

## ABSTRACT

LePREVOST, CATHERINE ELIZABETH. An Examination of Farmworker Pesticide Educators in a Southeastern State: Informal Science Educators and Risk Communication. (Under the direction of Margaret R. Blanchard and W. Gregory Cope.)

Because pesticide exposure is a significant hazard to farmworkers in their working and living environments, basic pesticide toxicology is a topic for farmworker science education that has implications beyond scientific literacy to encompass farmworkers' safety and health. Migrant and seasonal farmworkers have been identified as an at-risk population because of the cultural and linguistic barriers they face, their temporary employment and tenuous documentation status, and their low literacy levels and limited formal education. Despite the key role of pesticide educators in promoting farmworker scientific literacy, safety, and health, data regarding pesticide educators are absent in the literature. This dissertation investigated the nature of pesticide educators in a southeastern state. Drawing on quantitative and qualitative methods, the three studies contained within this body of work characterize the personal beliefs—including pesticide risk, self-efficacy, and teaching beliefs—of pesticide educators, as well as educators' personal goals and their beliefs about the environments in which they pursue those goals. The research allowed for the creation of a profile of the organizations that and individuals who provide pesticide education to farmworkers in a highly agricultural state.

The first study details the development and field testing of the *Pesticide Risk Beliefs Inventory*, a quantitative inventory to gauge pesticide risk beliefs, with a sample of pesticide educators (n=43) in a southeastern state. The 19-item, Likert-type inventory was found to be

psychometrically sound with a Cronbach's alpha of 0.780 and a valuable tool in capturing pesticide educators' beliefs about pesticide risk, assessing beliefs in four key categories. The *Pesticide Risk Beliefs Inventory* could be useful in exploring beliefs about pesticide risks and guiding efforts to address misconceptions held by a variety of formal and informal science learners, educators, practitioners, the agricultural labor force, and the general public.

A second mixed-method, multi-case study investigated 19 farmworker pesticide educators from four types of institutions in this southeastern state. A quantitative questionnaire and semi-structured interviews were employed to explore teaching beliefs, pesticide risk beliefs, and self-efficacy beliefs of these informal science educators. Teaching beliefs of pesticide educators ranged from *traditional* to *reform-based*, with most being *transitional* (i.e., focused on educator/farmworker relationships). Findings indicate that these pesticide educators have expert-like beliefs about pesticide risk. A positive correlation ( $r = 0.455, p = 0.0578$ ) existed between concern about adverse health outcomes associated with pesticides and student-centered teaching beliefs. Self-efficacy scores ranged from low to moderate, lower than is typically found in science teachers. Findings suggest an inverse relationship ( $r = -0.468, p = 0.0503$ ) between self-efficacy and farmworker-focused beliefs about teaching. Patterns of beliefs were apparent for teaching, pesticide risk, and self-efficacy by institutional affiliation and number of training sessions provided. Study results have direct implications for modifications to teacher belief constructs and pesticide educator professional development.

The third mixed methods study examines the state of pesticide education from an organizational perspective by comparing pesticide educators' (n=45) personal goals to those

of their institutions and examining the factors that shape educators' teaching practices. Findings indicate that individuals from all institutions share goals to reduce exposure and ensure safety and health for farmworkers, regardless of the missions of their organizations. Pesticide educators described time, farmworker basic needs, the physical setting, institutional missions, and training and curricular materials as shaping their teaching practices and restricting their goal attainment. This study suggests that congruence of personal goals provides a foundation for inter-institutional collaborations to meet the needs of this at-risk farmworker population.

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An Examination of Farmworker Pesticide Educators in a Southeastern State:  
Informal Science Educators and Risk Communication

by  
Catherine E. LePrevost

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## DEDICATION

To the men and women of the agricultural community, including farmworkers, farmers, and pesticide educators, whose labor provides the food and fibers that sustain us all.

## BIOGRAPHY

Catherine Elizabeth LePrevost was born in 1984 in Western North Carolina. Her parents Laurette and Charles LePrevost were post-secondary educators, both trained in the humanities, who desperately sought to supplement their daughter's pre-school training with documentaries on emergency medicine, *National Geographic* children's books, and ongoing trips to science museums. By the time she was ten years old, Catherine was functioning as a committed "lab urchin" –washing glassware, inoculating petri dishes, and helping to set up anatomy and microbiology labs. When she was sixteen, Catherine had summer employment in the research and development department at Greer Laboratories in Lenoir, North Carolina. While there, she completed an independent project, comparing commercially and individually prepared electrophoresis gels. Catherine graduated from Hickory High School in 2002, where she was able to complete a challenging science curriculum, earning the distinction of National Merit Scholar.

Catherine then studied biology at Wake Forest University, graduating summa cum laude in 2006. During her undergraduate years, Catherine participated in semester-abroad programs, first in Mexico and later in London. She also belonged to Delta Delta Delta and was honored with membership in Phi Beta Kappa. Catherine entered the Master of Toxicology program at North Carolina State University in 2006 and graduated in 2007. As a master's student, she taught introductory biology laboratory courses and participated in the Certificate of Accomplishment in Teaching program. In recognition of her work as a laboratory instructor, Catherine received the 2007 Graduate Student Association Outstanding

Teaching Assistant Award. In 2008, Catherine matriculated in the Science Education doctoral program at North Carolina State University under the direction of Dr. Margaret R. Blanchard and Dr. W. Gregory Cope.

Catherine's interests in teaching and learning inspired her involvement in writing a proposal and obtaining a grant with Julia Storm and Dr. W. Gregory Cope of the Department of Environmental and Molecular Toxicology for the development of the *Pesticides and Farmworker Health Toolkit* to create pesticide toxicology curricula for Latino migrant and seasonal farmworkers. Since her enrollment in the Science Education program, Catherine has served as Project Coordinator for the *Pesticides and Farmworker Health Toolkit*, continuing her research with farmworkers and pesticide educators.

Catherine is married to John Michael Baratta, who is completing his studies at Wake Forest University School of Medicine. His kindness, support, and wisdom in this and all life's projects are inestimable. John Michael and Catherine live in Winston-Salem with Emma, their Border Collie/Labrador Retriever.

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I am so appreciative of all of the men and women involved in farmworker pesticide education who graciously dedicated their time to participate in interviews and complete questionnaires. I hope that this work will ultimately benefit them as they strive to keep farmworkers and their families healthy and safe.

I am deeply thankful to my parents who have modeled for me excellent teaching, a love of learning, empathy for students, hard work, and integrity. Special thanks to my

mother who has proofread everything I have written since the first grade and who inspires greatness in her children and students alike. Thank you to my father for always knowing the right thing to say and to Charles for being such a steady and positive presence in my life.

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## **Chapter 1: Introduction**

Science educators who work with farmworkers, those individuals who provide the hand labor necessary to cultivate and harvest crops, acknowledge the charges of both the American Association for the Advancement of Science (AAAS) and the National Association for Research in Science Teaching (NARST) to foster the development of a science-literate population and to recognize the workplace as a science learning environment (AAAS, 1990; Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003). Because pesticide exposure is a significant hazard to farmworkers in both their working and living environments (Donham & Thelin, 2006), basic pesticide toxicology is a topic for farmworker science education that has implications beyond scientific literacy to encompass farmworkers' safety and health. Migrant and seasonal farmworkers have been identified as a special risk population by Donham and Thelin (2006) because of the cultural and linguistic barriers that these agricultural workers face in maintaining their safety and health within their working environments. These workers' temporary employment and tenuous documentation status (frequently as guest or undocumented workers) contribute to their feeling powerless within these environments and their fear of reporting unsafe working conditions, thereby presenting additional risks to this group (Donham & Thelin, 2006). Low literacy levels and limited formal education among farmworkers exacerbate their at-risk status (United States Department of Labor (US DOL), 2005; Tamassia, Lennon, Yamamoto, & Kirsch, 2007). Donham and Thelin (2006) assert that culturally-appropriate and effectively-communicated education is essential for preventing illness and injury among farmworkers. Furthermore, science education may empower farmworkers to improve their lives by making more informed decisions relating to pesticide risk (Barton, 2001).

## **Farmworker Population**

As the percentage of agricultural workers coming from farm families has steadily declined, the percentage of hired farm laborers in the United States, consisting primarily of migrant and seasonal workers, has increased to an all-time high (Kandel, 2008). Six states—North Carolina, California, Florida, Washington, Texas, and Oregon—account for half of the nationwide expenditures on hired agricultural labor (Kandel, 2008). Demand for hand laborers has been driven in part by an increase in consumer demand for fresh fruits and vegetables, which require human dexterity and judgment in harvesting; consumption of fresh fruits and vegetables (in contrast to processed products) has increased from 30% of all fruits and vegetables consumed in the United States in 1985 to 45% in 2004 (American Farm Bureau Federation Economic Analysis Team, 2006). Hired farmworkers, particularly migrant workers, comprise a larger proportion of individuals working in labor-intensive crops, such as fruits and vegetables (Kandel, 2008). The Southeast (defined as Alabama, Georgia, Florida, Kentucky, Mississippi, North Carolina, and South Carolina) has become the destination for 40% of the farmworkers in the United States (National Latina Institute for Reproductive Health, 2005).

The hired farm labor force is primarily comprised of young and middle-aged Latino males according to the National Agricultural Workers Survey (US DOL, 2005). The most recent report from US DOL indicates that 75% of hired farm laborers were born in Mexico and 2% in Central America, making the majority of hired farm laborers foreign-born and Spanish-speaking. The average age of farmworkers is 33 years. The population can be characterized generally as having limited formal education and low literacy skills. Most

workers have completed no more than seven years of formal education. Literacy skills in both Spanish and English have been found to be limited among Latino adult learners in the United States, although literacy levels are higher in Spanish than they are in English (Tamassia, Lennon, Yamamoto, & Kirsch, 2007). The majority of foreign-born workers from Mexico and other countries neither speak nor read English. Evidence exists that farmworkers seek formal education while working in the United States; twenty percent of crop workers have taken some type of adult education class since they have been in the United States, with English classes being the most popular (US DOL, 2005).

### **Pesticides as Hazards in Farmworkers' Working and Living Environments**

According to the most recent Census of Agriculture, the United States contains more than 406 million acres on which crops are grown (United States Department of Agriculture, 2009). While the total acreage of cropland has decreased from 434 million acres in 2002, the number of acres treated with insecticides, herbicides, nematocides, fungicides, and growth regulators has increased from 2002 to 2007. The latest reports of pesticide use in crop production indicate that more than 841 million pounds of pesticide active ingredients were applied in 2002 (Gianessi & Reigner, 2006a, 2006b). In their occupational environments, farmworkers encounter pesticide residues on plants and harvested crops or in the soil when they are participating in normal crop maintenance and harvesting activities. Less commonly, unanticipated pesticide exposure may occur during pesticide application through drift from adjacent fields or unintentional treatment of fields where farmworkers are working (Mobed, Gold, and Schenker, 1992).

Farmworkers and their families may be exposed to pesticides in their home environments in addition to their work environments (Donham & Thelin, 2006). The proximity of farmworkers' housing to agricultural fields and pesticide application sites presents the risk of pesticide residues and, consequently, of pesticide exposure in the home (McCauley et al., 2001). Farmworkers may introduce pesticides to the home by transporting residues on the clothing, skin, and shoes and through vehicles (Curl et al., 2002; McCauley et al., 2003). More directly, farmworkers may bring pesticide residues into the home by taking used pesticide containers from the farm for storage, as well as agricultural pesticides for treatment of the house or garden.

The environments of farmworkers predispose this population and their families to pesticide exposure and, subsequently, to pesticide illness and injury. Determining rates of pesticide exposure and illness in the farmworker population is difficult because the total number of farmworkers is not known. The farmworker population tends to be transient and suspicious of authority, farmworkers may return to their home countries to seek medical care, and no national monitoring system exists (McCauley et al., 2006). Limited access to medical care, misdiagnosis by health care providers, and fear among farmworkers contribute to significant underreporting of pesticide poisonings (Reigart & Roberts, 1999; Donham & Thelin, 2006).

Numerous studies have found an association between pesticide exposure and short-term and long-term health effects (McCauley et al., 2006; Donham & Thelin, 2006). Acute effects range from mild symptoms, including headaches and dizziness, to more severe effects, such as convulsions and respiratory distress. In the Agricultural Health Study,

pesticide applicators in Iowa and North Carolina have been found to have a higher incidence of specific cancers, including prostate cancer, and applicators in North Carolina had higher incidence of multiple myeloma, while overall cancer incidence and mortality rates were lower for applicators than for the general public (Koutros et al., 2010). This study of pesticide applicators and their spouses also suggested the association of pesticide exposure (both globally and related to specific chemicals) with neurological effects like depression and Parkinson's Disease (Beseler et al., 2008; Kamel et al., 2007), as well as reproductive effects like menstrual cycle influences (e.g., long cycles and missed menstrual periods) (Farr, Cooper, Cai, Savitz, & Sandler, 2004).

### **Farmworker Pesticide Education**

With the goal of reducing pesticide exposure and illness, the Worker Protection Standard mandates that every five years farmworkers receive pesticide education that “the workers can understand [i.e., in a language they understand]...using nontechnical terms” and that allows workers to ask questions (Worker Protection Standard, 1992, §170.130). Under the Worker Protection Standard, sources of pesticide exposure, ways to prevent having a pesticide enter the body, health effects associated with exposure, and appropriate emergency responses are mandatory topics for pesticide education. The latest study commissioned by the United States Environmental Protection Agency on the nationwide implementation of the Worker Protection Standard concluded that it was unclear how many workers were receiving the mandated training (Larson, 2000). Larson found that most employers tended to use videos for the training of workers. In the Southeast, work by Arcury, Quandt, Austin, Preisser, and Cabrera (1999) showed that only approximately one-third of farmworkers in

North Carolina had received pesticide education mandated by the Worker Protection Standard. Of the farmworkers who reported that they had received Worker Protection Standard education, the vast majority (nearly 85%) indicated that the lesson entailed watching one video. Most (75%) reported that a verbal presentation accompanied the video, but fewer than half of the workers reported that they were able to ask questions.

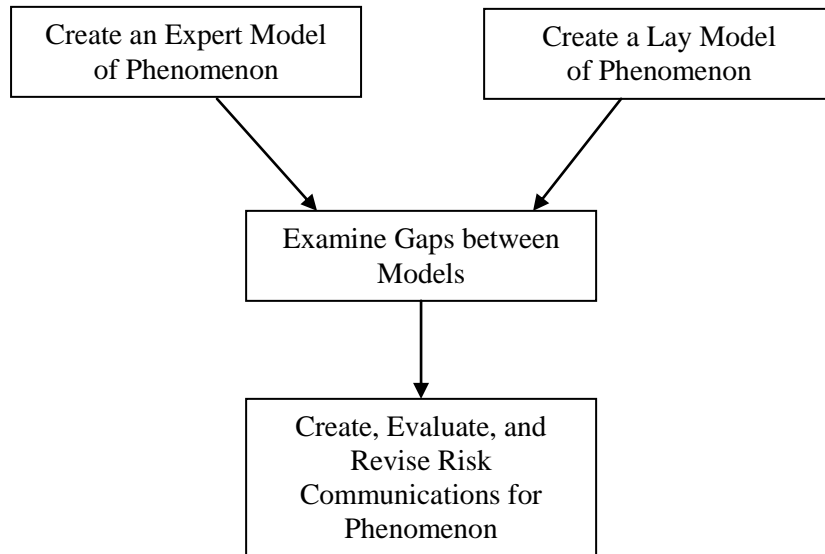
Face-to-face pesticide education is an alternative to video-based lessons and may enhance implementation of Worker Protection Standard education requirements.

Recognizing the utility of a more interactive approach to pesticide education, a southeastern state's farmworker health program (FHP) recently requested funds to hire bilingual educators to facilitate guided discussion and role play during farmworker pesticide education (FHP, 2009). Various organizations in this southeastern state provide health and education services to farmworkers and their families: the farmworker health program (FHP), migrant and community health centers, East Coast Migrant Head Start Project, the Migrant Education Program, the Cooperative Extension Service, and farmworker advocacy groups. These organizations are thought to provide farmworker pesticide education as part of their delivery of health and education services, but no known studies specifically explore the organizations and individuals that engage in farmworker pesticide education distinctly and apart from examining broadly the delivery of health services to farmworkers (Arcury & Quandt, 2007).

### **Theoretical Frameworks**

Morgan, Fischhoff, Bostrom, and Atman (2002) propose the mental models framework as a systematic approach to designing risk communications, emphasizing the

importance of understanding the knowledge and needs of the target audience of such communications in the design process (see Figure 1.1).



*Figure 1.1.* Mental models approach to risk communication, based on Morgan et al. (2002).

In this framework, mental models for both experts and for lay audience members are first created and then compared to determine inconsistencies between the models. Risk communications that address the most prevalent and pressing misconceptions and gaps in knowledge are created, evaluated, and revised on the basis of comparisons of the expert and target audience mental models.

Farmworker pesticide educators provide basic pesticide toxicology and safety lessons to farmworkers. Thus, the pesticide educator plays a critical role as a risk communicator. Given their involvement in the communication of pesticide risks to the susceptible

farmworker population, pesticide educators are an important group for the assessment of mental models for pesticide risk.

