ASSESSMENT OF A TEXAS STRUCTURAL PESTICIDE APPLICATOR TRAINING COURSE BASED ON PERFORMANCE OF PARTICIPANTS SEEKING COMMERCIAL OR NON-COMMERCIAL APPLICATOR LICENSES

A Thesis

by

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ABSTRACT

This study sought to examine the performance of participants in training courses of the Agricultural and Environmental Services (AES) unit and determine variables affecting participants' scores on the General Standards Examination (GSE). The data sample for the study comprised 150 individuals who completed the 8-hour course between February 2011 and February 2012 and submitted instruments developed for this study (demographic and evaluation survey, pre-test, post-test, and GSE). The demographics of the pest control industry in Texas—or, more specifically, the demographics of those taking a Structural Pesticide Applicator Training (SPAT) course from AES—have not changed much since 1998. The major differences in demographics between the two groups of individuals investigated (commercial and non-commercial applicants) were in age and size of business where employed. Commercial participants tended to be younger than non-commercial participants. Those seeking commercial certification tended to be employed in smaller firms than did those seeking non-commercial certification. This study found moderate, positive correlations between the pre-test, post-test, and GSE. Finally, though the examination scores were correlated, there were statistically significant differences between participants' performances on the pre-test, post-test, and GSE. These differences were quadratic; all three pairs—pre-test and post-test, post-test and GSE, and pre-test and GSE—differed, with pretest scores in the middle, then post-test scores highest, and GSE scores lowest.

The researcher recommended that further research be conducted on demographic variables that may affect the outcome of the examinations, and that the rigor and relevance of the pre-test and post-test be increased to predict more accurately the results of the GSE.

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CHAPTER I

INTRODUCTION

Whether it was hemlock and aconite being used to protect crops in ancient Egypt, or sulfur being used in ancient Greece in order to keep insects off plants, humans have looked to pesticides to increase crop yield and help to provide food for their families, and in agrarian societies to provide a source of income in households (Bohmont, 1997). "Pesticides have been used by humankind to protect crops, dwellings, and possessions since the beginning of recorded time" (Renchie, 1998, p. 1). Because of this fact and the risk/reward nature of pesticides, the United States Congress has deemed it necessary to highly regulate the production, distribution, and application of pesticides. Congress passed the Federal Insecticide, Fungicide, and Rodenticide Act, or FIFRA, in 1947, establishing laws and regulations to govern how pesticides could be used. In 1972, Congress amended the FIFRA, requiring individuals to meet certain criteria to become licensed applicators. States were allowed to implement their own training programs to prepare an individual to sit for their licensing examination; however, they had to meet the minimum standards as prescribed in Section 24 [136V] of the FIFRA and Title 40 of the Code of Federal Regulations Part 171.

Texas AgriLife Extension, under Memorandum of Agreement with the Texas Department of Agriculture, was designated as the training entity. The Texas Pesticide Safety Education Program (PSEP) is administered through the Agricultural and Environmental Safety (AES) unit in Texas AgriLife Extension Service. This unit

develops and distributes the applicator training materials for the 27 categories in which the Texas Department of Agriculture licenses applicators to apply pesticides to crops and livestock, around homes, businesses, and structures. Since 1996, the AES unit has conducted licensing training (certification) programs statewide to facilitate examination preparation.

Purpose

The purpose of this study was to examine the performance of participants in selected Structural Pesticide Applicator Training (SPAT) courses. This was accomplished by working with the AES unit to examine certain variables that may affect an individual's outcome on his or her General Standards Examination (GSE) and also to examine current demographics in the pest control industry.

Hypotheses

1. There is no correlation between pre-test and post-test scores.
2. There is no correlation between pre-test and GSE scores.
3. There is no correlation between post-test and GSE scores.
4. There is no difference in mean scores on pre-test between individuals seeking commercial or non-commercial license.
5. There is no difference in mean scores on post-test between individuals seeking commercial or non-commercial license.
6. There is no difference in mean scores on GSE between individuals seeking commercial or non-commercial license.

7. There are no differences in scores on the three examinations (pre-test, post-test, and GSE).
8. There is no difference in knowledge of pesticide application (performance on examinations averaged) based on kind of license sought (commercial or non-commercial).
9. There are no interaction effects between performance on examination (pre-test, post-test, or GSE) and kind of license sought (commercial or non-commercial).

Assumptions

This study was conducted under the following assumptions:

1. The pre-test and post-test were both good representations of what is needed to prepare applicator license candidates for the license examination (GSE).
2. The individuals involved in SPAT training completed the survey instrument and tests individually to the best of their ability.

Limitations

The following limitations were noted:

1. The study used data only from individuals in the SPAT training program of AES. No other training programs were evaluated.
2. The study used data from individuals involved in the SPAT trainings between February 2011 and February 2012.
3. The study did not include all variables that could affect the outcome (performance or scores) on the examinations.

Definition of Terms

The terms used in this study were defined as follows:

Applicator Certification: The process by which, under federal law, states administer pre-licensure educational programs and activities to pesticide applicator license candidates (Renchie, 1998).

Applicator License Candidate: An individual who, under state law, must seek licensure with the Structural Pest Control Service (SPCS) in order to lawfully engage in pest control activities in Texas (FIFRA, 1996). Licensees include Commercial Applicators (individuals who contract their services), Non-commercial Applicators (individuals who conduct pest control activities as a part of their jobs), or Technicians/Apprentices (individuals with no experience, or up to one year of experience, but who must work under the direct supervision of a Commercial or Non-commercial Applicator).

General Standards Examination (GSE): An exam administered by the SPCS to measure the knowledge of license candidates with regard to the laws and regulations governing pest control activities, and the decision-making steps utilized in effective pest management strategies (Renchie, 1998).

Structural Pest Control Service (SPCS): The state entity in the Texas Department of Agriculture which governs the activities of individuals engaged in pest control activities in and around buildings or structures (Renchie, 1998).

Structural Pesticide Applicator Training (SPAT): A training program overseen by the SPCS in which individuals (educators, industry personnel, and universities) provide training from a core manual to applicator license candidates (Texas Structural Pest Control Act, 2009). The program must be a minimum of eight hours of classroom and direct contact training to be approved by the SPCS.

Certified Commercial Applicator: A person licensed in category as a certified commercial applicator who can perform pest control services, identifications, and control measures without direct supervision but under supervision of the responsible certified commercial applicator (Texas Administrative Code, n.d.).

