	Grade completed	Reading activities per day	Computer activities per day	Television per day	Computer owner
cTRAIN Test Score	- 0.272	0.155	-0.092	0.047	0.133	-0.051
State Test Score	- 0.126	0.012	0.002	0.455	0.265	0.078

Table 5: Correlation between tests and various demographical information.

DISCUSSION:

The results suggest that the Pesticide Applicator Training Program was not an effective means of preparing the participants for the state certification test. While more than half of the participants were able to pass the Pesticide Applicator Training Program, none of the participants were able to achieve a high enough score on the state certification test to gain their certification. Oregon state data reveal that 9.65% of those who take the state certification test in Spanish pass the exam; the other 90.45% fall below 70% (Maynard 2007). This discrepancy between the percentage of people who passed the test when taken in English versus Spanish is significant. Of the people who took the state certification in English, 78.45% passed (Maynard 2007). The training results yield a percentage difference between the pre-test and post-test training scores that indicate a significant improvement after completing the training. These differences indicated the largest improvement in package 3, which mainly focused on risk management and the lowest improvement in package 4, which consisted of information on how to complete the Oregon Pesticide Applicator exam. Analyzing the pre-test and post-test for each package of the training program using a t-test, the statistical significances for each package (1-4) was found to be 0.00132, 0.00015, <0.001, and 0.0004, in that order. Although the results of the percent difference suggests that knowledge was gained from taking the training program, the information provided in the

training program appeared insufficient to prepare the participants for certification.

Data from the state indicated that the participants did poorly on label comprehension and pest characteristics (Maynard 2007). Modifications have been made to the Pesticide Applicator Training Program. Information has been revised and added including sections containing background information on pest characteristics and increased practice on reading labels. Plans are underway to pilot the second version of the Pesticide Applicator Program.

Due to the unsuccessful nature of the results the next step is to analyze the demographic data provided by each applicant and use any resulting significant information to modify the test accordingly. After running a correlation of several relevant variables the demographic characteristics of importance do not seem to have impacted the participants' ability to pass the state certification test. None of the correlations were statistically significant but the most correlated value occurred between number of hours of computer activities per day and the state certification test scores, at a value of 0.46.

As these comparisons yielded results that were largely inconclusive, it becomes necessary to evaluate what socioeconomic or cultural traits the applicants have in common that may be preventing them from successfully passing the state certification test. The most glaring commonality aside from country of origin is that all of the participants, with the exception of PAT006, began their schooling outside of the United States. It would not seem that this would be a significant factor in the outcome of the test, however, much of the

ability to relay what has been learned lies in understanding the inherent framework of the education system. For a person who began their education outside of the United States, this indispensable understanding is lacking. During the training, it became clear that many of the participants had never seen, let alone used, a scantron. As the state certification tests were administered via scantron, it may have been difficult to relay the information that was learned in the training programs. This inability to effectively communicate their knowledge may have prevented the participants from reporting what they knew, resulting in non-passing tests scores. This institutional bias makes it so that the test distinguishes people based on background rather than based on what they know. A similar testing situation can be carried out attempting to eliminate the racial bias, but this would be very difficult as a large majority of agricultural workers in Oregon are Latino. Attempting to recruit a pilot group of all Caucasian agricultural workers would probably require the participation of various vineyards, which could introduce other variables, such as varying geographic regions, which could lead to possible differences in the Caucasian education systems. Similarly, different vineyards represent varying levels of management and previous on the job training. While this diversity amongst workers introduces various new elements, this allows for a more diverse group of workers, which better simulates the diverse population that will be utilizing the program.

This scantron-based testing begs the issue of inconsistency in testing. The entire cTRAIN training program was completed entirely on the computer

with a 9-BUTTON keyboard. The state certification was completed using a scantron and a pencil. Although there was a short training segment in cTRAIN on how to properly use a scantron, many of the participants still needed help filling in their name and information on the scantron sheet once they arrived at the test. This seems to indicate that the information presented in that portion of the training was not retained enough to allow the participants to effectively relay what they knew. This may not have had any bearing had the participants began their schooling in the United States, but not having used scantrons in their education system, this became a barrier to them. Along with this, some of the participants were not completely literate even in their native language of Spanish and chose to complete the training programs using the audio provided. This form of testing was not available for the state certification test.