Although farmworker beliefs and perceptions surrounding pesticide risks have been studied (Quandt, Arcury, Austin, & Saavedra, 1998; Elmore & Arcury, 2001; Arcury, Quandt, & Russell, 2002), the beliefs of pesticide educators are not well-characterized. Because an understanding of pesticide educators' mental models for pesticide risk is critical in communicating risk to this population, assessing pesticide educators' beliefs about pesticide risks is essential before designing communications and professional development for this group. In the application of the mental models approach to pesticide education, disparities between expert (i.e., toxicologist) and pesticide educator mental models may be found. Likely areas for misalignment include the information used to evaluate the risk of particular pesticides, the assessment of long-term health outcomes, and the understanding of routes of exposure presenting the greatest risks. Discrepancies in expert and pesticide educator mental models will serve as a basis for professional development and risk communications for this particular audience.

According to Bandura's social cognitive theory (1986), personal, behavioral, and environmental factors interact reciprocally to determine one another and explain human functioning. Among personal factors are knowledge, cognition, beliefs, and attitudes. The mental models framework allows the examination of one personal factor—risk beliefs. This factor may interact with other personal factors, including self-efficacy and teaching beliefs, to explain pesticide educator practices. For example, science teaching efficacy beliefs, which have been shown to increase significantly as a result of professional development programs

(Posnanski, 2002), relate to a teacher's judgment of her performance in teaching science. Teacher efficacy has been associated with student achievement and various effective teacher behaviors, including use of praise, persistence in the face of failure, adoption of new curricula, changes in practice, and task orientation (Kagan, 1992). A common assessment of science teacher efficacy, the *Science Teaching Efficacy Beliefs Instrument* (Riggs & Enochs, 1990), draws on two personal factors from Bandura's social cognitive learning theory (1986, 1977), self-efficacy and outcome expectancy. Exploring farmworker pesticide education through the lens of science teaching efficacy beliefs, pesticide risk beliefs, and other teaching beliefs may provide insight into effective teaching of pesticide toxicology and communication of pesticide risks to farmworkers.

Morgan et al. (2002) describe the negative implications of poor risk communications:

If a communication omits critical information, then it fails the most obvious responsibility of communicators. It may leave recipients worse off if it creates an illusion of competence, so that recipients erroneously believe themselves to be adequately informed. If it presents irrelevant information, then it wastes recipients' time and diverts their attention from more important tasks. (p. 4)

Poor communications on the part of pesticide educators in communicating pesticide risks to farmworkers can result in failure to prevent pesticide exposure and resultant illness. Because the negative implications of poor risk communication are so great, as described above, understanding effective risk communication on the part of pesticide educators is essential. Farmworkers who engage in pesticide lessons with poor risk communicators may be at increased risk of pesticide exposure and illness if pesticide educators omit critical

information and if farmworkers have an “illusion of competence” (Morgan et al., 2002, p. 4). Extraneous information during pesticide lessons may divert farmworkers’ attention from the most critical concepts, and misunderstanding risk communications “denies them empowerment for dealing with the risk” (Morgan et al., 2002, p. 4). Conversely, effective risk communication regarding pesticides enhances farmworkers’ knowledge and contributes to their empowerment to make informed decisions regarding pesticide risks at work and home.

### **Rationale for Study**

Despite their potential for enhancing pesticide education for farmworkers and reducing pesticide illness within the at-risk farmworker population, pesticide educators remain largely absent from the literature. This study examines the individuals who provide pesticide education to farmworkers in a southeastern state in the United States, particularly investigating these educators’ ethnicity, country of origin, experiences educating farmworkers, agricultural experiences, and highest level of formal education attained. To enhance professional development for and improve understanding of pesticide educators, the beliefs about pesticide risk and science teaching efficacy, as well as the teaching beliefs, of this population will be assessed. Recognizing that pesticide educators operate within a system, the organizations through which educators engage farmworkers will be examined. Characterizing farmworker pesticide educators will facilitate the development of a science-literate population of pesticide educators and, ultimately, of farmworkers (AAAS, 1990). Recognizing pesticide educators as science teachers expands the field of science education to the workplaces of pesticide educators and farmworkers, thereby fulfilling the mandates of

both the AAAS and NARST to expand the science-literate population to include non-traditional adult learners (AAAS, 1990; Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003).

### **Research Questions**

The characteristics of pesticide educators must be better understood, recognizing the importance of personal biases and characteristics, in order to provide curricular materials and professional development for this group (Guskey & Huberman, 1995). A demographic profile of pesticide educators and their organizations, as well as an understanding of educators' beliefs about teaching, pesticide risk, and self-efficacy, would facilitate the development of culturally, linguistically, and educationally appropriate services and materials for farmworker pesticide educators in this state. In order to address this gap in the literature, to improve university services to pesticide educators, to enhance pesticide education for farmworkers, and ultimately, to reduce pesticide exposure and illness among farmworkers, the study consists of an examination of individuals who and organizations that provide pesticide education for farmworkers in a southeastern state.

The study employs a mixed methods design to answer the following questions:

1. What is the demographic profile of pesticide educators in the state, especially in relation to formal education level, experience with providing education to farmworkers, agricultural work experience, gender, ethnicity, and country of origin?
2. What are pesticide educators' beliefs surrounding risk related to pesticides? How can these risk beliefs be assessed?

3. What are pesticide educators' self-efficacy beliefs related to teaching pesticide toxicology?
4. What are pesticide educators' teaching beliefs, and how do these beliefs correlate with beliefs regarding pesticide risk and self-efficacy?
5. Through what organizations do pesticide educators engage farmworkers in pesticide lessons?
6. What are the personal and institutional goals of pesticide educators?
7. What are pesticide educators' beliefs about their teaching environments in which they pursue their goals?

### **Summary**

In this chapter, I presented the context and rationale for the proposed study and posed the research questions that will guide this mixed methods study. In the chapter that follows, Chapter 2, I review the literature that informs this study. The subsequent three chapters—Chapters 3, 4, and 5—are formatted as publication-ready manuscripts that include an abstract, a rationale, a literature review, a theoretical framework, methods, results, conclusions, and implications.

Chapter 3 is entitled, “The Pesticide Risk Beliefs Inventory: A Quantitative Instrument for the Assessment of Beliefs about Pesticide Risks.” This manuscript details the development of a risk beliefs inventory and confirms its psychometric strength. The *Pesticide Risk Beliefs Inventory* promises to be useful in exploring beliefs about pesticide risks and in guiding efforts to address misconceptions held not only by pesticide educators

but also by a wide variety of formal and informal science learners and educators, as well as the general public.

Chapter 4, “Describing the Nature of Farmworker Pesticide Educators in a Southeastern State: A Multi-Case, Mixed Methods Study of Informal Science Educators’ Beliefs” characterizes the beliefs of pesticide educators. This manuscript investigates pesticide educators’ teaching beliefs, beliefs about pesticide risks, and self-efficacy beliefs, exploring how these intersect. Patterns of beliefs about teaching, pesticide risk, and self-efficacy by institutional affiliation are explored, as well as implications for teaching belief constructs and for professional development for pesticide educators.

Chapter 5, the final manuscript, is entitled “An Institutional Perspective on Pesticide Education: A Mixed Methods Study of Farmworker Educators’ Organizations, Personal Goals, and Context Beliefs.” This chapter compares pesticide educators’ personal goals to those of their institutions and examines what environmental factors shape educators’ teaching practices. Using a mixed methods approach, this investigation examines a considerable portion (n=45) of the population of pesticide educators in a southeastern state. Study findings reveal who provides pesticide education for farmworkers, their goals, and the extent to which these are a function of the institutions for which they work or the contexts in which they teach.

In Chapter 6, the final chapter, conclusions and implications from the three manuscripts of Chapters 3, 4, and 5 are collated to synthesize the impact of the overall dissertation study. A more holistic view of the findings is discussed, using highlights from

the findings of the three studies. Finally, implications for policy and future research are explored.

## **Chapter 2: Review of the Literature**

Following the presentation of the rationale and research questions for the study in the previous chapter, this chapter contains a review of the relevant literature that informs this study. The major theoretical perspectives, which were introduced in Chapter 1, include risk communication and social cognitive theory. The academic origins of these frameworks are explored, and their use in other studies is discussed. This chapter concludes with a discussion of the study context, a southeastern state with a large agricultural base.

### **Risk Communication**

Risk communication, a term first coined in 1984, originated with the study of risk perception, a research tradition that surfaced in the 1960s (Leiss, 1996; Sjöberg, 2000). In response to disparities that were found in the risk perceptions of the general public and experts, risk communication emerged as a means by which to bridge the gap between public and expert risk perceptions, to facilitate dialogue about risks between experts and the public, and to enhance consensus on controversial aspects of risk characterization, assessment, and management (Leiss, 1996). Risk communication was viewed as “urgent” in light of the factors that the public utilized and the conclusions that they made related to risk associated with food safety, the environment, and hazardous materials (Gurabardhi, Gutteling, & Kuttschreuter, 2004). Common among various definitions of risk communication is the concept of iterative interactions among experts, institutions, and the public regarding risk characterization, assessment, and management (Leiss, 1996; Morgan, Fischhoff, Bostrom, & Atman, 2002; McComas, 2006).

The originators of the mental models approach to risk communication, Morgan, Fischhoff, Bostrom, and Atman (2002), propose a definition of risk communication that

stresses the desired outcome of contributing to the development of competent citizens: “Risk communication’ means communication intended to supply laypeople with the information they need to make informed, independent judgments about risks to health, safety, and the environment” (p. 4). This emphasis in risk communication on cultivating an informed citizenry that is capable of engaging in public debate and making decisions as workers and consumers parallels the goal of the American Association for the Advancement of Science (AAAS) for science educators to cultivate a science literate public (Morgan et al., 2002; Kovacs, Fischhoff, & Small, 2001; Bostrom, Atman, Fischhoff, & Morgan, 1994; AAAS, 1990). Rather than concentrating merely on providing advice or numbers associated with a particular risk, current aims for risk communication focus on the public’s understanding risk as a process whereby individuals learn to monitor their environments, identify risky situations, and respond appropriately to risks (Morgan et al., 2002).

Central to any discussion of risk communication are the terms “risk” and “risk perception.” While individuals identify many different items, activities, and technologies as “risks” (Morgan et al., 2002), Stern and Fineberg (1996) define risk as “things, forces, or circumstances that pose danger to people or what they value” (p. 215). Risk is frequently characterized as a function of the probability and the consequence of an adverse effect (Morgan et al., 2002). Sjöberg (2000) highlighted both objective factors (i.e., real risk) and subjective factors (e.g., heuristics, worldviews, and attitudes) as being influential in how individuals perceive risk.

The evolution of risk communication as a field of research has been described by Leiss (1996) as consisting of three phases: Phase I in which quantitative risk characterization

is emphasized, Phase II during which characteristics of successful communication are explored, and Phase III in which the social context of risk communication is stressed. The three phases in the practice of risk communication largely align with the eight developmental stages in risk management put forth by Fischhoff (1995) (see Table 2.1).

Table 2.1

*Comparison of Two Conceptualizations of the Evolution of Risk Communication*

Leiss's (1996) Three Phases	Fischhoff's (1995) Eight Developmental Stages
1. Stresses quantitative expressions of risk	1. All we have to do is get the numbers right 2. All we have to do is tell them the numbers
2. Stresses effective communication of risk	3. All we have to do is explain what we mean by the numbers 4. All we have to do is show them that they've accepted similar risks in the past 5. All we have to do is show them that it's a good deal for them 6. All we have to do is treat them nice
3. Stresses social context of risk communication	7. All we have to do is make them partners 8. All of the above

Early risk communication efforts, identified as Phase I by Leiss, stressed quantitative assessments of risk and the communication of these assessments to the public. This phase corresponds to two stages in Fischhoff's explanation: "all we have to do is get the numbers right" and "all we have to do is tell them the numbers" (Fischhoff, 1995, p. 138). According to both of the models, these early stages reflected a reluctance on the part of risk experts to share risk information with the public and a tendency to report risk information using

quantitative expressions or essentially raw data. In communicating numerical data to the public, experts frequently faced criticism and suspicion on the part of the public, who did not understand the risk information as presented and who adjusted risk estimates to compensate for perceived biases on the part of experts. The public's mistrust of expert analyses and the experts' resulting contempt for more subjective public perceptions contributed to an antagonistic relationship between experts and the public in the earliest risk communication efforts.

Leiss (1996) describes the second phase of risk communication as a drastic departure from previous efforts in that concepts from marketing communications were borrowed to make risk communication more persuasive. The audience's characteristics are taken into consideration and their perceptions are legitimized. Four stages of Fischhoff's paradigm may be equated to Leiss's Phase II: "all we have to do is explain what we mean by the numbers," "all we have to do is show them that they've accepted similar risks in the past," "all we have to do is show them that it's a good deal for them," and "all we have to do is treat them nice" (Fischhoff, 1995, p. 138). Recognition of the needs and beliefs of the audience became increasingly important through the evolution of risk communication as a field.

The culmination of risk communication in audience-appropriate communications is evident in Fischhoff's seventh and eighth phases: "all we have to do is make them partners" and the application of this and all of the previous seven phases (1995, p. 138). In these final phases, the public takes on a more active role in risk communication, adopting the position of partner. Active outreach on the part of institutions facilitates the building of trust between the general public and the institutions. Leiss's (1996) third phase focuses on the social

context of risk communications, specifically on the interactions among the various constituents of risk communication. The evolution of risk communication as a field has resulted in greater interest in audience beliefs and in their involvement in communications. With its emphasis on capturing how the public conceptualizes risk, the mental models approach reflects this trend of increasing attention to the target audience for risk communication.

### **Mental Models Approach**

Mental models are a “set of concepts a person uses to understand and generate inferences about a hazardous process” (Bostrom, Atman, Fischhoff, & Morgan, 1994, p. 789). Fischhoff (1995) describes the mental models approach to risk communication as fulfilling the public’s need to understand fully a process that produces risk. Borrowed from cognitive science (Zaksek & Arvai, 2004), this approach diverges from previous risk communication frameworks that assumed that an audience knew nothing prior to communication and needed to know nothing more than quantitative estimates related to risk. The mental models approach can be summarized by this statement that highlights the centrality of the target audience: “Like any good communication process, formulating an effective risk message begins by characterizing the information needs of its intended audience” (Fischhoff, 1999).

Early uses of mental models in risk communication focused on clarifying the public’s understanding, misconceptions, and knowledge gaps in relation to radon as an environmental contaminant in the home (Bostrom, Fischhoff, & Morgan, 1992; Atman, Bostrom, Fischhoff, & Morgan, 1994; Bostrom, Atman, Fischhoff, & Morgan, 1994). Risk messages served the

purpose of completing—and correcting as necessary—the public’s mental models of the risk presented by radon, recognizing initial beliefs and prior knowledge as important and focusing on discrepancies in expert and audience mental models. Communication centered on exposure, effects, and mitigation, as these topics were considered critical in homeowner decision making. Early studies established the utility of influence diagrams to represent expert beliefs. Influence diagrams were developed by interviewing experts and reviewing relevant literature for information about exposure, effects, and mitigation related to a risk. Emerging concepts were then graphically represented, denoting the relationships between concepts with arrows. These studies also established the method of using open-ended interviews followed by close-ended questionnaires to capture the public’s perceptions of risk, their mental models. The studies emphasized the use of these data from the audience to determine the structure and format, in addition to the content, of written communications.