Certified Non-Commercial Applicator: An employee of a governmental entity, apartment building, day-care center, hospital, nursing home, hotel, motel, lodge, warehouse, food-processing establishment, school or educational institution, and other non-commercial entity. The person licensed in category as a non-commercial certified applicator who can perform pest control services, identifications and control measures without direct supervision (Texas Administrative Code, n.d.).

Technician: A person licensed in category who performs pest control services under the direct supervision of a commercial or non-commercial certified applicator (Texas Administrative Code, n.d.).

Apprentice: A person, who is registered by a business or non-commercial entity to train for a technician license, has not passed the technician examination and who performs pest control services under the direct supervision of a licensed technician or a

certified applicator. An apprentice may work only for the business or non-commercial entity for which they are registered (Texas Administrative Code, n.d.).

CHAPTER II

REVIEW OF LITERATURE

The theoretical base for this study was developed from a review of literature divided into the following three parts: pesticide applicator industry related publications, extension and education program evaluations, and human resources and training literature.

Pesticide Applicator Industry Related Publications

In recent years there has been an increase in the number of published works pertaining to the pesticide industry. Vitzthum (1982) conducted the first comprehensive pesticide applicator training program evaluation that could be located. In his study he used a pre-test, post-test, post-post-test design to evaluate Nebraska's pesticide training courses with respect to Commercial Applicators. He gauged the knowledge level of students coming into the program with a pre-training matrix pre-test. He then compared these scores to the knowledge level when the individual was finished with the program. He then compared the pre-training scores to the General Standards test an individual took in order to obtain certification.

Vitzthum (1982) found that there were no significant differences between test scores when based on the demographics of age, years of service in the pesticide industry, hours spent studying, or status in the industry. He found significant differences in the scores of individuals based on training site and amount of education.

Creswell and Martin (1993) completed a survey analysis and assessment of the demographics, principles of teaching, and teaching strategies used in private pesticide applicator education of the cooperative extension agencies in Iowa, Wisconsin, Nebraska, and North Dakota. They first determined the demographics of the County Extension Agriculturalists, and found that they mostly consisted of highly experienced males with degrees beyond a Bachelors of Science Degree. Next, they determined which principles of teaching were perceived to be more effective to the individual instructors. The top two principles were the ability to provide the least restricted environment and variety in instruction strategies. They then determined which teaching methods were more commonly used, and which strategies were perceived to be the most effective. They determined that the most used strategies were 35 mm slides, overheard projectors, lecture-discussion, and question and answer sessions. The most effective strategies were demonstration, 35 mm slides, individualized instruction, and problem solving.

McIlveen, Hamman, and Gold (1993) examined the profile of the State of Texas structural pest control industry. They found that the gross sales of the industry were approximately $1.5 billion per year. Other findings were that the education level was high, with 85% of the certified applicators receiving a high school diploma or higher. They also found that most certified applicators had an average of 10 years experience in the industry, while licensed technicians had one to three years of experience in the pest control industry. In their conclusions, they made the following statements:

> There is a major need for development of up-to-date training materials and programs to support this industry. They [prospective trainees] appear to be willing to participate in these types of training efforts if they contain useful information that will assist them to meet state requirements for certification and recertification, and to provide a better service for their clientele. (McIlveen, Hamman, & Gold, 1993, p. 31)

Shodrock (1994) completed a survey of the Integrated Pest Management (IPM) Programs in Texas school districts. He found that 23% of the schools employed at least one certified applicator. He also found that 78% of the people responsible for pest control in Texas school districts had at least a high school diploma. He then found that 77.3% of school districts in Texas handled weed control internally (i.e., internal to the district).

Renchie (1998) studied the effectiveness of the Texas Structural Pesticide Applicator Certification Program (TSPACP) in preparing license candidates for the GSE. He compared the results of a pre-test and post-test that he gave at the beginning and end of his seminars and compared them to the GSE. He then determined whether there were significant differences in scores based on demographics, course providers, and teaching methods used. He also found which teaching practices were the most effective. He found that 65% of the applicants were between 20 and 39 years of age and that 98% had high school or above education levels. He found that 80% of applicants had less than one year of experience in the industry, and that the program and instructional methods used in the TSPACP were effective in preparing students. He also

found that the most effective teaching method for delivering material was lecture/discussion, and that course providers preferred classes of 25 or fewer participants (Renchie, Larke, & Jones, 2004).

Fishel (1999) used a survey of Missouri private applicators that consisted of Likert scales (Likert, 1932) which gauged opinions of individuals in a variety of areas. These areas included demographics, opinions on pesticide laws and regulations, ability of individuals to read pesticide labels, environmental concerns, pest basics, protective equipment and applicator safety, application equipment and safety, transportation, storage, and spill cleanup of pesticides. His survey results gave trainers a better understanding of the industry which, in turn, better prepares them to train current applicators and prospective applicators. He wrote, "With the constant public scrutiny of pesticides and their use, it is essential that private applicator's receive highly effective educational programs and utilize such knowledge in their operations" (Fishel, 1999, p. 10).

Snodgrass (2002) used pesticide applicator training instructors to form a panel of experts to determine the reliability and validity of each question on the GSE. This panel determined that the current form of the GSE was both reliable and valid.

Buhler and Whipker (2003) examined methods used to improve the effectiveness of their pesticide dealer-training program. They determined the best way to obtain data concerning program improvement was to create a survey that asked questions covering specific areas of their training programs. After this needs assessment was completed, they were able to pinpoint topics that needed to be addressed in more detail in the

training programs. Areas such as description of the dealer's overall scope of business, participant demographics, attendance at past training programs, preferences for content, format, and timing of future training programs, preferences for use of technology in training, and value placed on various information sources.

Adult Education and Extension Literature

Andrews (1983) discussed the recent shift in extension program accountability. He wrote that in the 1970s people's opinions of Extension shifted from how hard you tried to create a quality product to how good the quality of your product actually is. Extension has shifted from an effort-based system to a product-based system, and, with this transition, there has risen a need for more accountability within programs. This means there is an increased need for evaluation. He implied that Extension typically has only worried about evaluation in respect to program development, but the shift in accountability has, in turn, caused an increased need for evaluation in two other areas: organizational management and public relations.

Whent and Leising (1992) used a questionnaire that asked the participants pre-program and post-program opinions. The survey also included demographic data questions. They wanted to determine whether the following characteristics played a role in their program experiences and knowledge gained during the program; education level, age, pre-program experiences, and urban vs. rural community. They found that graduates with the fewest years of formal education gained the most from the training program, but that the other demographic variables were not significant in determining knowledge gain.