Similarly, the computer-based training system, itself, may not be an effective means of training immigrant workers. It would be pertinent to address the issue of the role of the education systems throughout Mexico. While the issue of lack of computer experience has been addressed by the simplicity of the cTRAIN training program and the 9-BUTTON keyboard, being able to use the computer may not be the only concern. For a participant that was not educated with computers, learning via computer-training may not be as successful as other methods of learning that are more common in the Mexican educational system.

Furthermore, the amount of information being tested may prevent high information retention. The training took place over a 4 day period, with two extra days scheduled to review and ask questions. One of the four training packages was to be completed each day and each training package took 6 hours on average to complete. Because of the high volume of information, and the fact that it was learned over such a short amount of time and not reviewed extensively, it may have been difficult for the participants to retain all of the instruction they received. This would suggest that before piloting a new training program, an interview should take place with pesticide applicators that already have their certification and were able to pass the state certification exam. This interview would provide insight into how these workers prepared for their exam and retained such large quantities of information.

Aside from the removal of institutional bias in the testing procedure, there are several other methods that can be considered in order to control for, and test the effects of, different social and contextual variables. One study that can be performed and addresses the issue of the language barrier that exists for agricultural workers who do not speak English as a first language. While the training and state certification tests exist in both Spanish and in English, speaking English as a second language poses a disadvantage for certain aspects of the test. For example, a section of the state certification test is based on reading and interpreting pesticide labels. Some research has been done in the way of effectively educating language minorities and it has been

found that “alternating between the two languages whenever necessary to ensure clarity of instruction” is important (August 1988). While some labels may be available in both Spanish and in English, it is more common for pesticide information to be listed in English. Training can be administered to teach Spanish-speaking participants the important parts of a pesticide label, but there is still going to be an advantage to a person who can accurately read and interpret the entire label. If a study such as this were to reveal that native English speakers were able to pass with the same amount of training and that the language barrier does in fact pose a barrier for Spanish speaking agricultural workers, we could state with more confidence that alterations must be made to the test or to the pesticide labels themselves.

Another flaw of the cTRAIN training is the ability to retain such an extensive amount of information. In order to assess the impact of retention time a study can be designed in which several pilot groups are run and varying amounts of time are allowed to pass between the training and the certification test. Similarly, studies can be outlined in which the participants are allowed varying amounts of time to study the information. Using the results from such studies, a decision can be made about how much time should be allotted for participants to prepare for the certification test and how much time should be allowed to pass between the training and the certification test.

One aspect of this study worth discussing was the small number of participants. Because so few participants were involved, the statistical significance of the results is in question. Ideally, a pilot group with many more

participants would take place. With representation from a more expansive, and possibly more diverse, group, the research would provide insight into how to train a more diverse population of workers. However, because this was a pilot and not a complete study, the number of participants is not such a major concern. Similarly, reviewing the demographic data, many of the participants seem to have many important characteristics in common. For example, all participants were Spanish-speaking males, born in central Mexico. Due to these similarities, it may be that this population was representative of the typical vineyard worker in the Willamete Valley or Oregon, which is the group to which cTRAIN would cater. Increasing the number of participants would require participants from various vineyards, which would allow for a wider array of vineyard workers as well. However, while increasing the number of participants would most likely not harm the results in any way, this is not a major priority until some other important changes have been made, attempting to remove institutional bias and literacy and language barriers.

RECOMMENDATIONS:

Looking to the future, there are several major concerns that need to be addressed before proceeding with training. First and foremost, while it does appear that cTRAIN is an effective way of communicating information, it may not be the most effective manner of preparing employees for the state certification exam. The discrepancy in testing styles is a major concern, especially for a population who may not be familiar with scantron-based, multiple choice testing. In the future, taking the final test of the training by scantron should be mandatory. Similarly, for the purposes of preparing for the state pesticide applicator exam, audio should be removed from the training, as it provides a false sense of comfort for participants who suffer from illiteracy.

Addressing the issue of the amount of time to prepare for the exam, if the amount of material is non-negotiable, which it appears to be, then the preparation time should be doubled. To effectively learn material, time should be provided to completely cover all material twice through.

While there are many other factors that could very well play a role in the efficacy of the training as a method of preparing for the state certification exam, after analyzing demographic data, it appears that the recommendations discussed may be key to providing the participants greatest success upon taking the state certification exam.

AUTHOR NOTES:

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