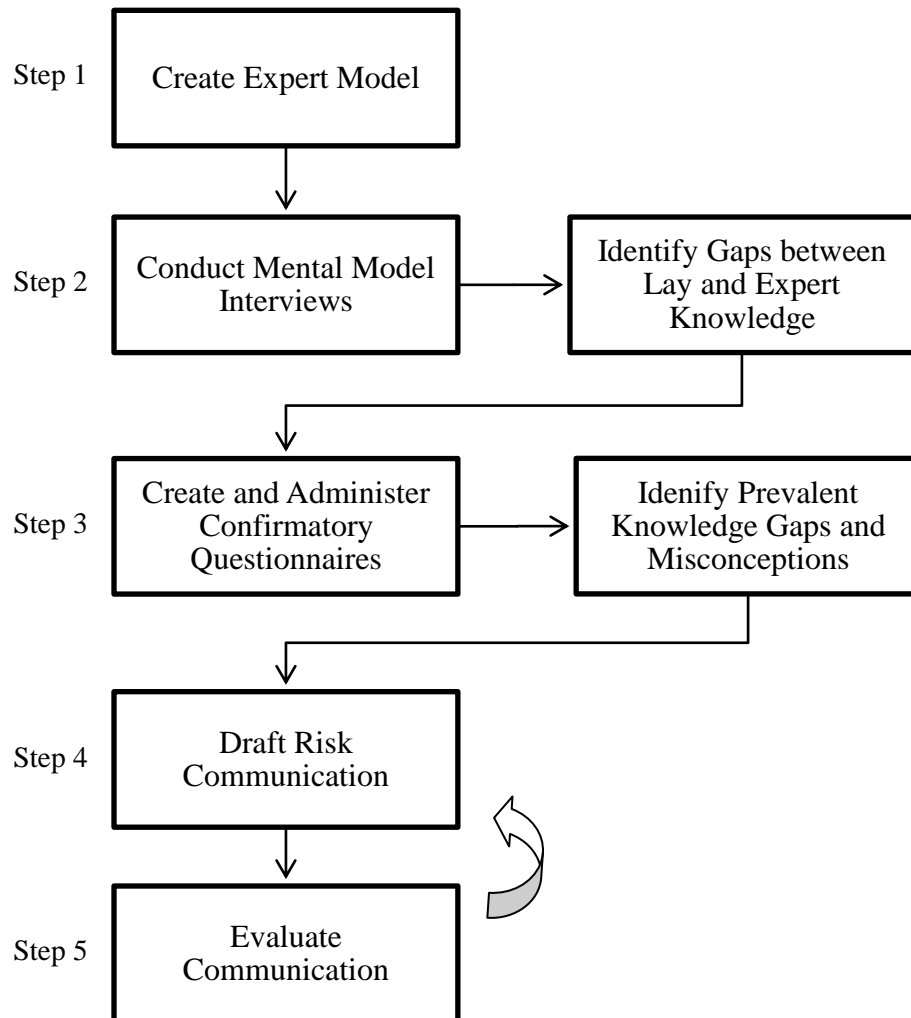
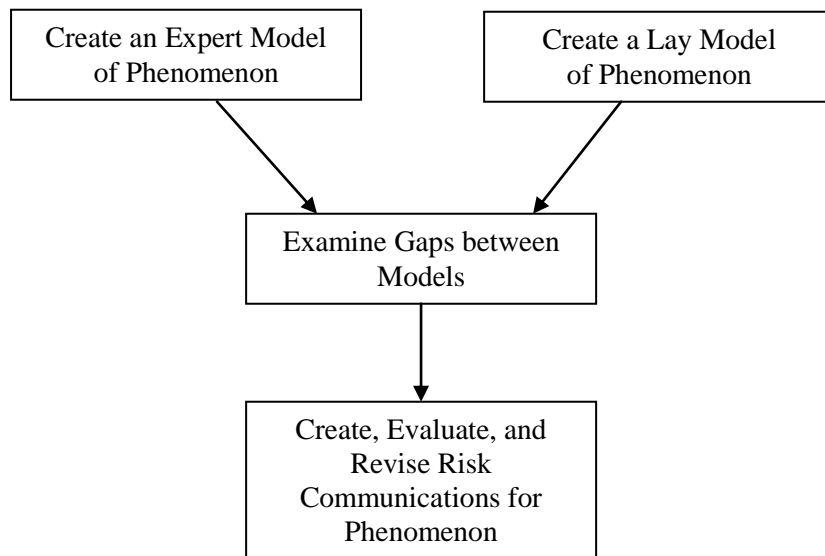


Figure 2.1. Methodology for mental models approach, based on Morgan et al. (2002).

Based on their previous work and the literature on using a mental models approach, Morgan, Fischhoff, Bostrom, and Atman (2002) formalized their systematic, five-step approach in *Risk Communication: A Mental Models Approach*. Morgan et al. (2002) summarized the five steps to risk communication as follows: Step 1: create an expert model; Step 2: conduct mental model interviews; Step 3: create and administer confirmatory

questionnaires; Step 4: draft risk communication, and Step 5: evaluate communication (see Figure 2.1). Because individuals' prior knowledge is recognized as being relevant to their decisions regarding risk and their understanding of communications, this framework includes eliciting the audience's "fragmentary beliefs" about a risk (i.e., mental models) and comparing these beliefs to expert models of the same phenomenon in order to develop risk messages that address the most prevalent and pressing gaps in the models (Morgan et al., 2002, p. 21). Figure 2.2 depicts the juxtaposition of expert and lay mental models that is central in developing risk communication materials. In this tradition, the terms lay and laypeople are frequently used to denote the target audience or the general public. Fischhoff (1999) notes that the use of this terminology refers to the source of the public's knowledge (e.g., self-education, indigenous technical knowledge) rather than the extent of their knowledge. The ultimate goal of the mental models approach to risk communication is to produce more informed decision makers.



*Figure 2.2.* Mental models approach to risk communication, based on Morgan et al. (2002).

Risk communication may best be classified as informal science education. Many areas in which risk messages have drawn on the mental models approach to risk communication are science topics. For example, homeowners have been the target audience for the design of risk messages pertaining to radon as an environmental contaminant (Bostrom, Fischhoff, & Morgan, 1992; Atman, Bostrom, Fischhoff, & Morgan, 1994; Bostrom, Atman, Fischhoff, & Morgan, 1994) and to wildland fires as a natural disturbance and danger to people and the environment (Zaksek & Arvai, 2004). Consumers of pharmaceutical products (Jungermann, Schütz, & Thüring, 1988) and of dry cleaning services (Kovacs, Fischhoff, & Small, 2001) have been targeted in efforts to develop individuals' mental models for these particular risks. Risk communication related to climate change has employed the mental models approach to understand the general public's understandings, misconceptions, and knowledge gaps in this subject (Bostrom, Morgan, Fischhoff, & Read, 1994; Sterman, 2008).

Communication of a variety of health-related risks has depended on research into individuals' mental models (Fischhoff, 1999; MacGregor, Slovic, & Malmfors, 1999; McComas, 2006). In general, qualitative data, which serve as the initial data source in Morgan et al.'s (2002) five-step process and as the basis for close-ended surveys and questionnaires, have greater representation in the literature. When quantitative assessments of an audience's beliefs about a risk have been included in these studies, the quantitative data collected from larger samples were of secondary importance to open-ended interviews.

Prior to developments in risk communication, workplace safety materials, like material safety data sheets (MSDS), were designed with little attention given to the end-users

of these safety materials. Research by Kovacs, Fischhoff, and Small (2001); Cox, Niewöhner, Pidgeon, Gerrard, Fischhoff, and Riley (2003); and Niewöhner, Cox, Gerrard, and Pidgeon (2004) has resulted in the creation of communications for chemical users in the dry cleaning and electronics industries that are user-centered in content and format and based on user and expert mental models of specific chemicals. Influence diagrams that represent expert beliefs were created by referring to the literature and other safety publications related to specific chemicals and by interviewing experts in occupational hygiene, chemicals, and toxicology. User beliefs were captured during interviews and focus groups and through questionnaires. These studies identified and addressed knowledge gaps and misunderstandings, as well as reinforced beliefs that aligned with expert models, in an attempt to improve workplace safety and to facilitate informed decision making on the part of chemical users.

Importantly, Niewöhner et al. (2004) concluded that improved communications were necessary but not sufficient to change workplace safety practices, suggesting that regulatory changes and technical innovations may also have significant roles in enhancing workplace safety. Because employees may decide not engage in safe practices despite their knowing the associated risks, workplace changes (regulatory or new technologies) that lead to a reduction in chemical use or in chemical toxicity may be necessary for improved safety. Cox et al. (2003) stressed that workers may continue to take chemical risks despite improved communications: “Well-informed workers might still decide to take what they consider to be acceptable risks—in the light of the perceived associated benefits” (p. 323). Ultimately, the goal of workplace chemical safety communications, as portrayed in these studies, is to

provide accessible, relevant, and usable information to chemical users to allow them to make informed decisions.

### **Lay Beliefs about Pesticide Risks**

The beliefs and perceptions of pesticide users have been characterized using quantitative and qualitative measures and employing other theoretical perspectives, particularly those from public health (e.g., PRECEDE-PROCEED model for health interventions, Health Belief Model, etc.). For example, the Health Belief Model is used by Arcury Quandt, and Russell (2002) to predict the adoption of health behaviors (e.g., pesticide safety) based on patient perceptions of susceptibility, severity, and benefits (e.g., farmworker perceptions of pesticide risk). These studies provide insight into the mental models of pesticide risks held by members of the agricultural community. Specifically, misconceptions and knowledge gaps regarding exposure to and effects of pesticides have been revealed in these studies.

Interestingly, the concept that pesticides pose a risk to the agricultural community is not universally accepted by agricultural audiences. Among a sample of 110 Missouri farmers, individuals who own farm land and manage crop production, pesticide exposure was identified as a “concern” by fewer than 50% (Wadud, Kreuter, & Clarkson, 1998). One quantitative assessment of farmworkers’ perceived risk using the Health Belief Model revealed that a substantial portion of the 293 North Carolina farmworkers who participated in the study did not perceive pesticides to be a significant risk (Arcury et al., 2002). More specifically, approximately 22% of the sample expressed that they did not perceive pesticides to be a risk to themselves or other farmworkers or did not perceive these risks to be great

enough to cause concern. Even larger percentages of the farmworkers in the sample failed to perceive risks to exist or be great enough to cause concern in relation to the health of farmworker children (approximately 26%), to the health of unborn children (approximately 28%), or to the potential to have children (28%). Furthermore, Quandt, Arcury, Austin, and Saavedra (1998) found that some farmworkers believed that pesticides are dangerous to weeds and insects but not to humans. Classification of pesticides as a risk, therefore, is not ubiquitous among farmers and farmworkers.

One documented belief in farmworkers' mental models of pesticide risks relates to the detection of pesticides using the senses. Focus group and interview findings have revealed that farmworkers inaccurately believe that pesticide odors can be used to determine when and where pesticides have been applied, as well as the presence of especially toxic pesticides (Quandt et al., 1998; Flocks, Monaghan, Albrecht, & Bahena, 2007). The correlation between odor and toxicity was reiterated in Elmore and Arcury's (2001) study of North Carolina farmworkers working in the Christmas tree industry. Flocks et al. (2007) and Elmore and Arcury (2001) found that farmworkers associated pesticide odors with experiencing adverse health effects. Quandt et al. (1998) described the use of taste, touch, and sight, in addition to smell, as important in farmworkers' detection of pesticides and their determination of the potential for pesticide exposure.

A qualitative study of farmworkers in North Carolina has shown that participating farmworkers considered natural body openings as the most relevant routes of exposure to pesticides (Quandt et al., 1998). Inhalation and ingestion were emphasized by farmworkers in the study as points of entry into the body. The skin, however, was incorrectly perceived as

an impenetrable barrier to pesticide absorption and as a source of exposure only when pesticides were transferred from the skin to natural openings. Elmore and Arcury (2001), however, found that farmworkers recognized dermal absorption, inhalation, and ingestion as routes of exposure but that farmworkers failed to discuss the risks of exposure to pesticide residues, particles that may remain in the soil, on plants, or on harvested materials after pesticide application.

Studies have shown that knowledge gaps exist in farmworkers' mental models related to the long-term health effects of pesticide exposure. Farmworkers were able to identify acute health effects of pesticide exposure (e.g., nausea, vomiting, headaches, dizziness, and skin diseases), but they were less likely to identify long-term effects, discuss chronic exposure, or describe individuals they know who have long-term health problems associated with pesticide exposure (Quandt et al., 1998). Elmore and Arcury (2001) reported that few farmworkers believe that adverse health effects resulting from pesticide exposure will last more than one day. These studies also indicated that farmworkers believe that individual susceptibility—based on gender, age, and perceived strength—determine sickness from pesticides (Quandt et al., 1998; Elmore & Arcury, 2001; Flocks et al., 2007). Women, the old and young, and others perceived as weak might be considered by farmworkers as having the greatest risk for pesticide illness.

In many cases, these lay beliefs contradict or fail to fully reflect scientific understandings of pesticides. Rather than recognizing physical properties (e.g., smell or taste) as relevant to toxicity, toxicologists typically conceptualize chemicals and their toxicity according to types of pesticides (i.e., fungicides, insecticides, and herbicides) and chemical

classes (e.g., organochlorines, organophosphates, and carbamates) (Cope, Leidy, & Hodgson, 2004). Because the skin is the body's largest organ and has a large surface area for exposure, dermal absorption is of great concern among toxicologists, contrary to the lay belief that inhalation and ingestion are the only significant routes of entry. Furthermore, numerous studies have found an association between pesticide exposure and short-term and long-term health effects (McCauley et al., 2006; Donham & Thelin, 2006). Acute effects range from mild symptoms, including headaches and dizziness, to more severe effects, such as convulsions and respiratory distress. In the Agricultural Health Study, pesticide applicators in Iowa and North Carolina have been found to have a higher incidence of specific cancers, including prostate cancer, and applicators in North Carolina had higher incidence of multiple myeloma, while overall cancer incidence and mortality rates were lower for applicators than for the general public (Koutros et al., 2010). This study of pesticide applicators and their spouses also suggested the association of pesticide exposure (both globally and related to specific chemicals) with neurological effects like depression and Parkinson's Disease (Beseler et al., 2008; Kamel et al., 2007), as well as reproductive effects like menstrual cycle influences (e.g., long cycles and missed menstrual periods) (Farr, Cooper, Cai, Savitz, & Sandler, 2004). These findings suggest potentially important discrepancies in lay and expert beliefs about pesticide risk.

Studies of the beliefs of farmworker pesticide educators, however, are noticeably absent in the literature. Furthermore, quantitative instruments to assess lay beliefs regarding pesticide risks do not exist. Assessing pesticide educators' beliefs regarding pesticide risk is essential in determining what gaps exist between educator and expert beliefs. Certainly an

understanding of beliefs and gaps is necessary in order to deliver professional development to this group and to examine if and how beliefs about pesticides influence teaching practices. A quantitative questionnaire seems a logical step in order to gather data to characterize any misconceptions or knowledge gaps, as well as expert-like beliefs, among farmworker pesticide educators. Data from administration of a quantitative questionnaire might be used to identify knowledge gaps to aid in the creation of communications and curricular materials to enhance the educators' ability to provide effective pesticide lessons to farmworkers, as well as to explore the relationship between risk beliefs and teaching beliefs.

Farmworker educators' pesticide risk beliefs, as well as their beliefs about their own teaching capabilities, might influence their teaching beliefs and practices. Personal factors like these have been found to shape an individual's behavior. Bandura's (1986) social cognitive theory is a theoretical framework that can help to explicate these factors.

### **Social Cognitive Theory**

According to Bandura's social cognitive theory (1986), cognition and other personal factors, behavior, and environmental events interact reciprocally to determine one another and explain human functioning. Among personal factors are perceived self-efficacy and outcome expectancy. Self-efficacy refers to an individual's judgment of his or her capability to execute actions to attain a certain level of performance. Outcome expectancy, in contrast, focuses on the consequence of an action, denoting a judgment of the anticipated result of a certain performance (see Figure 2.3). Both factors shape behavior, and these two factors are related in that expected outcomes depend on perceived efficacy. Efficacy judgments are shaped by performance accomplishments, vicarious experience, verbal persuasion, and

emotional arousal. Perceived self-efficacy is a proximal determinant of choice behavior, effort and persistence, thoughts, and emotions. In fact, according to Bandura (1977), self-efficacy is a better predictor of successful completion of novel tasks than past performance.

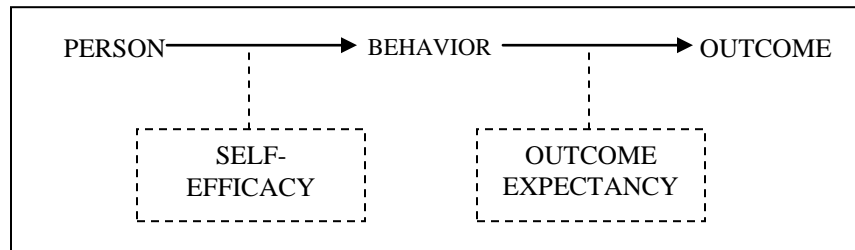


Figure 2.3. Differentiation of self-efficacy and outcome expectancy judgments, based on Bandura (1977).

### Teaching Efficacy

Bandura's social cognitive theory has informed a strand of research focusing on the construct of teaching efficacy. Gibson and Dembo (1984) have shaped much of the teaching efficacy field with their two-factor *Teacher Efficacy Scale (TES)*. The subscales of the *TES* reflect Bandura's personal factors of perceived self-efficacy, referred to as *personal teaching efficacy* in the *TES*, and outcome expectancy, referred to as *teaching efficacy*. When applied to teaching, self-efficacy—or personal teaching efficacy—relates to a teacher's judgment of her ability to effect positive change in her students' learning. Outcome expectancy or teaching efficacy reflects a teacher's belief that teaching can generally result in positive learning outcomes despite the many factors that are beyond a teacher's control, including school and home environments and student intelligence. This perspective proposes a multidimensional conceptualization of teacher efficacy, recognizing both perceived self-efficacy and outcome expectancy.

Ross (1998) reviewed teacher and environmental characteristics found to influence teaching efficacy judgments. While females generally exhibited higher perceived teaching efficacy, males reported higher perceived self-efficacy in science teaching and other domains traditionally identified as masculine. The general teaching efficacy factor was found to decline with greater experience in teaching while the personal teaching efficacy factor increased. In other words, as teachers gained experience, they were more confident in their ability to facilitate student learning but became less confident in the effectiveness of teaching in general for effecting positive change in student outcomes. Having a graduate degree correlated with increased teaching efficacy. Teachers with higher science achievement in secondary and college science courses and more experience with science courses had higher levels of science teaching efficacy. That is, teachers with more advanced course work were more likely to believe that their own teaching would result in positive student outcomes. Environmental factors shown to correlate positively with teaching efficacy included classes with high-ability and orderly students, a collaborative school culture, a supportive principal, and a moderate workload. Said another way, teachers in supportive environments were more likely to judge their teaching abilities as positively influencing student learning.