Stup (2003) discussed the usefulness of program evaluations. He inferred that Extension needed to perform evaluations of their programs in order to demonstrate its value to its clients. There has been an increase in the amount of outside extension sources for training, and in order for Extension to prove that it is a better option than other sources, it must continually perform evaluations. Evaluations enable program coordinators to determine that their program is useful, and allows them to improve their programs so they may be better competitors in the changing markets.

Roucan-Kane (2008) determined that the reasons for doing an evaluation were to identify the strengths and weaknesses of a program, make improvements, document changes, and to determine whether to retain a program. She also made the assumption that pre-testing and post-testing was a viable method of evaluation, but came to the conclusion that most people prefer to administer a pre-program knowledge survey at the end of the program because clients were sometimes more likely to be truthful when they know the survey is not significant in determining their outcome in the program.

Human Resources and Training Literature

Kirkpatrick (2008) wrote that the reason for doing an evaluation was to determine if a program should be continued or dropped, to learn how a program can be improved, to justify the program's budget, to ensure learning compliance, to maximize the value of the program, and to align the program with teaching strategies. He also implied that there were four levels of evaluation: reaction, learning, behavior, and results. He made it clear that nothing can be inferred from any level until you have completed the previous level. He used reaction as the base level of evaluation. Reaction

is also known as customer satisfaction. To many people this level of evaluation has been often trivialized. Reaction evaluations have been just as important as the others because it was a way to see if the trainee's needs were being met (Kristiansen, 2008). Evaluation became less effective when individuals did not factor in all of the necessary variables in order to properly design an effective level one evaluation. He listed some of the questions that needed to be answered to insure a reaction evaluation was effective including:

- What do learners need to know?
- What are the learner's needs and objectives?
- What content will be included?
- What methods of instruction will be used?
- What activities will be included?
- Who should deliver this course?
- Where should the training be conducted?
- What is the best seating arrangement?
- How should the training be scheduled?
- How long should the training last? (Kristiansen, 2008, pp. 499-500)

Kristiansen (2008) implied that in order to make the reaction evaluation effective, take the time to design a quality instrument. If these steps are taken for granted, the level one evaluation was rendered useless.

Kirkpatrick (2008) determined that the next level of evaluation was learning. Learning evaluation was what skills were developed, what knowledge was gained, and

what attitudes were changed. This has been the most commonly used type of evaluation. The easiest way to perform this type of evaluation was to use the pre-test/post-test method. According to Kirkpatrick, in order to make a successful pre-test/post-test, it was necessary that time to be taken to develop a quality pre-test and post-test:

> Just as important is the specific information the pre-test and post-test evaluation of learning provides. By analyzing the changing answers to individual items, instructors can see where they have succeeded and where they have failed. (Kirkpatrick, 2008, pp. 487-488)

Cascarelli and Shrock (2008) wrote about the five steps used to develop a quality pre-test and post-test. They surmised the steps were to analyze or determine what to test; determine validity, or if the test tests what it purports to measure; construct the test; set standards or establish a legally defensible cutoff or mastery skill level; determine reliability of the method.

Level number 3 of Kirkpatrick's (2008) four levels was behavior. He stated that in order to be successful, a behavior change needed to be caused. In order to do this, trainers were required to let some time pass post-training in order for individuals to actually put what they learned into action. According to Brinkerhoff and Mooney (2008), the benefits of doing this type of evaluation were that it showed what a trainer has actually taught was being retained and not just memorized for a short period. It also pointed out whether the skills and ideas taught during the seminar were hindered from being put into action.

The last level and what many consider the most important level was the results evaluation (Kirkpatrick, 2008). This level is where trainers determine whether the trainee's output was improved based on what they learned in the seminar. In order to do this successfully, McCain (2008) implied that companies would need to provide control group data in order to successfully compare data sets. Results evaluation could sometimes be known as return on investment. Return on investment is a process by which a good trainer would be able to show an actual dollar amount increase, based on the trainer's program. Phillips (2008) called this the "show me the money" evaluation. Phillips (2008) and Kirkpatrick (2008) both believed that the ability to put a dollar value on a program was a significant advantage.

These four levels of evaluation are important to anyone doing any type of program assessment; however, this study was performed at Level 1 and 2 evaluations, which are reaction and learning.

Shenk (2000) discussed the effects an individual's customs have on their ability to diffuse knowledge. Shenk implied that even though trainers perceive the language barrier, sometimes they overlook the cultural barriers. Weber, Kinro, Snedeker, and Swift (2004) completed a study where they determined the need for non-English materials during training programs. They determined that the increase in diversity within the pesticide industry had created a need for more diversity in teaching materials to continue to prepare highly qualified individuals.

Summary

The pesticide safety education literature provides the major framework for this study. Renchie's (1998) dissertation was the piece of literature that was the basis for this study, and the other dissertations and articles from the pesticide safety field helped to develop the instruments used to complete the study and provided the background for evaluation in the pesticide safety training field. The adult education and Extension literature provided examples in which the pre-test and post-test design methods were used successfully in the Extension field, and gave examples of how demographics could effect the scores of individual. The human resources and training literature guided the evaluation aspect of this study. Kirkpatrick (2008) discussed four levels of evaluation, and the last two articles discussed trends in diversity—both language and culture—in the pest management industry. These articles, dissertations, and publications all built the foundation for this study. They added to the body of knowledge and helped create a framework upon which this study has been conducted.

CHAPTER III

METHODS AND MATERIALS

Context of the Study

In order to understand whether an individual is using the knowledge gained during the instructional process of this study (the training seminar), it must first be determine how much knowledge the participants brought to the training. This was done by, presenting them with a pre-test, which covers questions that would be addressed during the training. Participants took part in an eight-hour course in which they were presented information in several ways. (i.e. kinesthetically, visually, and auditory) Lastly, a post-test was administered to measure how much knowledge each participant gained during the instructional phase. Each step was performed to see if there was a relationship with the primary dependent variable of the study, which were the GSE scores.

This study examined the demographics of the population by assessing demographic variables (age, years of experience, education level, and number of employees in the participant's company). Because the instrument used to collect demographic information was done anonymously, and separately from the examinations, there was no way to link the demographic data with the scores (Appendix A). So, no inferences could be made about relationships between demographics and performance on the pre-test, post-test, or GSE (scores on the examinations) for the purpose of this study.

Population and Sample

The theoretical population for this study was individuals who took, or will take, the SPAT training course offered by AES. The accessible population for the study comprised individuals who completed the SPAT course taught by Dr. Don Renchie from February 2, 2011, to February 17, 2012. The data sample from the population comprised all individuals who completed each of the instruments during the time period of the study (i.e., individuals who have completed the pre-test, post-test, and GSE). The total number of individuals in the sample and who provided useable data was 150.

Instrumentation

The instruments used to collect data for this study were almost identical pre-tests (Appendix B) and post-tests (Appendix C) and consisted of ten questions selected to sample participant knowledge from the following learning domains:

1. Applicator certification and licensing
2. State laws and regulations
3. Federal pesticide laws
4. Toxicity of pesticides
5. Residue, tolerance, and registration
6. Ecology and environmental protection
7. General safety precautions
8. Protective equipment and personal safety
9. Pesticide poisoning

10. Integrated pest management
11. Pests
12. Types of pesticides
13. Labeling
14. Formulations
15. Fillings and mixing practices
16. Calculations for mixing pesticides
17. Equipment
18. Calibration
19. Weather-wise application
20. Disposal
21. Storage
22. Record keeping and liability (Renchie, 2012, p. iii)

At the end of the post-test was a question that asked participants whether they were seeking a commercial or non-commercial license.

The instrument used to collect data of perceptions and demographics was a 17-item questionnaire (Appendix A). The first six items used were Likert scale items (Likert, 1932) to determine the perceived effectiveness of the course. These were followed by six yes/no questions that asked whether an individual planned to adopt the practices presented in the class. The next five questions were also Likert Scale items designed to determine an individual's perceptions of the effectiveness of the speaker. The last portion of the questionnaire collected demographics. The first question asked

for the age of the participant within five-year intervals. The next demographic was the participant's education level, with levels ranging from elementary school to doctoral degree. Another demographic was length of service in the pest control industry which was separated in the following intervals/categories: less than one year, 1 year, 2-5 years, 6-10 years, 11-20 years, and over 20 years. The final demographic was the number of employees in a participant's company. The last data source used was the General Services Examination (GSE).

Data Collection

At the beginning of each SPAT course, the instructor administered a pre-test (D. Renchie, personal communication, September 24, 2010), and after the 8-hour course was conducted, he administered the post-test and the demographic survey. The GSE scores of the participants were obtained from the Texas Department of Agriculture (TDA). After obtaining the scores from TDA, the researcher paired the data with the pre-test and post-test data for each individual and then removed the identifiers.

Data Analysis

Descriptive statistics (means, standard deviations, frequencies, and percentages) were used to describe the sample. Because the sample is considered to be a sample in time, inferential statistics were used to draw conclusions about the larger population of individuals who take or will take the Structural Pest Control Service pesticide training courses and, subsequently, will complete the licensing examination (GSE).

To determine if the examination scores were related, the researcher calculated Pearson product moment correlation coefficients (Field, 2009, p. 170), quantifying the

relationships between the pre-test and post-test, between the pre-test and the GSE, and between the post-test and the GSE.

To determine if there were significant differences in the scores of applicator license candidates taking the pre-test based on their desired type of license (commercial or non-commercial), the researcher used an "independent-samples *t*-test" (Field, 2009, p. 325).

To determine if there were significant differences in the scores of applicator license candidates taking the post-test based on their desired type of license, the researcher used an "independent-samples *t*-test" (Field, 2009, p. 325).

To determine if there were significant differences in the scores of applicator license candidates taking the GSE based on their desired type of license, the researcher used an "independent-samples *t*-test" (Field, 2009, p. 325).

Finally, the researcher used a "mixed design ANOVA" (Field, 2009, p. 506)—with a repeated-measures factor (within-subjects variable) of pre-test, post-test, and GSE scores and a between-subjects factor of kind of license sought—commercial or non-commercial—to determine if scores change over time (operationalized as test administration of pre-test, post-test, and GSE) based on the kind of license (operationalized as commercial or non-commercial) sought.

CHAPTER IV

FINDINGS AND DISCUSSION

Demographics

The first objective of this study was to examine the demographics of individuals who were participants in the 8 hour SPAT training courses. The results showed that 54.7% of the participants were trying to obtain a commercial applicator's license and 45.3% were trying to obtain a non-commercial license. The research results also showed that most individuals were less than 40 years old, and only two people were over the age of 65. The survey also included a question regarding education level. Completed education levels of participants were mainly focused at two levels, those who had obtained a high school diploma or GED (45%) and individuals who had attended a vocational/technical school or community college (33.6%). Another finding was that 84 of the 141 participants taking the 8-hour course had less than one year of experience in the pest control industry. The last characteristic was the number of employees in the individual's company. The results showed that this was an evenly distributed statistic with 30.6% of individuals worked at a company that had one to three individuals currently employed, 34.3% with four to 10 individuals currently employed, and 27.6% with 21 or more employees. Only 7.5% of participants worked at companies that employed 11 to 20 workers (See Table 1).

Table 1

Demographic Characteristics of Participants, N=150

Characteristics	Frequency	Percent
Age		
Less than 30	36	24.3
30 to 39	52	35.1
40 to 49	32	21.6
50 to 59	21	14.2
60 and over	7	4.7
Total	148*	
Education Level		
Some High School or Less	3	2.1
High School Diploma or GED	63	45.0
Community College or Technical School	47	33.6
Bachelor's Degree	23	16.4
Graduate or Post Graduate Degree	4	2.7
Total	140*	
Length of Service in the Pest Control Industry		
Less than one year	84	59.6
1 year	15	10.6
2 to 5 years	23	16.3
6 to 10 years	8	5.7
11 to 20 years	9	6.4
Over 20 years	2	1.4
Total	141*	
Number of Employees in Their Company		
1 to 3	41	30.6
4 to 10	46	34.3
11 to 20	10	7.5
21+	37	27.6
Total	134*	
Certification Type		
Commercial	64	54.7
Non-Commercial	53	45.3
Total	117*	

*Note: Frequencies for a characteristic did not total 150 because of missing data.

The questionnaire also contained two sections of satisfaction ratings (Kirkpatrick, 2008) to evaluate both the course and the instructor. The course evaluation scale comprised of six statements (Appendix A) to which participants responded on a "typical" grading scale of A, B, C, D, or F. These alphabetic grades were recoded to allow computation of a "GPA"—from 4.0 (highest) to 0 (lowest). Similarly, five statements were used in the instructor rating scale (Appendix A), and participants responded to those statements using the same grading scale.

The results of the analysis of satisfaction ratings are shown in Table 2. Overall, the course was "graded" an A (GPA = 3.70, SD = 0.43), and the instructor received a GPA of 3.94 (SD = .26)—an almost perfect score. Additionally, the course evaluation scale and the instructor evaluation scale show excellent internal consistencies, with the Cronbach's coefficient alphas (Field, 2009, p. 674) of 0.82 and 0.93, respectively.