Teachers with high perceived teacher efficacy tend to employ teaching strategies and engage in classroom practices known to enhance student learning. Gibson and Dembo (1984) found that teachers who scored higher on their *TES* instrument spent more time in preparation, used less criticism in responding to students, and exhibited greater persistence in working with student failures. In his review of teacher efficacy, Ross (1998) noted a trend in increased risk-taking behaviors among teachers with high perceived self-efficacy, including

implementing new curricula, experimenting in the classroom, and participating in action research. Additionally, teachers with high perceived personal efficacy held high expectations for their students and promoted student autonomy. These practices corresponded with positive impacts on students as high teacher efficacy was found to be associated with student outcomes of improved cognitive and affective achievement.

Teacher efficacy is most frequently measured using quantitative, self-administered questionnaires (Ross, 1998). Gibson and Dembo's (1984) *Teacher Efficacy Scale (TES)*, one of the most popular instruments used to assess teacher efficacy, informed the development of the domain-specific *Science Teaching Efficacy Beliefs Instrument (STEBI)*; Riggs & Enochs, 1990). Like the *TES*, the *STEBI* consists of two dimensions that parallel Bandura's personal factors of self-efficacy and outcome expectancy; these subscales are referred to as *personal science teaching efficacy* and *science teaching outcome expectancy*, respectively. Riggs and Enochs (1990) asserted that their instrument more closely aligns with Bandura's social cognitive theory in that it is domain-specific rather than global as in previous efforts. *TES* items were modified to reflect the context of the elementary science classroom.

Though it was originally designed for in-service elementary science teachers, the *STEBI* has been used with teachers of other grade levels, like middle grades (Khourey-Bowers & Simonis, 2004), and modified to measure teacher efficacy among pre-service science teachers (Enochs & Riggs, 1990), chemistry teachers (Rubeck & Enochs, 1991), and even mathematics teachers (Wenner, 2001). The adaptability of the instrument, as well as the utility of the construct in predicting teaching practices and student outcomes, suggests the appropriateness of modifying the *STEBI* to reflect the context and content of pesticide

education to measure perceived efficacy among pesticide educators. Pesticide educators' beliefs about their pesticide teaching efficacy, in addition to their beliefs about pesticide risks, have potential implications for their delivery of pesticide lessons and for farmworkers' learning of pesticide concepts.

### **Farmworkers and Pesticide Educators in the Southeastern Study State**

With more than 8.6 million acres of farmland, the state of focus for this study is ranked in the top three for states producing tobacco, sweetpotatoes, Christmas trees, and cucumbers, according to Agricultural Statistics (2009). In 2008, the agricultural sector added more than \$2.8 billion to the state's economy. As a prominent producer of tobacco, sweetpotatoes, Christmas trees, cucumbers, strawberries, blueberries, tomatoes, apples, bell peppers, and grapes, the state depends on hand labor to cultivate and harvest crops. Hired farmworkers, particularly migrant workers, comprise a large proportion of individuals working in labor-intensive crops, such as fruits and vegetables (Kandel, 2008).

The transient nature of the population makes determining the exact number of migrant and seasonal farmworkers difficult. The Southeast—defined as Alabama, Georgia, Florida, Kentucky, Mississippi, North Carolina, and South Carolina—has become the destination for an estimated 40% of the farmworkers in the United States (National Latina Institute for Reproductive Health, 2005). Estimates of the state farmworker population in 2009, based on the farmworkers' use of migrant and community health centers, was approximately 86,000 according to the state farmworker health program.

Given the large population of migrant and seasonal farmworkers in the state, various organizations provide health and outreach services to this group. The farmworker health

program (FHP), a statewide migrant health voucher program, funds 22 medical and dental facilities across the state. The FHP identifies 28 facilities, including migrant and community health centers, as migrant health access points. The Migrant Head Start Project and the Migrant Education Program are also recognized by FHP as providing education-related services to farmworker parents and their children. The Cooperative Extension Service at both the state and county levels develops curricula and offers programs for farmworkers and their families. Farmworker advocacy groups are active in educating farmworkers in the state. The diversity of organizations that serve the farmworker population statewide makes this state an appropriate site for examining pesticide educators and their beliefs related to pesticides and teaching about pesticides.

### **Summary**

In this chapter, I provided a review of the literature that informs this study of pesticide educators and their beliefs about pesticides and teaching. First, I defined risk communication and described the evolution of risk communication as a field of research. The audience-centered mental models approach was then examined as a subset of the risk communication literature, and the documented lay beliefs regarding pesticide risks were reviewed. Next, I discussed social cognitive theory and its usefulness in examining the relationship between beliefs and practices, specifically teaching beliefs and practices. Finally, I concluded with a description of farmworkers and farmworker pesticide educators in the study state. A review of the literature revealed several critical gaps: a lack of discussion of pesticide educator demographics and beliefs about pesticides and teaching and the absence of a quantitative instrument to assess beliefs about pesticide risks.

**Chapter 3: The Pesticide Risk Beliefs Inventory: A Quantitative Instrument for the  
Assessment of Beliefs about Pesticide Risks**

## Abstract

Recent media attention has focused on the risks that agricultural pesticides pose to the environment and human health; thus, these topics provide focal areas for scientists and science educators to enhance public understanding of basic toxicology concepts. This study details the development of a quantitative inventory to gauge pesticide risk beliefs. The goal of the inventory was to characterize misconceptions and knowledge gaps, as well as expert-like beliefs, concerning pesticide risk. This study describes the development and field testing of the *Pesticide Risk Beliefs Inventory* with an important target audience: pesticide educators in a southeastern U.S. state. The 19-item, Likert-type inventory was found to be psychometrically sound with a Cronbach's alpha of 0.780 and to be a valuable tool in capturing pesticide educators' beliefs about pesticide risk, assessing beliefs in four key categories. The *Pesticide Risk Beliefs Inventory* could be useful in exploring beliefs about pesticide risks and in guiding efforts to address misconceptions held by a variety of formal and informal science learners, educators, practitioners, the agricultural labor force, and the general public.

Recent discussions of agricultural pesticides in popular media, including the CNN series *Toxic America* (Martin & Hellerman (Directors), 2010) and an article in *Newsweek* that relates pesticide exposure to Attention Deficit Hyperactivity Disorder in children (Dailey, 2010), are representative of growing national attention to pesticide risks. With an increase in public interest, scientists and science educators seek to enhance public understanding of basic toxicology concepts related to pesticides (American Association for the Advancement of Science (AAAS), 1990). However, little is known about the current beliefs of the public or of pesticide educators regarding pesticide risk. Prior to developing communications and curricular materials focusing on pesticide risks for the general public or agricultural audiences, the current knowledge and beliefs of these groups must be characterized. No known quantitative instrument currently captures individuals' understandings of pesticides and their risks.

In both their working and living environments, pesticide exposure is a hazard to farmworkers, who supply the manual labor necessary to cultivate and harvest crops (Donham & Thelin, 2006). Therefore, knowledge of basic pesticide toxicology has significant implications for farmworkers' safety and health, and communication of pesticide risks is essential to preventing pesticide illness and injury. Acute pesticide poisoning has been identified as a public health concern for agricultural workers globally, specifically to those in developing countries (Jeyaratnam, 1990). Migrant and seasonal farmworkers are identified as a special risk population because of the cultural and linguistic barriers that these agricultural workers face in maintaining their safety and health within their working environments (Donham & Thelin, 2006). In the United States, the majority of hired farm

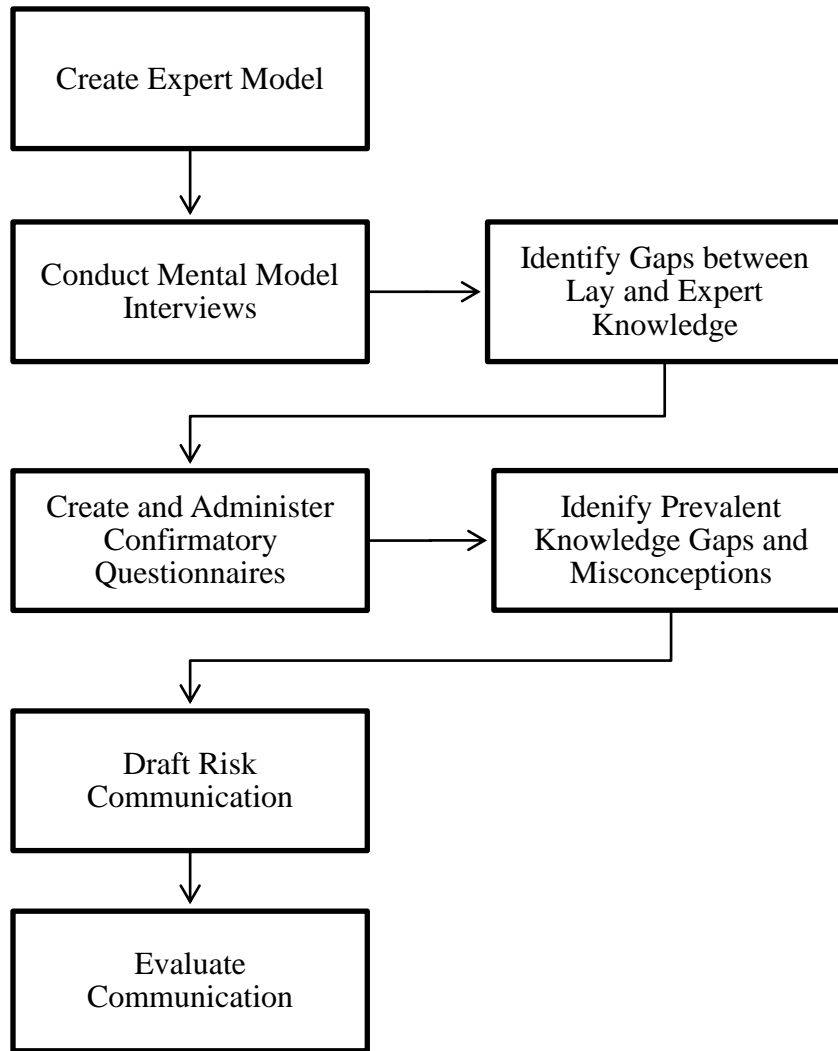
laborers are foreign-born and Spanish-speaking; Mexico is the country of origin for 75% of hired farm laborers, with Central American countries accounting for an additional 2% (United States Department of Labor (US DOL), 2005). Farmworker pesticide educators provide basic pesticide toxicology and safety lessons to farmworkers. Given their critical role in the communication of pesticide risks to the susceptible farmworker population, pesticide educators are an important group for the assessment of beliefs regarding pesticide risk.

This study details the development of the *Pesticide Risk Beliefs Inventory*, including testing with pesticide educators in a southeastern state in the United States, to identify beliefs about pesticides and their risks. A quantitative questionnaire that focuses on pesticide risk beliefs held by scientists, educators, and the general public (ranging from novices to experts) will facilitate the characterization of misconceptions and knowledge gaps, as well as expert-like beliefs. This information will assist curriculum developers in the creation of communications and curricular materials, with the goal of enhancing the audience's decision-making ability by addressing the most prevalent and pressing discrepancies in expert and audience beliefs.

### **Theoretical Framework**

The evolution of risk communication as a field has resulted in greater interest in audience beliefs and in their involvement in communications (Leiss, 1996; Fischhoff, 2005). With its emphasis on capturing how the public conceptualizes risk and its focus on developing the public's understanding of a hazardous process, the mental models approach reflects this trend of increasing attention to the target audience for risk communication.

Morgan, Fischhoff, Bostrom, and Atman (2002) propose the *mental models* framework, a systematic approach to designing risk communications that emphasizes understanding the knowledge and needs of the target audience in the design process (Figure 3.1). To the extent that beliefs shape practices (Bandura, 1986), the emphasis on beliefs in the mental models approach is useful in understanding a target audience's actions related to a risk. Because individuals' prior knowledge is recognized as being relevant to their decisions regarding risk and their understanding of communications, this framework includes eliciting the audience's "fragmentary beliefs" about a risk (i.e., mental models) and comparing these beliefs to those of expert models, in order to develop risk messages that address disparities in the models. The terms 'lay' and 'laypeople' are frequently used to denote the target audience or the general public and are not reflective of the extent of the audience's knowledge; Fischhoff (1999) clarifies that the use of this terminology refers to the *source* of the public's knowledge (e.g., self-education, indigenous technical knowledge) rather than the *extent* of their knowledge. The ultimate goal of the mental models approach to risk communication is to produce more informed decision makers.



*Figure 3.1.* Mental models approach to risk communication, based on Morgan et al. (2002).

The mental models approach to risk communication has been used in environmental health communications. For example, homeowners have been the target audience for the design of risk communications pertaining to radon as an environmental contaminant (Bostrom, Fischhoff, & Morgan, 1992; Bostrom, Atman, Fischhoff, & Morgan, 1994) and to wildland fires as a natural disturbance and danger to people and the environment (Zaksek &

Arvai, 2004). Consumers of pharmaceutical products (Jungermann, Schütz, & Thüring, 1988) and of dry cleaning services (Kovacs, Fischhoff, & Small, 2001) were the focus for development of mental models for these particular risks. Risk communication related to climate change has employed the mental models approach to understand the general public's perceptions, misconceptions, and knowledge gaps in this subject (Bostrom, Morgan, Fischhoff, & Read, 1994; Sterman, 2008).

Prior to developments in risk communication, workplace safety materials, like material safety data sheets (MSDS), were designed with little attention given to the end-users of these safety materials. The mental models approach to risk communication has informed the development of user-friendly materials that address chemical risks in the workplace. Research by Kovacs, Fischhoff, and Small (2001); Cox, Niewöhner, Pidgeon, Gerrard, Fischhoff, and Riley (2003); and Niewöhner, Cox, Gerrard, and Pidgeon (2004) has resulted in the creation of communications for chemical users in the dry cleaning and electronics industries that are user-centered in content and format and based on user and expert mental models of specific chemicals.

### **Literature Review**

Agricultural audiences do not necessarily believe that pesticides pose a risk to the agricultural community. In a study of Missouri farmers, individuals who own farm land and manage crop production, pesticide exposure was identified as a "concern" by fewer than 50% (Wadud, Kreuter, & Clarkson, 1998). One quantitative assessment of farmworkers' perceived risk was conducted using the Health Belief Model, a framework for public health intervention (Arcury, Quandt, & Russell, 2002). Approximately 25% of the 293 North

Carolina farmworkers who participated in the study did not perceive pesticides to be a significant risk to themselves, other farmworkers, farmworker children, or unborn children. Study findings from North Carolina suggest that the respondents did not perceive risks to themselves because they do not believe that pesticides can pose risks, rather than because they were using proper techniques and measures to mitigate any such risks. The authors found no relationship between perceived risk and pesticide safety behaviors.

Focus group and interview findings indicate that farmworkers hold many misconceptions about pesticides that can undermine safety measures and increase health risks. For example, several studies found that farmworkers incorrectly believe that pesticide odors can be used to determine when and where pesticides have been applied, as well as the presence of especially toxic pesticides (Quandt, Arcury, Austin, & Saavedra, 1998; Elmore & Arcury, 2001). Quandt et al. (1998) described individuals' reporting the use of taste, touch, and sight, in addition to smell, as important in detecting pesticides and the potential for pesticide exposure. A qualitative study of farmworkers in North Carolina has shown that participating farmworkers consider natural body openings as the most relevant routes of exposure to pesticides (Quandt et al., 1998). Inhalation and ingestion were emphasized by farmworkers in the study as points of entry into the body, which is accurate according to expert models. The skin, however, was perceived as an impenetrable barrier to pesticide absorption and as a source of exposure only when pesticides were transferred from the skin to natural openings, when in fact the skin is the largest surface area for pesticide absorption.

Many knowledge gaps in farmworkers' mental models relate to the long-term health effects of pesticide exposure. Farmworkers were able to identify accurately acute health

effects of pesticide exposure (e.g., nausea, vomiting, headaches, dizziness, and skin diseases), yet they were less likely to identify long-term effects, discuss chronic exposure, or describe individuals they knew who had long-term health problems associated with pesticide exposure (Quandt et al., 1998). Elmore and Arcury (2001) reported that few farmworkers believe that adverse health effects resulting from pesticide exposure will last more than one day.

In many cases, these lay beliefs contradict or fail to fully reflect scientific understandings of pesticides, with the potential for increased health risks to farmworkers and their families. Rather than recognizing physical properties as relevant to toxicity, toxicologists typically conceptualize chemicals and their toxicity according to types of pesticides (i.e., fungicides, insecticides, and herbicides) and chemical classes (e.g., organochlorines, organophosphates, and carbamates) (Cope, Leidy, & Hodgson, 2004). Because the skin is the body's largest organ, dermal absorption is of great concern among toxicologists, contrary to the lay belief that inhalation and ingestion are the only significant routes of entry. Furthermore, numerous studies have found an association between pesticide exposure and short-term and long-term health effects (Donham & Thelin, 2006; McCauley et al., 2006). Acute effects range from mild symptoms, including headaches and dizziness, to more severe effects, such as convulsions and respiratory distress. In the Agricultural Health Study, pesticide applicators in Iowa and North Carolina have been found to have a higher incidence of specific cancers, including prostate cancer, and applicators in North Carolina had higher incidence of multiple myeloma, while overall cancer incidence and mortality rates were lower for applicators than for the general public (Koutros et al., 2010). This study of pesticide applicators and their spouses also suggested the association of pesticide exposure (both globally and related to specific chemicals) with neurological effects like depression and Parkinson's Disease (Beseler et al., 2008; Kamel et al., 2007), as well as reproductive

effects like menstrual cycle influences (e.g., long cycles and missed menstrual periods) (Farr, Cooper, Cai, Savitz, & Sandler, 2004). These findings suggest potentially important discrepancies in lay and expert beliefs about pesticide risk.

### **Research Objective**

Specific aspects of lay mental models for pesticide risks have been described in a number of studies, but no single study has examined pesticide beliefs comprehensively. A quantitative inventory for pesticide risk beliefs would facilitate characterization of the beliefs of larger samples and allow for generalizations to be made about prevalent misconceptions and knowledge gaps in pesticide risk beliefs. The objective of this study, therefore, was to develop a pesticide risk belief inventory and test the inventory with one relevant target audience: pesticide educators in a southeastern state in the United States. This is the audience most able to directly impact the pesticide beliefs and knowledge of farmworkers, an at-risk group. As a reminder, ‘lay’ refers to the target audience, pesticide educators, who may or may not have pesticide risk beliefs that match those of experts.

### **Methods**

Morgan et al. (2002) formalized their systematic, five-step approach to designing communications in *Risk Communication: A Mental Models Approach*: (1) create an expert model, (2) conduct mental model interviews, (3) create and administer confirmatory questionnaires, (4) draft risk communication, and (5) evaluate communication. Referring to the literature to understand expert mental models and qualitative assessments of lay mental models, this study focused on the third step of the mental models approach. A questionnaire

that captured important beliefs from the expert model and misconceptions from the qualitative studies of lay audiences was created and administered.

### **Inventory Development**

Three experts in the field of pesticide toxicology confirmed the expert model of pesticide risks derived from the literature and provided guidance in the selection of facets and items for this inventory. Experts in environmental and molecular toxicology helped to identify the following four facets for measuring pesticide risk beliefs: (1) determination of pesticide risk using physical properties, (2) determination of pesticide risk using chemical properties, (3) association of risk with pesticide routes of entry into the body, and (4) association of risk with adverse health outcomes resulting from pesticide exposure. These facets reflected expert conceptualization of pesticide hazards (Donham & Thelin, 2006; McCauley et al., 2006), as well as lay beliefs captured in studies of the agricultural community (see Table 3.1 for inventory facets and items). The inventory was also available in Spanish. The instrument was translated by a third party from English into Spanish and back-translated from Spanish into English to ensure consistency between versions (Brislin, 1970).

The inventory contained 19 Likert-type items with six-point scales. A six-point scale was chosen to prevent neutral responses while providing a reasonable range for respondents. Four items corresponded to the facet for determination of risk using physical properties, and three items related to chemical properties. Six items each comprised the facets for association of risk with routes of entry into the body and association of risk with adverse health outcomes of pesticide exposure. The items appeared in random order, as determined

by a random number generator, rather than according to facet. Six items were reverse coded. For the purpose of scoring and analyzing the *Pesticide Risk Beliefs Inventory* data, the response “strongly disagree” corresponded to a score of 1, “disagree” corresponded to 2, “somewhat disagree” corresponded to 3, “somewhat agree” corresponded to 4, “agree” corresponded to 5, and “strongly agree” corresponded to 6. For reverse-coded items, “strongly disagree” corresponded to a numerical score of 6 and so forth. Each of the four items related to determination of risk using physical properties were scored as reverse-coded items so that a higher score related to a more expert-like belief. For all inventory items, a score of 4 or higher represented agreement with expert beliefs.

Table 3.1

*Pesticide Risk Facets and Items Used in the Pesticide Risk Beliefs Inventory*

<b>No.</b>	<b>Facet</b>	<b>Item</b>
1	Physical Properties	I can determine if a pesticide is dangerous by its smell.
2	Routes of Entry	When I am working with a pesticide, I am worried about having the pesticide enter my body when I breathe.
3	Chemical Properties	I can determine if a pesticide is dangerous by reading its chemical label.
4	Health Outcomes	When I am working with a pesticide, I am not worried about getting cancer in the future.
5	Physical Properties	I can determine if a pesticide is dangerous by seeing whether it is a powder, liquid, or granule.
6	Health Outcomes	When I am working with a pesticide, I am worried about having a recurrent problem with my skin.
7	Routes of Entry	When I am working with a pesticide, I am not concerned about covering my nose.
8	Routes of Entry	When I am working with a pesticide, I am not worried about having the pesticide enter my body through my skin.
9	Health Outcomes	When I am working with a pesticide, I am worried about having to go to the emergency room.
10	Physical Properties	I can determine if a pesticide is dangerous by its color.
11	Routes of Entry	When I am working with a pesticide, I am concerned about covering my skin.
12	Chemical Properties	I can determine if a pesticide is dangerous by knowing the family of chemicals that the pesticide belongs to.
13	Chemical Properties	I can determine if a pesticide is dangerous by knowing its ingredients.
14	Routes of Entry	When I am working with a pesticide, I am not worried about having the pesticide enter my body through my eyes.
15	Health Outcomes	When I am working with a pesticide, I am worried about losing my ability to have children.
16	Routes of Entry	When I am working with a pesticide, I am worried about having the pesticide enter my body when I eat or drink.
17	Health Outcomes	When I am working with a pesticide, I am not worried about having difficulty breathing.
18	Health Outcomes	When I am working with a pesticide, I am not worried about being poisoned.
19	Physical Properties	I can determine if a pesticide is dangerous by its taste.

Six experts in the field of science education reviewed the items for reading level. This review resulted in re-writing one item. The item originally included language that

might not be accessible for the general public: “I can determine if a pesticide is dangerous by knowing its *chemical structure*.” To address chemical structure in a way that would not draw as heavily on scientific terminology, the item was replaced with “I can determine if a pesticide is dangerous by knowing the family of chemicals that the pesticide belongs to.” Expert review of the item relevance and content coverage provided evidence of content-validity for this inventory (Reynolds, Livingston, & Willson, 2009).

In addition to assisting in item development, experts in pesticide toxicology evaluated the finished product. One revision based on expert review of the completed inventory included the deletion of the following item: “I can determine if a pesticide is dangerous by knowing whether it kills bugs, weeds, or plant diseases.” Although the classes of pesticides associated with the most symptomatic illnesses are insecticides (i.e., organophosphates, pyrethrins, and pyrethroids) (Reigart & Roberts, 1999), an entomologist described the concern that a range of toxicity levels exists within the broad category of insecticides: “An insecticide can range from everything from insecticidal soap to Temik® [a toxic carbamate], so just knowing if it's an insecticide, herbicide, or fungicide doesn't tell you anything at all about how it will affect people or what environmental effects it may have” (personal communication, January 26, 2011). Removing this question improved facet and inventory internal consistency.

### **Administering the Inventory: Testing and Validation**

A sample of 43 farmworker pesticide educators from one state in the southeastern United States participated in the testing of the *Pesticide Risk Beliefs Inventory*. Seventeen pesticide educators who attended one of two pesticide education workshops provided by a

land-grant university in the southeastern United States completed pen-and-paper versions of the inventory. The link to an online version of the inventory was distributed using relevant professional electronic subscription lists (i.e., listservs). Twenty-six online respondents completed the online questionnaire. Responses were scored, facet means and Cronbach's alpha values were determined, and the inventory Cronbach's alpha was calculated. For survey submissions missing fewer than 15% of item responses (i.e., 3), the respondent's average score for the missing item's corresponding facet was used as the response.

The sample was predominantly female (n=26) and comprised largely of White/European American (n=15) and Latino/Hispanic individuals (n=24). Education levels ranged from the high school diploma to the doctoral degree. Various employer organizations represented in the sample included migrant and community health centers, Cooperative Extension, state agencies, Migrant Education, Migrant Head Start, and farmworker advocacy groups. These pesticide educators reported that they typically provide as few as one and as many as 600 pesticide lessons to farmworkers each year.

### **Findings**

Cronbach's alpha is a reliability measurement that is sensitive to content sampling error and that assesses the content homogeneity of the inventory (Reynolds et al., 2009). Findings from this study indicated a strong internal consistency when the inventory was used with the pesticide educator study group. Using the sample of 43 pesticide educators, the Cronbach's alpha for the entire inventory was found to be 0.780. The Cronbach's alpha values for the individual facets ranged from 0.758 to 0.864 (Table 3.2). Expert review of the item relevance and content coverage provided evidence of content validity for this inventory.

Table 3.2

Pesticide Risk Beliefs Inventory *Facets with Cronbach's Alpha and Mean Values*

<b>Facet</b>	<b>Facet Cronbach's Alpha</b>	<b>Facet Mean</b>
Determination of Risk Using Physical Properties	0.864	5.390
Determination of Risk Using Chemical Properties	0.805	4.574
Risk Associated with Routes of Entry into Body	0.758	4.988
Risk Associated with Adverse Health Effects	0.782	4.271

### **Pesticide Educators' Beliefs**

Pesticide educators' composite scores on the inventory ranged from 64 to 111. The mean score was 90.8. In all four facets, the sample was in agreement with expert-like beliefs regarding pesticide risk. For all but two items, which received ambivalent average responses of 3.442 (related to concern about losing the ability to have children with pesticide exposure) and 3.558 (related to concern about visiting the emergency room due to pesticide exposure), all items were answered with general agreement, indicating alignment with expert-like beliefs.

Pesticide educators strongly disagreed with the belief that they could use physical properties of a pesticide to determine risk. They most strongly disagreed with using the taste (5.581) and color (5.488), respectively, to assess the danger posed by a pesticide. In strongly disagreeing with the belief that pesticide risk can be determined by a pesticide's physical properties, the sample of pesticide educators exhibited agreement with expert-like beliefs. The sample less strongly agreed that they could use chemical properties of pesticides to determine risk. The lowest average scores were for the items related to using the ingredients (4.209) and the chemical family (4.233) to determine risk.

The sample agreed that pesticide risk was associated with the routes of entry of the pesticides into the body (4.988) and with adverse health effects (4.271). The sample indicated the greatest concern with the skin as a route of entry (5.395). They agreed that a poisoning event (4.842) was a concern but were less worried about losing the ability to have children (3.442) and having to visit the emergency room (3.558).

### **Discussion**

In this study, the *Pesticide Risk Beliefs Inventory* was developed and tested with a group of pesticide educators as a first attempt to quantitatively assess audience mental models of pesticide risks. Disparate studies have revealed misconceptions and knowledge gaps in lay conceptualizations of pesticide risks, and these findings informed the selection of inventory items. Expert beliefs about pesticide risks were derived from the literature, confirmed by pesticide toxicologists, and likewise used to create inventory items regarding important beliefs. Testing of the inventory demonstrated the psychometric strength of this instrument, using the standard that a reliability estimate of 0.7 or higher is appropriate (Nunnally & Bernstein, 1994), with the inventory Cronbach's alpha of 0.780. Expert review supported content validity. The extent to which findings regarding educators' beliefs are as expected and the internal reliability estimates are adequate provide weak evidence for the instrument's construct validity; future work might focus on more rigorous testing of construct validity. Morgan et al. (2002) proposed the usefulness of confirmatory questionnaires, like the inventory used in this study, for assessing the prior knowledge of the audience, focusing the content of risk communications (e.g., chemical properties useful in assessing pesticide toxicity), and evaluating the effectiveness of risk communication.

In general, the pesticide risk beliefs of pesticide educators in this southeastern state aligned with an expert perspective. This finding is reassuring because pesticide educators have the critical task of communicating risks to the special risk farmworker population. Despite the pesticide educators' having generally high (expert-like) scores on the inventory, the inventory was useful in identifying possible areas for professional development. Although the sample strongly disagreed with the belief that physical properties of a pesticide might be useful in determining risk, they less strongly agreed in the usefulness of chemical properties. While pesticide educators rejected the lay belief, they were less committed to the expert belief. This finding suggests that professional development programs for pesticide educators might focus on discussions of chemical families and ingredients. The survey could be re-administered following the professional development program to assess the presence of more expert-like beliefs.

Given that highly technical questions regarding pesticides and their risks were not asked, an assessment of pesticide educators' knowledge and beliefs of technical information—beyond basic beliefs related to exposure, routes of entry, and health outcomes—cannot be made. The importance of beliefs in shaping practices (Bandura, 1986), however, suggests the centrality of identifying pesticide educator basic beliefs about the content of their risk communications in understanding their teaching and communication practices.

This study was designed to assess risk beliefs of pesticide educators in a southeastern state. As such, the items and language used were determined by a group of experts in both pesticide toxicology and science education and validated with pesticide educators ranging

from those with a high school education to the doctoral degree and including both native Spanish and English speakers. A possible limitation of this study is that the instrument, its items, and its scaling have not yet been validated with migrant farmworkers or with individuals representing a full range of ethnicities (beyond Latino and European American) and having experiences with pesticides that would be reflective of the general public. Researchers would be advised to validate this instrument with groups that differ greatly from the educators in this study.

Given the results of this study, a recommended next step is administering the inventory to larger samples and different groups, especially farmworkers (including those in other countries) and the general public, who may demonstrate more of the lay beliefs regarding pesticide risk documented in the literature. The low literacy levels and limited formal education of the farmworker population (Tamassia, Lennon, Yamamoto, & Kirsch, 2007; US DOL, 2005), may require oral administration of the inventory for all non-readers.

### **Conclusions**

The *Pesticide Risk Beliefs Inventory* developed in this study has been shown to be psychometrically sound. Our testing demonstrated its ability to gauge pesticide beliefs in a group of pesticide educators in a southeastern state, who express predominantly expert beliefs. This inventory holds promise for exploring beliefs about pesticide risks for a variety of other audiences—students, secondary science teachers, college science professors, the agricultural labor force, and the general public. The inventory could be used to compare beliefs among different groups or to prepare relevant risk communication materials, professional development sessions, and informal science lessons. By using this inventory,

scientists and science educators can pre-assess beliefs and content knowledge as well as post-assess the effectiveness of risk communications in addressing misconceptions, filling knowledge gaps, and expanding expert-like beliefs.

**Chapter 4: Describing the Nature of Farmworker Pesticide Educators in a  
Southeastern State: A Multi-Case, Mixed Methods Study of Informal Science  
Educators' Beliefs**

## Abstract

Pesticide educators have important roles as informal science educators and risk communicators for the at-risk farmworker population. Cultural and linguistic barriers, temporary employment, and tenuous documentation status contribute to farmworkers' at-risk designation. Despite the key role of pesticide educators in promoting farmworker science literacy, safety, and health, data regarding pesticide educators are absent in the literature. Educator beliefs shape practices; therefore, this mixed-method, multi-case study investigated the beliefs of 19 farmworker pesticide educators from four types of institutions in one southeastern U.S. state. *What are these educators' teaching beliefs? What are their beliefs about pesticide risks? What are their self-efficacy beliefs? Does a relationship exist between pesticide educator teaching beliefs and their self-efficacy and pesticide risk beliefs?* Teaching beliefs of pesticide educators ranged from *traditional* to *reform-based*, with most being *transitional* (i.e., focused on educator/farmworker relationships). Findings indicate that these pesticide educators have expert-like beliefs about pesticide risk. A positive correlation ( $r = 0.455, p = 0.0578$ ) existed between concern about adverse health outcomes associated with pesticides and farmworker-centered teaching beliefs. Self-efficacy scores ranged from low to moderate, lower than is typically found in science teachers. Interestingly, findings suggest an inverse relationship ( $r = -0.468, p = 0.0503$ ) between self-efficacy and farmworker-focused beliefs about teaching. Patterns of beliefs were found for teaching, pesticide risk, and self-efficacy by institutional affiliation and number of training sessions provided. Study results have direct implications for modifications to teacher belief constructs and for pesticide educator professional development.

The American Association for the Advancement of Science (AAAS) and the National Association for Research in Science Teaching (NARST) have charged science educators with fostering the development of a science-literate population and recognizing the workplace as a science learning environment (AAAS, 1990; Dierking, Falk, Rennie, Anderson, & Ellenbogen, 2003). Pesticide education for farmworkers addresses these calls with its goal of augmenting farmworker knowledge of basic pesticide toxicology and the risks presented by occupational and home exposure to pesticides. Because this pesticide exposure is a significant health hazard to farmworkers (Donham & Thelin, 2006), basic pesticide toxicology is a topic for farmworker science education that has implications beyond science literacy to include farmworker safety and health.