Table 2

Satisfaction Ratings by Participants of the Course and of the Instructor, N = 150

Satisfaction With	*Frequency*	*M*	*SD*	*Cronbach's Coefficient Alpha*
Course	150	3.70	0.43	0.82
Instructor	150	3.94	0.26	0.93

Next, because the primary variable of interest in terms of a grouping variable was the license being sought, the data were broken down further in order to examine the demographics of each desired license (commercial versus non-commercial) and to compare the two groups. Because there were 33 participants who did not respond to the question concerning their desired kind of license, the data sample for this analysis comprised 117 individuals (Table 3). The results showed that the only significant differences between the participants seeking the two types of licensing were in age and in number of workers employed by the participant's company. Participants seeking commercial certification were younger than their counterparts seeking non-commercial certification. There were 40 individuals seeking commercial certification who were under 40 years old, while non-commercial had 21 participants. There were 31 individuals 40 years of age or older in the study group. Twenty-six participants seeking commercial certification worked for companies with three or fewer employees. Non-commercial participants had only eight with three or fewer employees. The other two categories (years of service and education level) were distributed similarly between the two types of certification applicants.

Table 3

Characteristics of Commercial and Non-commercial Applicants, N=117

Characteristics	Commercial *Frequency*	Non-Commercial *Frequency*	Total	χ^2
Age				
Less than 40	40	21	61	
40 and over	23	31	54	
Total	63	52	115[a]	6.11*
Education Level				
Some High School or Less	2	1	3	
High School Diploma or GED	26	25	51	
Community College or Technical School	15	18	33	
Bachelor's Degree	16	5	21	
Graduate or Post Graduate Degree	2	1	3	
Total	61	50	111[a]	5.69
Length of Service in the Pest Control Industry				
Less than one year	37	34	71	
1 year	9	3	12	
2 to 5 years	8	4	12	
6 to 10 years	2	4	6	
11 to 20 years	5	2	7	
Over 20 years	2	0	2	
Total	63	47	110[a]	6.22
Number of Employees in Their Company				
1 to 3	26	8	34	
4 to 10	19	16	34	
11+	17	19	36	
Total	62	43	105[a]	6.68*

[a]Note: Frequencies for a characteristic did not total 117 because of missing data.
*$p < 0.05$

Analysis of the dependent variables used in this study included the pre-test, the post-test, and the GSE. On average, participants passed all three examinations with mean scores above the required 70% correct. Standard deviations suggest that 40% failed the pre-test, less than 10% failed the post-test, but 40% again failed the GSE. Further analyses of the 10-item pre-test and the 10-item post-test reveal Cronbach's coefficient alphas (Field, 2009 p. 674) of 0.47 and 0.40, respectively (Table 4). The internal consistency of the GSE could not be calculated as total scores only were given to the researcher, but Snodgrass (2002) reports a Cronbach's alpha (Field, 2009, p. 674) of 0.80 on the 2001 version of the GSE.

Table 4

Means, Standard Deviations, and Cronbach's Coefficient Alpha for the Pre-test, Post-test, and GSE Examinations for Commercial and Non-commercial Applicants

Measure	*Frequency*	*M*	*SD*	*Cronbach's coefficient alpha*
Pre-test	144	75.76	16.92	0.47
Post-test	144	85.86	12.45	0.40
GSE	107	74.02	12.24	0.80*

*This value was taken from Snodgrass, 2002, p. 42.

Findings Related to Hypotheses 1, 2, and 3

The next objective of the study was to determine if the pre-test, post-test, and GSE scores were correlated. Pearson product moment correlation coefficients (Field, 2009 p. 170) were calculated to quantify the relationships pre-test, post-test, and GSE (Table 5). The correlation of the pre-test and post-test scores was 0.62, a high, positive

correlation coefficient (Davis, 1971). The coefficients for the correlation of the pretest with the GSE (0.23) and of the post-test and GSE (0.34) were low, positive and moderate, positive, respectively (Davis, 1971). All three coefficients were statistically significant at $p < 0.01$. The three null hypotheses of no correlations were rejected.

Table 5

Intercorrelations of Pre-test, Post-test, and GSE

Measure		Pre-test	Post-test
Post-test	*r*	0.62	
	p	<0.01	
	n	144	
GSE	*r*	0.23	0.34
	p	<0.01	<0.01
	n	107	107

Findings Related to Hypotheses 4, 5, and 6

The next hypotheses tested were that there was no difference in mean scores on pre-test between individuals seeking commercial or non-commercial certification, there was no difference in mean scores on post-test between individuals seeking commercial or non-commercial certification, and there was no difference in mean scores on GSE between individuals seeking commercial or non-commercial certification. The *t*-tests comparing pre-test scores of commercial and non-commercial applicants failed to detect a difference in the means. Similarly, the *t*-test comparing the post-test scores of commercial and non-commercial applicants failed to detect a difference in the means.

The third *t*-test comparing GSE scores of commercial and non-commercial applicants failed to detect a difference in the means. (See Table 6.) Thus, the researcher failed to reject null hypotheses 4, 5, and 6.

Table 6

Differences for Pre-test, Post-test, and GSE Between Groups That Were Seeking Commercial and Non-commercial Licenses

	Commercial		Non-commercial			
	M	*SD*	*M*	*SD*	*t*-value	*p*
Pre-test	76.67[a]	15.30	77.78[a]	13.46	0.38	0.71
Post-test	88.15[b]	13.19	86.89[b]	11.25	-0.51	0.61
GSE	74.40[a]	11.36	73.61[a]	11.10	-0.29	0.77

[ab]Means sharing a letter do not differ statistically significantly using Duncan's multiple range test.

Findings Related to Hypotheses 7, 8, and 9

The last analyses conducted were to examine the changes in scores (pre-test to post-test to GSE) between commercial and non-commercial applicants. Using a mixed design with a repeated measures as a within-subjects variable (pre-test, post-test, and GSE scores) and commercial versus non-commercial applicant as a between-subjects variable, a hypothesis was tested to determine if scores changed from one to another collection of a performance measure. Then, commercial versus non-commercial applicants were compared to test a hypothesis that performance was no different. Finally, an interaction of performance measure (pre-test, post-test, GSE) and commercial

versus non-commercial applicant was tested. Data in Table 6 show the descriptive results, and data in Table 7 provide the results of the inferential analyses.