## **Literature Review**

### **Farmworkers as Science Learners**

The hired farm labor force is primarily comprised of young and middle-aged Latino males, according to the National Agricultural Workers Survey (United States Department of Labor (US DOL); 2005). Seventy-five percent of hired farm laborers were born in Mexico and 2% in Central America, making the majority of hired farm laborers foreign-born and Spanish-speaking. The average age of farmworkers is 33 years. The population can be characterized, generally, as having limited formal education and low literacy skills; most workers have completed no more than seven years of formal education. Literacy skills in both Spanish and English have been found to be limited among Latino adult learners in the United States, although literacy levels are higher in Spanish than they are in English (Tamassia, Lennon, Yamamoto, & Kirsch, 2007). The majority of foreign-born workers

from Mexico and other countries neither speak nor read English. Evidence exists that farmworkers seek formal education while working in the United States; twenty percent of crop workers have taken some type of adult education class since they have been in the United States, with English classes being the most prevalent (US DOL, 2005).

Migrant and seasonal farmworkers have been identified as a special risk agricultural population by Donham and Thelin (2006) because of the cultural and linguistic barriers that these agricultural workers face in maintaining their safety and health within their working environments. These workers' temporary employment and tenuous documentation status (frequently as guest or undocumented workers) contribute to their feeling powerless within these environments and their fear of reporting unsafe working conditions, thereby presenting additional risks to this group. Donham and Thelin assert that culturally-appropriate and effectively-communicated education is essential for preventing illness and injury among farmworkers. Furthermore, science education efforts may empower at-risk farmworkers to improve their lives by making more informed decisions relating to pesticide risk (Barton, 2001). From a critical perspective (Freire, 1970; Barton & Yang, 2000; Barton, 2001), science emerges from the everyday lives of farmworkers, and knowledge of science is a means of improving their lives.

### **Pesticide Education and Educators**

With the goal of reducing pesticide exposure and illness, the federal Worker Protection Standard mandates that initially and every five years thereafter farmworkers receive pesticide education that “the workers can understand [i.e., in a language they understand]...using nontechnical terms” and that allows workers to ask questions (Worker

Protection Standard, 1992, §170.130). Sources of pesticide exposure, ways to prevent having a pesticide enter the body, health effects associated with exposure, and appropriate emergency responses are mandatory topics for pesticide education under the Worker Protection Standard.

The latest study commissioned by the United States Environmental Protection Agency on the implementation of the Worker Protection Standard concluded that it was unclear how many workers were receiving the mandated training (Larson, 2000). Larson found that most employers tended to use videos for the training of workers. In the Southeast, work by Arcury, Quandt, Austin, Preisser, and Cabrera (1999) showed that approximately one-third of farmworkers in North Carolina had received pesticide education mandated by the Worker Protection Standard. Of the farmworkers who reported that they had received Worker Protection Standard education, the vast majority (nearly 85%) indicated that the lesson entailed watching an approximately hour-long video in Spanish. Most (75%) reported that a verbal presentation accompanied the video, but fewer than half of the workers reported that they were able to ask questions. These data suggest that as few as one-sixth of the farmworkers received pesticide education in which they were able to ask questions, and those questions were based on the viewing of one video.

Face-to-face pesticide education is an alternative to video-based lessons and may enhance implementation of Worker Protection Standard education requirements. Recognizing the utility of a more interactive approach to pesticide education, a southeastern state's farmworker health program (FHP) recently requested funds to hire bilingual educators to facilitate guided discussion and role play during farmworker pesticide education (FHP,

2009). Perceived benefits of face-to-face pesticide education include greater farmworker engagement and cultural relevance and, therefore, increased learning about pesticide risks and preventative practices. Various organizations in the selected study state provide health and education services to farmworkers and their families: the statewide farmworker health program, migrant and community health centers, the Migrant Head Start Project, the Migrant Education Program, the Cooperative Extension Service, and farmworker advocacy groups. These organizations are thought to provide farmworker pesticide education as part of their delivery of health and education services, but no known studies specifically explore the organizations and individuals that engage in farmworker pesticide education distinctly and apart from examining broadly the delivery of health services to farmworkers (Arcury & Quandt, 2007). Pesticide educators from farmworker services organizations are thought to serve as science educators and risk communicators, addressing basic pesticide toxicology and risk messages related to pesticides.

### **Theoretical Frameworks**

According to Bandura's social cognitive theory (1986), personal, behavioral, and environmental factors interact reciprocally to determine one another and explain human functioning (see Figure 4.1). Among personal factors are cognition, beliefs, and attitudes. The present study focuses on beliefs as a first step in describing pesticide educators and the teaching of pesticide toxicology to farmworkers. Beliefs about teaching, pesticide risks, and self are selected for examination. Bandura's assertion of the centrality of beliefs in understanding action suggests the significance of describing the beliefs of this poorly understood group: "People regulate their level and distribution of effort in accordance with

the effects they expect their actions to have. As a result, their behavior is better predicted from their beliefs than from the actual consequences of their actions” (Bandura, 1986, p. 129). Based on Bandura’s factors, Figure 4.1 represents the specific factors as they relate to pesticide educators in this study.

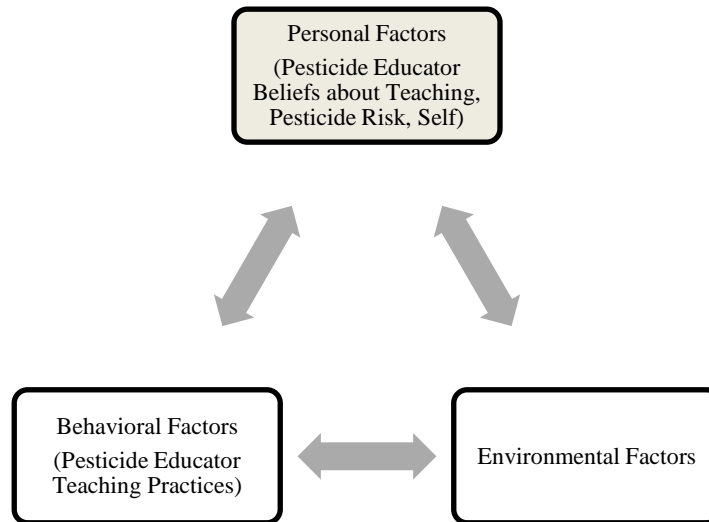


Figure 4.1. Reciprocal determinism, as described by Bandura (1986), applied to pesticide education.

Nespor’s (1987) framework describing the structure of beliefs is useful in understanding the role of beliefs in teaching practices. Nespor’s features of beliefs include: *existential presumption, alternativity, affective and evaluative aspects, and episodic storage*. If applied to pesticide educators’ beliefs, these four features might surface as assumptions regarding immutable farmworker characteristics, representations of ideal yet unrealistic learning environments for pesticide lessons, emphasis on pesticide concepts that are most compelling, and critical episodes that shape pesticide educators’ practices, respectively. As examples of critical episodes, a pesticide educator may remember an especially rewarding

laboratory-based high school chemistry class, a formative experience as a Peace Corps volunteer, or a challenging pesticide lesson in her first year of teaching. Nespor asserts that, taken together, these beliefs frame teachers' tasks: "[T]o understand teaching from teachers' perspectives we have to understand the beliefs with which they define their work" (p. 323). He argues that the "ill-structured" and "entangled" nature of the teaching context requires the use of beliefs in problem-solving (p. 324). In an analysis of the construct of teachers' beliefs, Pajares (1992) concludes that educational beliefs should be examined within the context of their connections to other beliefs.

Bandura's (1986, 1977) personal factor of self-efficacy refers to an individual's judgment of his or her capability to execute actions to attain a certain level of performance. Focusing on the consequence of an action, outcome expectancy denotes a judgment of the anticipated result of a certain performance. When applied to teaching (Gibson and Dembo, 1984), self-efficacy—or personal teaching efficacy—relates to a teacher's judgment of her ability to effect positive change in her students' learning (e.g., 'I understand pesticide concepts well enough to be effective in teaching farmworkers.'). Outcome expectancy or teaching efficacy reflects a teacher's belief that teaching can generally result in positive learning outcomes despite the many factors that are beyond a teacher's control, including school and home environments and student intelligence (e.g., 'Farmworkers' lack of pesticide knowledge can be overcome by good teaching.').

Kagan (1992) found that teachers' beliefs about self (i.e., self-efficacy) and content correlated with a number of teacher practices, such as being task-oriented, use of praise, employment of new curricula, and teaching orientation (e.g., discovery, didactic, or

conceptual change). Self-efficacy beliefs are among the most thoroughly studied of Bandura's personal factors. High self-efficacy among teachers has been associated with a number of teacher practices corresponding to positive impacts on students; practices include greater persistence, more preparation, less criticism of students, and more risk-taking (Gibson and Dembo, 1984; Ross, 1998).

Ross (1998) reviewed studies about the antecedents of teacher efficacy, including teacher and environmental characteristics. He found that although females exhibited higher perceived teaching efficacy overall, males reported higher perceived self-efficacy in science teaching and other domains traditionally identified as masculine. As teachers gained experience, they were more confident in their ability to facilitate student learning but became less confident in the effectiveness of teaching in general for effecting positive change in student outcomes. Teachers with more advanced course work were more likely to believe that their own teaching would result in positive student outcomes. Teachers in supportive environments were more likely to judge their teaching abilities positively.

After an examination of pre-service teachers in diverse settings, however, Settlage, Southerland, Smith, and Ceglie (2009) cautioned against the inclination to focus on increasing self-efficacy through teacher education programs. The authors found that pre-service teachers were overly confident in their teaching abilities, resulting in a mismatch in beliefs and practices. This over-confidence prevented pre-service teachers from experiencing self-doubt that could lead them to examine their practices and improve their teaching. Similarly, Wheatley (2002) argues that self-doubt facilitates teacher learning and

improvement, citing potential benefits of teaching efficacy doubts as disequilibrium and change, reflection, motivation to learn, and productive collaboration.

Southerland, Sowell, Blanchard, and Granger (2010) describe the construct of *pedagogical discontentment*, defined as dissonance with regard to science teaching goals and current practices, as a means to understand teachers' receptivity to change through professional development. Teachers who are less content with what they currently are doing, they posit, are more likely to be receptive to messages of reform. They argue that moderate self-efficacy paired with moderate or high levels of pedagogical discontentment increases the likelihood of a teacher's adopting more reform-based practices. A recent two-year study by Blanchard, Osborne, and Albert (2011) found that middle school science and mathematics teachers with moderate to high self-efficacy and higher pedagogical discontentment were nearly eight times as likely to change their practices to more reform-based following professional development. The findings of Ross (1998), Blanchard et al. (2011), and Settlage et al. (2010) support the powerful influence of teaching beliefs.

### **Research Questions**

Despite their potential for enhancing pesticide education for farmworkers and reducing pesticide illness within the at-risk farmworker population, pesticide educators remain largely absent from the literature. This descriptive multi-case study examines a large portion of the total population of pesticide educators in a southeastern state in the United States. To enhance professional development for and improve understanding of pesticide educators, pesticide educators' beliefs about teaching, as well as beliefs about pesticide risk

and science teaching efficacy, are assessed. The research questions guiding this study are as follows:

1. What are pesticide educators' teaching beliefs?
2. What are pesticide educators' beliefs about pesticide risk?
3. What are pesticide educators' beliefs about self?
4. Is there a relationship between pesticide educator teaching beliefs and their self-efficacy and pesticide risk beliefs?

### **Methods**

This mixed-method, multi-case study engaged 19 pesticide educators in a southeastern state with a large farmworker population and an established farming industry. This study focuses on the personal factors of pesticide educators in the state, particularly their beliefs about teaching and the influence of their beliefs regarding pesticide risks and self-efficacy on those teaching beliefs (see Table 4.1). Quantitative data sources included a questionnaire to capture pesticide risk beliefs, self-efficacy beliefs, and demographic information. Qualitative sources included interviews to examine teaching beliefs, pesticide risk beliefs, and discontentment, as well as field notes by the first author.

Table 4.1

*Data Sources and Instruments*

<b>Construct</b>	<b>Data Source(s)</b>	<b>Instrument</b>
Demographic Information	Questionnaire	16-item survey created for study
Pesticide Risk Beliefs	<ul style="list-style-type: none"> <li>• Questionnaire</li> <li>• Interviews</li> </ul>	<i>Pesticide Risk Beliefs Inventory (PRiBI; LePrevost, Blanchard, &amp; Cope, in press)</i>
Self-Efficacy Beliefs	Questionnaire	<i>Science Teaching Efficacy Beliefs Instrument (STEBI; Riggs &amp; Enochs, 1990)</i>
Pedagogical Discontentment	Interviews	Open-ended questions, based on items from <i>Pedagogical Discontentment Instrument (PDI; Southerland et al., in review)</i>
Teaching Beliefs	<ul style="list-style-type: none"> <li>• Interviews</li> <li>• Field Notes</li> </ul>	<i>Teacher Belief Interview (TBI; Luft &amp; Roehrig, 2007)</i>

**Participants**

Nineteen pesticide educators participated in this study. Participants engaged in semi-structured interviews, consisting in part of modified questions from the *Teacher Belief Interview (TBI; Luft & Roehrig, 2007)*. Participating educators also completed a personal questionnaire, which included demographic questions, the *Pesticide Risk Beliefs Inventory (PRiBI; LePrevost, Blanchard, & Cope, in press)*, and the *Science Teaching Efficacy Beliefs Instrument (STEBI; Riggs & Enochs, 1990)*. The criterion for invitation to participate was current or previous involvement in the instruction of farmworkers on pesticide risks, including providing pesticide lessons directly, administering farmworker pesticide programming, and enforcing federal mandates for pesticide education for farmworkers. Table 4.2 provides profiles for each of the participants.

A link to an online version of the questionnaire was circulated using organization electronic subscription lists (i.e., listservs) for farmworker services organizations listed on the

statewide farmworker health program website. Additionally, questionnaires were distributed during workshops on a new pesticide toxicology curriculum for pesticide educators.

Individuals who completed the survey were asked to include their names and phone numbers if they were willing to be contacted for participation in interviews. All respondents who indicated a willingness to participate in interviews were contacted. In order to ensure representation of the four major categories of institutions involved in pesticide education (i.e., health care, advocacy, state agencies, and the Cooperative Extension Service/universities), additional phone calls were made to personal contacts for their participation or referrals to pesticide educators who met the study criteria.

Table 4.2

*Description of Study Participants*

<b>Educator Pseudonym</b>	<b>Gender</b>	<b>Country of Origin</b>	<b>Ethnicity*</b>	<b>Highest Level Education</b>	<b>Affiliation</b>	<b>Avg. No. Lessons Yearly</b>	<b>Handled/ Applied Pesticides</b>
Adam	Male	USA	EA*	Bachelor's	SA	2	Yes
Ashley	Female	USA	EA*	Bachelor's	HC	15	No
Alicia	Female	USA	Multiple*	Bachelor's	A	13	No
Adriana	Female	Mexico	Latino*	Some College	HC	500	No
Bridget	Female	USA	EA*	Bachelor's	SA	2	No
Chris	Male	USA	EA*	Graduate	CES/U	10	Yes
Dana	Female	USA	EA	Graduate	CES/U	1	Yes
Fabiola	Female	Peru	Latino*	Bachelor's	HC	3	No
Isabel	Female	Mexico	Latino*	High School	HC	180	No
Janet	Female	USA	EA	Graduate	CES/U	0	Yes
Joe	Male	USA	EA*	Graduate	CES/U	3	Yes
Lisa	Female	USA	EA*	Bachelor's	SA	2	No
Lata	Female	USA	Multiple	Bachelor's	A	0	No
Marissa	Female	Puerto Rico	Latino*	Graduate	A	3	No
Renee	Female	USA	EA*	Graduate	SA	4	Yes
Ruth	Female	USA	EA	Graduate	CES/U	1	No
Salvador	Male	Mexico	Latino*	Graduate	SA	0	No
Scott	Male	USA	EA*	Bachelor's	HC	450	Yes
Sharron	Female	USA	EA*	Bachelor's	HC	300	No

*Note.* \* = Proficient in Spanish; EA= European American; SA = state agency; CES/U = Cooperative Extension Service/university; HC = health care; A = advocacy.

**Data Sources and Analyses**

**Questionnaire: Pesticide educators' demographic information.** Participating pesticide educators answered demographic questions related to their personal characteristics, their experiences with farmworker pesticide education, their organization affiliations, and

their experiences with pesticides (see Appendix A). Demographic questions comprised 16 items of a 59-item questionnaire.

**Questionnaire: *Pesticide Risk Beliefs Inventory*.** The *Pesticide Risk Beliefs Inventory* (*PRiBI*; LePrevost, Blanchard, & Cope, in press) was administered to the pesticide educators as part of a 59-item questionnaire to assess the extent to which individuals' beliefs regarding pesticide risks reflected lay- and expert-like conceptualizations of pesticide hazards. The inventory contains 19 Likert-type items with six-point scales (see Appendix B). Four items correspond to the facet for determination of risk using physical properties (e.g., smell or taste), and three items correspond to chemical properties (e.g., ingredients or chemical family). Six items each comprise the facets for association of risk with routes of entry into the body (e.g., dermal or ingestion) and association of risk with adverse health outcomes of pesticide exposure (e.g., infertility or difficulty breathing).