Table 7

Repeated Measures/Within-Subjects ANOVA of Pre-test, Post-test, and GSE, Between-Subjects ANOVA of Commercial Versus Non-commercial, and Interaction Effects of Within Subjects and Between Subjects Variables

Source of Variation	*SS*	*df*	*MS*	*F*	*p*
Repeated Measures Linear	414.69	1	414.69	3.59	0.06
Repeated Measures Quadratic	5411.46	1	411.46	75.03	0.00
Repeated Measures x Commercial vs. Non-commercial Linear	8.59	1	8.59	0.07	0.79
Repeated Measures x Commercial vs. Non-commercial Quadratic	17.13	1	17.13	0.24	0.63
Error Linear	7964.37	69	115.43		
Error Quadratic	4976.55	69	72.12		
Between Subjects Variable of Commercial vs. Non-commercial	25.44	1	25.44	0.08	0.78
Error	310.98	69	310.98		

Statistical results in Table 6 showed that participants scored approximately 77% ± 14 on the pre-test, 87% ±12 on the post-test, and 74% ±11 on the GSE. The results in Table 6 revealed that there was not a linear effect of the training on the examinations but rather a quadratic effect. (This quadratic effect can be seen in *Figure 1*.) Thus, null hypothesis 7 is rejected. A Duncan's (Duncan, 1955) mean separation post hoc test revealed that the differences found were between the post-test scores and both pre-test and GSE scores. Furthermore, there were no differences detected between commercial and non-commercial applicants in terms of overall examination scores, nor were there any interaction effects of test administration and kind of certification sought. Thus, the researcher fails to reject hypotheses 8 and 9.

A plot of the means of the mixed design is presented in Figure 1. The change in "height" of the three points defining each line indicates the quadratic effect of the differences in performance on the three exams. The closeness of the two lines indicates that there were no differences in performance (examination scores) of commercial and non-commercial applicants and that there were no significant interaction effects.

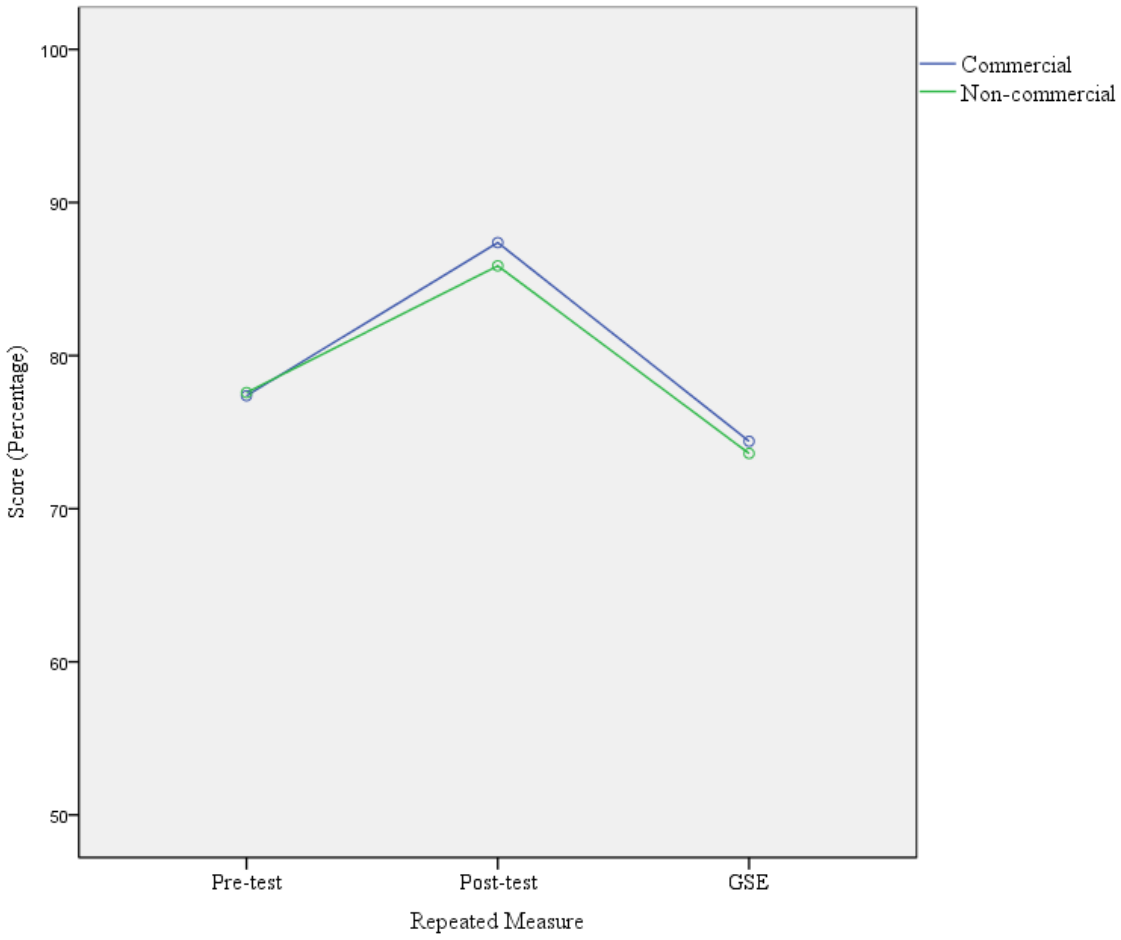

Figure 1. Plot of pre-test, post-test, and GSE scores (repeated measure) and commercial versus non-commercial applicants (between-subjects factor).

Discussion

The data show that the number of commercial and non-commercial participants was fairly even at 54.7% and 45.3%. The commercial applicants were younger than the non-commercial applicants, and the non-commercial applicators worked at larger companies. Most individuals (59.6%) applying for either certification had less than one year of experience in the pesticide industry, and had completed high school (45.0%) or attended a technical school/community college (33.6%) as their highest educational

attainment. The research also showed that there were relationships between each of the pairs of tests (pre-test/post-test, pre-test/GSE, and post-test/GSE), but there were no significant differences in the scores of commercial applicators versus non-commercial applicants on any of the three examinations. However, the internal consistency of both the pre-test and post-test was significantly lower than the internal consistency of the GSE (as reported by Snodgrass, 2002). The results also showed that the change in scores of participants was not a linear trend from pre-test to post-test to GSE. Rather, they differ significantly from test to test in a quadratic relationship. That is, scores of applicants on the pre-test were relatively average (among the three test administrations). Then, the scores on the post-test were significantly. However, the applicants' scores on the GSE dropped to statistically significant lower levels than scores on the post-test, on average, and somewhat lower than their pre-test scores.