For the purpose of scoring and analyzing the *PRiBI* data, the response “strongly disagree” corresponds to a score of 1, “disagree” corresponds to 2, “somewhat disagree” corresponds to 3, “somewhat agree” corresponds to 4, “agree” corresponds to 5, and “strongly agree” corresponds to 6. For reverse-coded items, “strongly disagree” corresponds to a numerical score of 6 and so forth. Individuals' facet and composite scores were calculated by summing item scores. A score of 4 or higher on the *PRiBI* relates to agreement with an expert-like belief regarding pesticide risk.

**Questionnaire: Modified *STEBI*.** Though it was originally designed for in-service elementary science teachers, the *Science Teaching Efficacy Beliefs Instrument* (*STEBI*; Riggs & Enochs, 1990) has been used with teachers of other grade levels, like middle grades

(Khourey-Bowers & Simonis, 2004), and modified to measure teacher efficacy among pre-service science teachers (Enochs & Riggs, 1990), chemistry teachers (Rubeck & Enochs, 1991), and even mathematics teachers (Wenner, 2001). To assess the pesticide educators' self-efficacy and outcome expectancy related to their teaching of pesticides, the *STEBI* was modified (e.g. using 'farmworker' in place of 'student' and 'pesticide concepts' in the place of 'science') and administered as part of the quantitative questionnaire.

The original instrument consists of 25 Likert-type items with five-point scales. The *STEBI* is comprised of two dimensions that parallel Bandura's personal factors of self-efficacy and outcome expectancy; these sub-scales are referred to as *personal science teaching efficacy* (PSTE) and *science teaching outcome expectancy* (STOE), respectively. Thirteen items relate to PSTE, and twelve correspond to STOE. Thirteen items in the original instrument were reverse coded. For this study, the wording of the items was modified to reflect the content and context of pesticide educators (see Appendix C). One item related to parents was omitted in the modified *STEBI*: "If parents comment that their child is showing more interest in science at school, it is probably due to the performance of their child's teacher" (Riggs and Enochs, 1990, p. 635).

As for the original *STEBI*, a response of "strongly disagree" corresponds to a score of 1, "disagree" corresponds to 2, "uncertain" corresponds to 3, "agree" corresponds to 4, "strongly agree" corresponds to 5. For reverse-coded items, "strongly disagree" corresponds to a numerical score of 5 and so forth. Individuals' personal science teaching efficacy and science teaching outcome expectancy scores, as well as their composite scores, were calculated by summing responses.

**Interviews.** The first author interviewed each of the 19 participants. Each interview was between 30 minutes and 1.5 hours in duration. Interviews took place face-to-face when possible and via phone when travel distances prohibited face-to-face interviews. An audio recording was made of each interview, and interviews were transcribed verbatim by a third party. Approximately 275 single-spaced pages of transcriptions were yielded from interviews. The first author had both professional and personal knowledge of the participants from her work in pesticide education over a period of four years, reflecting sustained relationships as recommended in the literature (Erlandson, Harris, Skipper, & Allen, 1993).

**Interviews: *Teacher Belief Interview.*** Using the established protocol and adapted questions from the *Teacher Belief Interview (TBI)* (Luft & Roehrig, 2007), the first author interviewed the pesticide educators in order to understand their beliefs about teaching pesticide concepts to farmworkers. Each interview began with a discussion of the educator's experiences with pesticide education for farmworkers. The following semi-structured interview questions reflect adaptations to Luft and Roehrig's (2007) *TBI* to match the content and context of farmworker pesticide education:

1. How do you describe your role as a pesticide educator?
2. How do you maximize farmworker learning during pesticide lessons?
3. How do you know when farmworkers understand?
4. For pesticide lessons, how do you decide what to teach and what not to teach?
5. How do you decide when to move on to a new concept/idea during pesticide lessons?
6. How do your students/farmworkers learn pesticide concepts/ideas best?
7. How do you know when learning is occurring during pesticide lessons?

Given the differences between the formal context of secondary science teaching for which the *TBI* was first developed and the informal context of farmworker pesticide education, two additional questions were added to the interview guide to facilitate the analysis of ambiguous interview responses:

8. How do you define teaching in the context of farmworker pesticide education?
9. How do you define learning in the context of farmworker pesticide education?

Responses to the *TBI* are coded on a continuum from teacher-centered to student-centered beliefs using the following categories: *traditional*, *instructive*, *transitional*, *responsive*, and *reform-based* (Luft & Roehrig, 2007). The following descriptions of the five belief categories provided by Luft and Roehrig (2007) guided the analysis and coding of responses:

Traditional: Focus on information, transmission, structure, or sources.

Instructive: Focus on providing experiences, teacher-focus, or teacher decision.

Transitional: Focus on teacher/student relationships, subjective decisions, or affective response.

Responsive: Focus on collaboration, feedback, or knowledge development.

Reform-based: Focus on mediating student knowledge or interactions. (p. 54)

Using verbatim transcriptions of the interviews, two authors independently coded the seven adapted *TBI* question responses for each educator. The first author/coder had extensive personal knowledge of the study participants, and the second coder did not have any personal knowledge of the participants. For every response for which the two authors did not agree in their initial codes, a negotiated code was determined through discussion and

further review of the interview transcription (Patton, 2002). The inter-rater reliability was 74.4% for the initial coding process and 100% after negotiation. A numerical score of 1 through 5 was assigned to each category (i.e., 1 corresponds to *traditional*, 2 corresponds to *instructive*, 3 corresponds to *transitional*, 4 corresponds to *responsive*, and 5 corresponds to *reform-based*). A numerical score on the *TBI* was then determined for each pesticide educator by summing scores for the seven items. See Table 4.3 for exemplary quotations from the study group for each of the five categories.

Table 4.3

*Exemplary Quotations for Coding TBI Responses*

<b>Score</b>	<b>Category</b>	<b>Example Quotation from Participant</b>
1	<i>Traditional</i>	“The pesticide educator role... is a person who has the knowledge... to deal with pesticides in a safely [sic] way, how to protect it. The person would help or minimize the risks of being exposed to the pesticides and transfer this information to the worker...” (Salvador, state agency, Latino)
2	<i>Instructive</i>	“Based on practical experience... that’s...how I decide [what to teach], based on what I think is pertinent in the field.... [I]f I look at some kind of, I don’t know, pre-made handout or other educational material, or if I’m doing a training, I do it based on observation, what I’ve seen in the field, and also what I have done personally hands-on in the field.” (Joe, Cooperative Extension Service/university, European American)
3	<i>Transitional</i>	“I speak to them in Spanish which is... usually their first language... because there’re a lot of the indigenous languages that come through... Just trying to make sure, first, that they’re comfortable with me, so it’s more like an interaction between equals instead of me coming in there in, like, specifically as a teacher role.” (Ashley, health care, European American)
4	<i>Responsive</i>	“... as a “teacher” [in quotes] you need to be ready... to provide the information when people ask you and when people are ready to receive that information. So, my role was, one, to be ready and have the materials with me at all times and...be knowledgeable about the topic, and...follow their lead, and give them as much information as they wanted... when they were interested and ready. You provide support.” (Marissa, advocacy, Latino)
5	<i>Reform-based</i>	“So you do become more of a facilitator...an informant...a resource to people, and a motivator in many ways, so that as people begin to discover or make the connections for themselves, then you continue to provide more venues or resources so they continue to grow in that learning.” (Fabiola, health care, Latino)

**Interview: Pesticide risk beliefs.** In order to triangulate quantitative responses on the *PRiBI* to qualitative data, semi-structured interview questions regarding pesticides and risks were asked following *TBI* questions. Triangulation is a way to gain insights into a situation through several different data sources (Stake, 1995). Questions about beliefs regarding pesticide risk mirrored those presented by Morgan, Fischhoff, Bostrom, and Atman (2002) to elucidate mental models for risk:

- How do you define the term “pesticide”?
- What, if any, risks do pesticides pose to farmworkers?
- What are the 2-3 most important pesticide concepts for farmworkers to understand?

Using the four facets of the *PRiBI* (LePrevost, Blanchard, & Cope, in press) as a priori codes, the responses to the pesticide risk questions were coded by the first author. Emerging codes were identified.

**Interview: Pedagogical discontentment.** Southerland, Nadelson, Sowell, Kavechi, Saka, and Granger’s (in review) *Pedagogical Discontentment Instrument (PDI)* was adapted for use during interviews with pesticide educators. The *PDI* subscales include science content knowledge, assessing science learning, depth versus breadth of instruction, teaching all students, and implementing inquiry. Based on the first author’s experiences working with pesticide education for four years, the science content knowledge questions were determined to be the most relevant to the context of pesticide education. Four questions from this subscale were adapted as follows:

- How content are you with your knowledge of pesticides?

- How content are you in your ability to generate pesticide lessons/sessions?
- How content are you in your ability to facilitate discussion among farmworkers?
- How content are you with teaching pesticide concepts that are unfamiliar to you?

Educators' responses to the *PDI* questions were qualitatively analyzed for a priori codes (i.e., discontentment and contentment with each of the four areas) and for emerging codes by the first author. An emerging code, for example, was 'dissatisfaction with using an interpreter.'

**Field notes.** Throughout the study period, the first author collected field notes from formal and informal interactions with the pesticide educator participants. She described and reflected upon phone calls, e-mail correspondence, in-person interactions, and observed pesticide lessons. These field notes allowed for triangulation of interview and questionnaire data.

## Findings

### Pesticide Educators' Teaching Beliefs

The *TBI* revealed a range in educators' beliefs from primarily teacher-focused (Adam, Adriana, Chris, Dana, Lisa, Renee, and Salvador) to transitional (Ashley, Bridget, Isabel, Janet, Joe, Lata, Ruth, Scott, and Sharron) to learner-focused (Alicia, Fabiola, and Marissa) (see Table 4.4). The responses to questions 4 (How do you decide what to teach and what not to teach?), 5 (How do you decide when to move on to a new concept?), and 7 (How do you know when learning is occurring during pesticide lessons?) were most often coded as *instructive* (i.e., a score of 2 for quantitative analyses). That is, the science educator usually

used her knowledge of what was important in deciding what to teach, moved on after it seemed the farmworkers ‘got it,’ and determined farmworkers understood after they were able to replicate an activity, such as matching a toxicity label on a plastic jug.

The remaining questions (i.e., 1, 2, 3, and 6) were most often coded as *transitional* (i.e., a score of 3 for quantitative analyses). These questions relate to how pesticide educators describe their roles, how they maximize learning, how they know farmworkers understand, and how farmworkers learn concepts best. *Transitional* codes refer to an interaction between the pesticide educator and the farmworker. For example, the educators often described their role as balancing what they thought was important with what the farmworkers wanted to know and assessed understanding based on farmworkers’ demonstrating in real-world settings what they had learned, such as picking out correct clothes to wear in the field. The most common type of response coded across all *TBI* questions was *transitional*.

Interestingly, patterns of differences in *TBI* scores were observed according to institutional affiliation, with educators associated with state agencies and universities having a more teacher-centered approach and advocates and health care workers having a more learner-centered approach. The differences in group mean scores were significant ( $p = 0.0098$ ), which is noteworthy given the small number of participants, but the small sample size within each group requires caution in interpreting this finding.

Table 4.4

*Educators' Numerical Composite TBI Scores and Representative Quotations with Associated Codes*

<b>Educator</b>	<b>TBI</b>	<b>Affiliation</b>	<b>Representative Quotation with Associated Code</b>
Adam	11	SA	<i>Traditional</i> : “[My role involves] educating the farmworkers as to when they can reenter the field or educating the farmers to make sure they communicate to the farmworkers so that the... worker will be safe and not get injured or not get any diseases from a chemical.”
Salvador	12	SA	<i>Instructive</i> : “[F]irst of all, you have to learn to communicate with them using their own language, their jargon, and the educator needs to learn to communicate at that level with that specific jargon for being able to pass information, start passing information. This is very important; one of the most crucial things about education with these people is to find the right level being targeted to educate this, like when you go to an elementary school they have different grades.”
Dana	14	CES/U	<i>Instructive</i> : “[T]he ones that would be actually applying [pesticides] that’s where you need to get into the actual calibration side of it and making sure the reentry signs are posted...and teaching ‘em about making sure they’re not spraying with other people around, to make sure the area is clear. And then, the ones that don’t actually handle the mix and are spraying make sure they understand...the signs of possible exposure to pesticides, so they know what to look for, ‘cause if they start feeling bad, they may not really think...about relating it to a pesticide.”
Lisa	14	SA	<i>Instructive</i> : “I define teaching as a process communicating...thoughts and ideas, but for...pesticide training...it’s a process of communicating standards and requirements in a way that the audience can understand.”
Chris	15	CES/U	<i>Instructive</i> : “...we need more training to be able to communicate with them in a way, to keep them safe, and a more comfortable setting for Latinos. Not necessarily exclusive just for Latinos but, you know, inclusive settings, but utilizing and focusing on their learning styles. Um, I think if there were more resources for that...”

Table 4.4 Continued

Adriana	16	HC	<i>Instructive:</i> “If they did not seem too tired from work, then I try to teach as much as I can. If they seem tired or hungry, I tried to make the training as short and educational as possible.”
Renee	16	SA	<i>Instructive:</i> “Teaching to me is presenting concepts that are relevant to the person being taught... [A pesticide educator] is someone who completely understands pesticides and someone completely understands how they’re being used by the person that they’re trying to teach.”
Scott	17	HC	<i>Transitional:</i> I would say [that farmworkers learn best by] probably going to where they’re at like going to where they work and live and doing the training there. And using as many props as you can, instead of just getting up there and talking...trying to get them involved, ...taking out incentives, water bottles, even just some kind of a bag of a candy or a bag of toothbrushes or little things that when they answer questions you can give ‘em for participating, whether they’re right or wrong...”
Bridget	18	SA	<i>Transitional:</i> “[Training] should be hands-on. They should be doing and participating and not just sitting there listen to us lecture about pesticides, you know? If it were to involve application training on their farm that their farmer was giving then they should be involved in how to properly mix and put on their PPE and they should do it and not just see it demonstrated.”
Isabel	18	HC	<i>Transitional:</i> “Number one is [farmworkers’] trusting the person that is coming to do... the training.... Number two I think it’s very important that you make them feel that they are important and that you are interested in teaching them... or showing them.”
Janet	18	CES/U	<i>Transitional:</i> “...[T]he best way to do it is to sit down with a focus group or with workers and...find out wherever they’re at now, so that you can, kind of, just determine what more they need to learn or what they’re not doing...”
Joe	19	CES/U	<i>Transitional:</i> “[S]ay you’re a farm worker and someone is coming to talk to you about pesticide safety...if you empathize with your audience on certain topics...Most of the presentation materials ...related to pesticide education and safety are pretty lame. Trying to make the topic as personally pertinent to the individual, I think, is the way to really be an effective pesticide educator.”

Table 4.4 Continued

Ruth	19	CES/U	<i>Transitional:</i> “Different people learn different ways, and I think that when you’re a good teacher that you have to realize that some of your audience may learn by what they see, some may learn by what they hear, some may learn by what they are able to [do]... [S]ometimes I’m the lecturer, sometimes I’m the resource point, sometimes I’m the facilitator and sometimes I’m the - the interactive - you know, just part of the group, and so I think that my role as a pesticide educator is just as multifaceted as the different kinds of learning styles that people have.”
Lata	20	A	<i>Transitional:</i> “Some people learn by seeing. Some people learn by hearing it. Some people learn by doing and taking action, so we try to use visuals, as well as printed materials... Like I said with the more creative like theater skits... it’s more interactive, and it may get at the topic in a way that really reflects their lives, and gets them to start thinking and forming a dialogue around the issue.”
Ashley	22	HC	<i>Transitional:</i> “[I]t’s not about a test, it’s not about memorizing something for a test, it’s about learning something for - a skill that’s gonna help them with their life, with their health and their safety. So I feel like if they’re actively involved in the learning process, they’re gonna take a lot more out of it.”
Sharron	22	HC	<i>Transitional:</i> “...Our setting was us going to their homes and sitting down.... You know, we were on the couch with them, so it seemed like the way that worked the best. I even came up with some Power Points and, you know, and I had my laptop... And I would try to set up appointments with the guys, ask them what they were interested in being educated on, you know, what were some of the things they want to know beforehand and then I would try to show up with that and leave them with additional resources for more information.”
Marissa	24	A	<i>Responsive:</i> “I think the first step is to find out where people are, what people know, and their interest... Are people concerned about pesticides? And many times they’re not. And if this is not a concern they have... you can give them as much information as you want, but they might take in very little. So people have to be ready... usually pesticides was something that came later... When people can take what you’ve said and apply it or, you know, they have an ah-ha moment... When you go back and you see that they are taking the steps and the measures that you’ve talked about, that they have the clothes separated. You go to camps, and they have the boots outside, for example, and they have clothes hanging outside and not near their bed or they have a separate bucket with the work clothes.”