When participants' scores were separated by the factor of commercial and non-commercial prospective certification and examined across the three administrations, there was no significant interaction. That is, the trends (slopes) of performance for participants seeking commercial certification were not statistically significantly different from the trends of performance of participants seeking non-commercial certification.

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to examine the performance of participants in SPAT training courses offered through AES. This was accomplished by working with the AES Unit to examine selected variables that may affect an individual's outcome on the General Standards Examination (GSE), and also to look at current demographics in the pest control industry. The hypotheses developed for this study were as follows:

1. There is no correlation between pre-test and post-test scores.
2. There is no correlation between pre-test and GSE scores.
3. There is no correlation between post-test and GSE scores.
4. There is no difference in mean scores on pre-test between individuals seeking commercial or non-commercial license.
5. There is no difference in mean scores on post-test between individuals seeking commercial or non-commercial license.
6. There is no difference in mean scores on GSE between individuals seeking commercial or non-commercial license.
7. There are no differences in scores on the three examinations (pre-test, post-test, and GSE).

8. There is no difference in knowledge of pesticide application (performance on examinations averaged) based on kind of license sought (commercial or non-commercial).
9. There are no interaction effects between performance on examination (pre-test, post-test, or GSE) and kind of license sought (commercial or non-commercial).

The data sample for this study comprised 150 individuals who completed the Renchie eight-hour course between February 2, 2011, and February 17, 2012, and who responded to instruments developed for this study (demographic and evaluation survey, pre-test, post-test, and GSE).

Conclusions

Based on the findings of the study, the following conclusions were drawn. The demographics of the pest control industry in Texas—or, more specifically, the demographics of those taking a SPAT course from AES examined for the purposes of this study—have not changed significantly in the past decade or more. In 1998, 98% of individuals participating in training had a high school diploma or more (Renchie, 1998), and in this study 97.9 % of individuals. Renchie (1998) found that 65% of the participants were between 20 and 39 years of age, and in this study the percentage was 59.4%. However, in the 1998 study 80% of individuals had less than one year of experience in the industry; in the current study the students had slightly more experience, with 59.6% having less than one year of experience.

The major differences in demographics between of the two groups of individuals investigated (commercial and non-commercial applicants) were in age and size of firm in which they were employed: commercial participants tended to be younger than non-commercial participants, and those seeking commercial licenses also tended to be employed in smaller companies/firms/entities than did those seeking non-commercial licenses.

This study found moderate, positive correlations between the pre-test, post-test, and GSE. Therefore, null hypotheses one, two, and three were rejected. It is concluded that the three tests—pretest, posttest, and GSE exam—were moderately positively correlated. The research also showed that the internal consistencies of the pre-test and of the post-test were significantly lower than that of the GSE. Also, the data did not detect any significant differences between the scores of individuals on any of the instruments (pre-test, post-test, and GSE) based on their desired license. Therefore, the researcher fails to reject null hypotheses four, five, and six. Finally, though the examination scores were related, there were statistically significant differences between participants' performances on the pre-test, post-test, and GSE; so, the researcher rejected null hypothesis seven. These differences were not linear. Rather, the differences were quadratic; thus, two of the three pairs—pre-test and post-test and post-test and GSE differ statistically; the differences, when graphed, showed that the pretest scores were moderate, the post-test scores were highest, and the GSE scores were lowest. This result differed from the two previous studies, Renchie (1998) and Snodgrass (2002). In the Renchie study the data showed that the average pre-test score in 1998 was 49.55%

±22.74, the average post-test score was 73.55% ±19.00, and an average GSE score of 79.63% ±12.33. Snodgrass found that the average score for an individual on the GSE in 2002 was 84%. Snodgrass (2002) even went so far as to state, "The exam may have been somewhat of an easy exam for the individuals who took the exam" (p. 41). It is concluded that test scores differed by the timing of the administration/kind of performance examination (pre-test, post-test, and GSE). Finally, commercial and non-commercial applicants performed virtually identically to each other on the exams. Thus, the researcher failed to reject null hypotheses eight and nine.

Implications

First, the positive correlations between the pre-test and GSE and the post-test and GSE indicate that they (pre-test and post-test) are predictive of performance on the GSE. However, because in both cases, the average scores on the two precursors were higher than the average scores on the GSE, applicants' performance on those tests may give applicants a false sense of security about how they might perform on the GSE—the only examination of the three that determined certification. In other words, performance on the pre-test and post-test may give an individual taking the eight-hour course (and the pre-test and post-test) the idea that they will perform at the same level on the GSE as they did on the post-test. Individuals may believe that, after completing the eight-hour course and performing well on the post-test exam, they are well prepared for the GSE and that they do not need to continue studying before taking the GSE test (even though it is recommended by the instructor to do so) (D. Renchie, personal communication, November 11, 2011). There are a few other factors that could affect the outcome of the

scores. The first is the relevance of the GSE. The last time that the GSE was updated was 2009, and the industry and the trainers have changed their materials with the current industry trends since then (D. Renchie, personal communication, July 2, 2012). Similarly, the relevance of the training program itself was not examined. The third is the fact that the amount of time that passed between completion of the training with the post-test and GSE was not taken into account. Also, the data show that individuals who are applying for a commercial applicator license are younger and work for companies that employ fewer individuals, and non-commercial applicants are older and work for companies that have a higher number of employees. This implies that the younger individuals who become commercially licensed are employed by smaller, entrepreneurial companies that do jobs for hire while the older, non-commercial applicators are employed by larger firms or institutions; these employees work within the company rather than for hire.

Recommendations

Because the scores on the pre-test and on the post-test (especially) were considerably higher than the scores on the GSE (even though the three sets of scores were intercorrelated), the pre-test and post-test should be examined and perhaps rewritten to increase the rigor and relevance (discerning) to give participants in the course better understanding of how they may perform on—and how they need to further prepare for—the GSE. It is recommended that further research be done into the relevance of the GSE to determine if it is current with the industry. Similarly, the training program itself should be examined to ensure/establish its relevance to industry standards. The amount of time that passes between the class ending and when an individual takes the GSE

should be examined to determine if the amount of time that passes affects an individual's score. Also, it is recommended that the results of the demographic and evaluation survey, the pre-test, the post-test, and the GSE all be linked (matched or paired) in order to give instructors (and researchers) a better understanding of (and ability to determine through research) what antecedent variables affect performance (test scores). It will also aid in interpreting course evaluations and speaker evaluation, and enhance what is currently being done as a level one, satisfaction evaluation (Kirkpatrick, 2008). It would be beneficial to the instructor if demographics were looked at in relation to the pre-test, post-test, and GSE scores. Finally, it is recommended that race/ethnicity and primary language (e.g., English, Spanish) be added to the current list of demographics. With changes in the demographics of Texas (Ennis, Rios-Vargas, & Albert, 2011) and thus in the pest control industry, this would be a trend to investigate further. Weber et. al (2004) discuss the increased need for more bilingual materials because of the increase in diversity of the industry.

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APPENDIX A

AgriLIFE EXTENSION
Texas A&M System

Structural Technician Apprentice/Applicator Training Course Evaluation

Date:_____

Instructor: Dr. Don L. Renchie

With A Being the Highest

Course Evaluation:

1.	Overall Rating of this Program was:	A	B	C	D	F
2.	How would you rate the handouts:	A	B	C	D	F
3.	How would you rate the demonstrations:	A	B	C	D	F
4.	Audio Visuals were:	A	B	C	D	F
5.	How well was the subject matter covered?	A	B	C	D	F
6.	In meeting my individual objectives the program was:	A	B	C	D	F
7.	Do you intend to adopt any practices or skills discussed today?	Yes				No

Speaker Evaluation:

1.	How well did the speaker state objectives and communicate materials?	A	B	C	D	F
2.	How well did the speaker use current information, pertinent materials and examples?	A	B	C	D	F
3.	How well did the speaker do in keeping the session interesting?	A	B	C	D	F
4.	How well did the instructor respond to questions?	A	B	C	D	F
5.	What is your overall rating of the instructor?	A	B	C	D	F

What is your age group? less than 18 18-24 25-29 30-34 35-39 40-44 45-49
50-54 55-59 60-64 65-69 70+

What is the highest level of education completed to date? Elementary School Some High School
High School Diploma GED Vocational/Technical school - Community College
Bachelor's Degree Master's Degree Doctorate degree Other:

What is your length of service in the Pest Control Industry? less than one year 1 year 2-5 years
6-10 years 11-20 years Over 20 years

Number of employees in your company? 1-3 4-10 11-20 21+

Have you worked with pesticides previously as either agricultural applications yes no
or urban applications yes no

☐ **Commercial Applicator Candidate** ☐ **Non-Commercial Applicator Candidate**

APPENDIX B

AgriLIFE EXTENSION
Texas A&M System

Structural Technician Apprentice/Applicator Training Course Pretest

Name:_____

Date:_____

Instructor: Dr. Don L. Renchie_____

1. Pesticides can move down through the soil and into ground water through a process called _____?
   a. Percolation
   b. Runoff
   c. Adsorption
   d. Leaching

2. The Texas Department of Agriculture requires licensing of Private Pesticide Applicators if they use pesticides classified as _____.
   a. General use
   b. Restricted use
   c. State-limited use
   d. Any of the above
   e. B and C

3. Which of the following is information that can be found on a pesticide label?
   a. The rate of application
   b. Methods of application
   c. Pest for which the pesticide can be used.
   d. All of the above

4. _____ toxicity refers to how poisonous a pesticide is after one short-term exposure.
   a. Time
   b. Chronic
   c. Dose
   d. Acute

5. If a person has swallowed a poison, you should make them vomit except when _____.
   a. The victim has swallowed a corrosive poison
   b. The victim is unconscious or has convulsions
   c. The victim has swallowed a petroleum base product
   d. All of the above.

6. Which of the following can be changed to increase the application rate of a ground spray rig?
   a. Reduce ground speed
   b. Change to a nozzle with larger holes
   c. Increase pressure
   d. All of the above

7. A pesticide can enter the applicators body through which of the following routes of exposure?
   a. Inhalation
   b. Dermal
   c. Oral
   d. All of the above

8. When pouring pesticides, which of the following is an incorrect statement?
   a. Never use your mouth to siphon pesticides.
   b. Do not leave a tank unattended while filling.
   c. Stand with your head below the container and filling hole of the spray tank.
   d. Work so that the wind does not blow pesticide into your face.

9. How should you clean your washing machine after laundering pesticide-soiled clothing?
   a. Run a rinse cycle only
   b. Use a fabric softener
   c. Run a complete, but empty cycle using hot water and detergent
   d. Clean the inside of the machine by hand

10. The _____ of a substance is it's capacity to injure a living organism.
    a. Toxicity
    b. Exposure
    c. Effect
    d. Harmful effect

APPENDIX C

AgriLIFE EXTENSION
Texas A&M System

Structural Technician Apprentice/Applicator Training Course Post Test

Name:_____ ☐ **Commercial Applicator Candidate**

Date:_____ ☐ **Non-Commercial Applicator Candidate**

Instructor: Dr. Don L. Renchie

1. Pesticides can move down through the soil and into ground water through a process called _____?
   a. Percolation
   b. Runoff
   c. Adsorption
   d. Leaching

2. The Texas Department of Agriculture requires licensing of Private Pesticide Applicators if they use pesticides classified as _____.
   a. General use
   b. Restricted use
   c. State-limited use
   d. Any of the above
   e. B and C

3. Which of the following is information that can be found on a pesticide label?
   a. The rate of application
   b. Methods of application
   c. Pest for which the pesticide can be used.
   d. All of the above

4. _____ toxicity refers to how poisonous a pesticide is after one short-term exposure.
   a. Time
   b. Chronic
   c. Dose
   d. Acute

5. If a person has swallowed a poison, you should make them vomit except when _____.
   a. The victim has swallowed a corrosive poison
   b. The victim is unconscious or has convulsions
   c. The victim has swallowed a petroleum base product
   d. All of the above.

6. Which of the following can be changed to increase the application rate of a ground spray rig?
   a. Reduce ground speed
   b. Change to a nozzle with larger holes
   c. Increase pressure
   d. All of the above

7. A pesticide can enter the applicators body through which of the following routes of exposure?
   a. Inhalation
   b. Dermal
   c. Oral
   d. All of the above

8. When pouring pesticides, which of the following is an incorrect statement?
   a. Never use your mouth to siphon pesticides.
   b. Do not leave a tank unattended while filling.
   c. Stand with your head below the container and filling hole of the spray tank.
   d. Work so that the wind does not blow pesticide into your face.

9. How should you clean your washing machine after laundering pesticide-soiled clothing?
   a. Run a rinse cycle only
   b. Use a fabric softener
   c. Run a complete, but empty cycle using hot water and detergent
   d. Clean the inside of the machine by hand

10. The _____ of a substance is it's capacity to injure a living organism.
    a. Toxicity
    b. Exposure
    c. Effect
    d. Harmful effect