Table 4.4 Continued

Alicia	27	A	<i>Reform-based:</i> “I’m a pesticide agitator. So, I think, I think my role is different from what I perceive... a lot of trainers to be in that we kind of go beyond ‘Here’s all the information you need to protect yourself,’ and we try to look at the larger picture of like, ‘Why is it necessary to protect yourself in this way in the first place? What is the system behind the way that we’re doing things now? You’ve learned already the dangers that this presents to you, what do you think can be done about it at the systemic level?’... [W]e usually end up talking about empowerment at the individual - as a very key component of not only concerns about pesticide exposure and poisoning, and things like that, but also everything else, like wages, wage violations, housing problems, contractor problems... [W]e take a fairly holistic approach to the problem.”
Fabiola	29	HC	<i>Reform-based:</i> “[With] pesticide education, where you’re trying to change behavior and get people to think critically about how this impacts their lives and what they can do differently and to have motivation come from inside of themselves, then it does require a different approach, where there is no expert. There is no matter how much you tell me I’m going to die and statistics say, you know, it’s not gonna make any change until I internalize it... I think of the learner as an individual who is coming to explore a concept, and my role then becomes creating enough scenarios or tools or situations where they can discover those messages for themselves until they find what they need to make the necessary changes.”

*Note.* The *TBI* has a range of 7 to 35. SA = state agency; CES/U = Cooperative Extension Service/university; HC = health care; A = advocacy.

## Pesticide Educators' Beliefs about Pesticide Risk

**Quantitative analyses.** Generally, pesticide educators displayed agreement with expert-like beliefs with *PRiBI* facet means all above 4 (see Table 4.5). Mean responses for each inventory item indicated agreement with expert-like beliefs related to determination of risk and association of risk with routes of entry and adverse health effects; the only exceptions were ambivalent responses regarding concern about being hospitalized (3.11) and infertility (3.32) associated with pesticide exposure. Interestingly, educators who had experience mixing, loading, or applying pesticides had lower ( $p = 0.053$ ) composite scores on the *PRiBI* than those educators who had not had experiences working with pesticides in this capacity. Specifically, they had lower scores on the routes of entry ( $p = 0.071$ ) and adverse health outcomes ( $p = 0.008$ ) sub-scales. Pesticide educators who had not worked directly with agricultural chemicals appeared to be more cautious in assessing risk.

Table 4.5

### *Pesticide Educators' Facet Mean Scores on the PRiBI*

<b>Facet</b>	<b>Facet Mean</b>
Determination of Risk Using Physical Properties	5.53
Determination of Risk Using Chemical Properties	4.82
Risk Associated with Routes of Entry into Body	4.83
Risk Associated with Adverse Health Effects	4.07

*Note.* *PRiBI* scores range from 1 to 6; scores of 4 and above are considered 'expert.'

**Qualitative analyses: Chemical and physical properties.** Qualitative analyses support the quantitative finding that pesticide educators exhibit expert-like beliefs regarding the utility of chemical properties and the problematic nature of physical properties in determining pesticide risk. In defining pesticides and discussing their risks, pesticide educators described the usefulness of chemical features of pesticides. Educators reflected expert beliefs when they stated that risk depends on the “potency of the chemical” (Fabiola, health care), “how toxic the chemical is” (Adam, state agency), and “the industry and the pesticide being applied and used” (Sharron, health care). Marissa (advocacy) discussed the problematic nature of using physical properties to assign risk and identify pesticide exposure: “One, you might not be able to see [pesticides]... You might not be able to smell them.” She went on to describe the tendency of farmworkers and others to use these characteristics:

I’m not sure... if it’s only farmworkers that don’t have the concept of you might not be able to see, smell, or taste pesticide. I think with the job I have now [working with the general public], I see it more as a human nature. You know, our senses warn us of bad things for us, and when those warning signals are not there, it’s harder for us to make those decisions even if we have the knowledge and even if we know that these things could be dangerous.

Pesticide educators’ *PRiBI* responses revealed strong disagreement with using physical properties to determine pesticide risk, indicating more expert-like beliefs than those Marissa (advocacy) ascribed to farmworkers and the general public in the above quotation.

**Qualitative analyses: Routes of entry.** During interviews, several pesticide educators correctly described the routes of entry into the body in discussing pesticide risk,

demonstrating their expert knowledge. Ruth (Cooperative Extension Service/university) explained how pesticides pose a risk to farmworkers; “they [farmworkers] can have dermal exposure, respiratory exposure, ingestion exposure.” Others, including Adam (state agency) and Ashley (health care), mentioned only one route of entry. Marissa (advocacy) described farmworkers’ ingesting pesticides “if they don’t wash their hands...when they’re having their lunch or breakfast or dinner in the field or at home.” Lisa (state agency) expressed that symptoms depend on the route of entry. Although not all educators discussed routes of entry when describing pesticide risks, the educators who did enumerate one or multiple routes of entry exhibited accurate beliefs, consistent with the results of the *PRiBI*.

**Qualitative analyses: Adverse health outcomes.** Much more ubiquitous were educators’ comments about adverse health outcomes; each participant described health effects as risks of pesticide exposure. The majority of educators identified both short-term and long-term health effects. Among the specific health outcomes named by educators, the most common were rashes and other dermal effects (n=8), cancer (n=7), respiratory effects (e.g., coughing, wheezing, and difficulty breathing) (n=6), infertility (n=5), birth defects and other effects on the fetus (n=5), and neurological effects (e.g., seizures and Parkinson’s disease) (n=5). Unexpectedly, cancer and infertility were among the most common explicitly mentioned health outcomes of pesticide exposure despite educators’ generally providing equivocal responses to items on the *PRiBI* regarding concern with these outcomes.

In interviews, educators tended to highlight the range of symptoms from relatively benign to severe and from short-term to long-term, as demonstrated by Fabiola (health care):

[W]e've talked about some of the immediate things, like reaction to the eyes, coughing...as it gets worse, vomiting, dizziness, those kind of things, that people could immediately experience, depending on the potency of the chemical, all the way to long-term cancer issues and diseases that can occur with long-term exposure over a period of time.

Janet (Cooperative Extension Service/university) and Marissa (advocacy) indicated that not all potential risks associated with pesticides are known. Marissa (advocacy) was particularly concerned about the lack of information about the long-term effects of pesticides and about exposure in the farmworker population:

I was...very unhappy with the fact that there is the lack of research about pesticides, and the amount of information we don't know. And that still is the case where I work right now that, "Oh, pesticides could be harmful, but, you know, we don't know," and what will it take for us to know, and be able to take stronger measures to protect people from exposure to harmful chemicals? That was very frustrating also to be unable to pinpoint what's pesticide exposure and what's not. For example, I mean workers working in tobacco fields, they get nausea. Well, is it the pesticide? Is it the nicotine in the tobacco?

Scott (health care) expressed similar concerns that "none of the real hardcore studies...have been done" regarding long-term effects of pesticide exposure.

**Summary: Beliefs about pesticide risks.** In general, beliefs concerning pesticide risk were accurate, matching expert views. Individuals who had direct experience handling or applying pesticides were more likely to work for the Cooperative Extension Service or the

university and were less cautious in their assessments of pesticide risk. These educators, however, expressed expert-like beliefs. Those educators who expressed greater concern with the health risks of pesticides tended to be affiliated with health care and advocacy groups.

### **Pesticide Educators' Beliefs about Self**

**Self-efficacy.** Participants expressed a range of low to moderate self-efficacy beliefs related to teaching pesticide risks to farmworkers, with combined *STEBI* scores from 45 to 71. An inverse relationship was found between *PRiBI* scores for determination of risk using chemical properties and *STEBI* personal science teaching efficacy scores ( $r = -0.428, p = 0.0761$ ); educators with higher personal science teaching efficacy scores were less likely to have expert-like beliefs regarding the use of chemical properties to assess pesticide risks. Educators who provided increased numbers of trainings each year tended to have lower combined *STEBI* scores ( $r = -0.474, p = 0.0469$ ). Educators from state agencies had significantly higher personal science teaching efficacy beliefs ( $p = 0.071$ ).

In summary, individuals generally had moderate levels of self-efficacy. Higher personal science teaching efficacy correlated with less expert beliefs regarding the usefulness of chemical properties of pesticides in determining risk and affiliation with a state agency. Delivering more trainings each year corresponded to lower overall efficacy beliefs.

**Pedagogical discontentment: Pesticide knowledge.** When asked how content they were with their knowledge of pesticides, many pesticide educators (Adam, Alicia, Adriana, Bridget, Isabel, Lisa, Lata, and Salvador) indicated an interest in enhancing their pesticide knowledge but lacked strong discontentment with their current pesticide knowledge. Adriana and Isabel had similar perspectives in that they were “happy and willing to learn more”

(Isabel, health care). Others expressed particular areas of their pesticide knowledge they wished to improve. Bridget (state agency) would like to become “more familiar with the different chemicals that people are using and their effects and how they’re applied,” and Alicia (advocacy) stated that she wanted to know more of the biology of effects on human health caused by pesticides and the specific chemicals used in each crop.

**Pedagogical discontentment: Generating pesticide lessons.** When they were asked how content they were with their ability to generate a pesticide lesson or training for farmworkers, the sample of pesticide educators had little pedagogical discontentment. Only one educator (Adam, state agency) expressed any discontentment with his ability to generate pesticide lessons, and this discontentment was limited to an interest in learning more: “I’d like to know more, but I have a basic understanding.” Adam (state agency) was the only pesticide educator to communicate some level of discontentment across all questions in this portion of the interview.

**Pedagogical discontentment: Facilitating discussion.** Facilitating discussion was a source of discontentment for Adam (state agency), Lisa (state agency), Salvador (state agency), Chris (Cooperative Extension Service/university), Dana (Cooperative Extension Service/university), Janet (Cooperative Extension Service/university), and Lata (advocacy). Limited proficiency in Spanish and/or having to use an interpreter were most commonly cited as the causes for discontentment in this category. Janet (Cooperative Extension Service/university) voiced a belief that her Spanish language abilities, gender, and education level contribute to her discontentment with her ability to facilitate discussion among farmworkers:

I don't speak the language but then, also, I'm not sure that I would be the one that the farmworker would pay attention to, anyway....Instead of an academic woman with PhD, they'd be more likely to pay attention to someone...who actually grows trees and is out in the fields a lot and, so, has a lot more practical experience.

**Pedagogical discontentment: Teaching unfamiliar topics.** Educators exhibited minimal discontentment with their abilities to teach unfamiliar topics. In fact, Alicia (advocacy), Chris (Cooperative Extension Service/university), and Fabiola (health care) had difficulty imagining a pesticide concept with which they were unfamiliar: "I really haven't encountered that" (Chris, Cooperative Extension Service/university). Joe (Cooperative Extension Service/university), Marissa (advocacy), and Renee (state agency) described the need to take time to prepare when teaching unfamiliar topics because "it's an important topic that has health implications" (Joe, Cooperative Extension Service/university).

Ashley (health care), Fabiola (health care), Scott (health care), Susan (health care), Joe (Cooperative Extension Service/university), Ruth (Cooperative Extension Service/university), Marissa (advocacy), and Renee (state agency) responded that they had high levels of contentment with their pesticide knowledge and their abilities to generate pesticide lessons, facilitate discussion, and teach unfamiliar topics.

**Summary: Pedagogical discontentment.** In general, the greatest source of pedagogical discontentment was related to facilitating discussion. This discontentment seemed to be a greater issue with non-native Spanish speakers and non-Latino individuals affiliated with state agencies and the Cooperative Extension Service or university. These pesticide educators delivered fewer numbers of trainings each year.

## **Relationship of Self-Efficacy and Pesticide Risk Beliefs to Teaching Beliefs**

In examining relationships between teaching and pesticide risk beliefs, a positive correlation ( $r = 0.455, p = 0.0578$ ) existed between teaching beliefs (*TBI*) and beliefs regarding the association of risk with adverse health effects (*PRiBI*). Educators who expressed greater concern over adverse health outcomes associated with pesticide exposure were more likely to express learner-centered beliefs. An inverse relationship was found between *TBI* scores and *STEBI* scores for personal science teaching efficacy ( $r = -0.468, p = 0.0503$ ). Individuals with higher scores on the personal science teaching efficacy sub-scale were more likely to express teacher-focused beliefs about teaching pesticides. In summary, educators who expressed greater concern with adverse health outcomes associated with pesticide exposure and who expressed lower levels of personal science teaching efficacy were more likely to express student-centered beliefs concerning teaching.

## **Discussion**

### **Pesticide Educators' Teaching Beliefs**

This multi-case, mixed methods study explored the teaching beliefs of farmworker pesticide educators and examined relationships between beliefs about teaching, pesticide risks, and self. Though pesticide educators expressed a range of beliefs on the *TBI* from teacher-focused to student-focused, the majority of their responses were *transitional* (42%) and *instructive* (28%). That is, pesticide educators' teaching decisions were primarily determined by their interactions with farmworkers or by what they thought was best for farmworkers. These informal science educators, therefore, exhibited beliefs similar to those

of beginning secondary science teachers (Luft, Fletcher, Fortney, 2005), who served as the study group in the *TBI* development process (Luft & Roehrig, 2007).

Advocates and health care workers were more student-centered in their teaching beliefs than their counterparts at the Cooperative Extension Service or university and state agencies; the limited number of participants in each group, however, restricts the extent to which these findings are generalizable. Although an examination of institutions may further elucidate this finding, one possible explanation for group differences is that the educators from organizations with more student-centered beliefs (i.e., advocacy, health care) work almost exclusively with farmworkers, whereas the Cooperative Extension Service or university and state agencies serve a broader audience, including farm owners and operators. Health care and advocacy educators' narrow focus on farmworkers may correspond to greater comfort and familiarity with engaging farmworkers in lessons and with allowing farmworkers to shape the direction and form of pesticide lessons.

### **Pesticide Educators' Beliefs about Pesticide Risk**

Regardless of prior experience with pesticides, educators demonstrated general agreement with expert beliefs and an ability to describe basic pesticide risks during semi-structured interviews. Given their critical role in providing pesticide education to the at-risk farmworker population (Donham & Thelin, 2006), pesticide educators' beliefs regarding the content of pesticide lessons is encouraging. Given that highly technical questions regarding pesticides and their risks were not asked, an assessment of educators' knowledge and beliefs of technical information—beyond basic knowledge of exposure, routes of entry, and health outcomes—cannot be made.

A substantial proportion of the variation seen in pesticide risk beliefs was explained by whether an educator had ever mixed, loaded, or applied pesticides. Individuals who had not engaged in these hands-on activities with agricultural chemicals were more likely to express cautious beliefs about pesticide risks overall and routes of entry and health outcomes in particular. ‘Critical episodes’ (Nespor, 1987) described by Janet (Cooperative Extension Service/university) present possible explanations for this observation:

[W]hen I first started as a graduate student in '82, and I think back...about pesticides and peanut plots and, man, I would be out there in a halter top and short-shorts and get a tan, cuttin' out pods and stuff, you know? I wasn't worried gettin' a tan, any kinda safety and I think back then people were really lax about safety...the chemical representative would come and drink a little bit of whatever chemical it was, “Oh, it's safe, it's safe.”

Experiences like these in which pesticides were handled flippantly might explain the less cautious beliefs expressed by individuals who have mixed, loaded, and applied pesticides. Nevertheless, Joe asserts that these “real-world” experiences are necessary for a pesticide educator to be effective:

[T]hat's one thing that I think is important for all educators; they need to participate in whatever activities they're trying to educate on. It really - it's kind of frustrating to me to read or hear folks that have never stepped in an agricultural field, that have never put on PPE themselves and gone out and worked a day in the field to...claim that they are effective educators.

The influence of educators' pesticide experience on farmworker learning during pesticide lessons is not known, but the findings present a conundrum in which the educators who have more experience with the content of pesticide lessons are less cautious regarding pesticide risks related to routes of entry and health effects.

Nespor (1987) describes the important role of 'critical episodes' in shaping educator's beliefs. These findings highlight the importance of specific pesticide experiences that functioned in shaping the beliefs of these pesticide educators. Interestingly, the authentic science experiences promoted by science educators and the *National Standards Education Standards* (NRC, 1996) potentially *lessen* the effectiveness of the pesticide educator if he minimizes pesticide risks based on less cautious beliefs. This unexpected result is a reminder that not all authentic experiences are necessarily appropriate for achieving desired educational results. This finding suggests the importance of educators' being mindful of the influence their pesticide experiences have on their risk beliefs prior to their working with farmworkers.

The combination of quantitative and qualitative data sources proved to be useful in capturing the pesticide risk beliefs of pesticide educators. For example, educators generally provided equivocal responses to items on the *PRiBI* regarding concern with cancer and infertility outcomes, but these health outcomes of pesticide exposure were among the most common explicitly mentioned outcomes during educator interviews. Additionally, educators revealed during interviews their belief that not all potential risks associated with pesticides are known, a concern that could not be captured on the *PRiBI*. Using multiple data sources allowed for a richer understanding of educator pesticide risk beliefs than relying on the *PRiBI*

alone. The qualitative data explicated pesticide risk beliefs that were not captured on the quantitative instrument, demonstrating a strength of using mixed methods (Stake, 1995).

### **Pesticide Educators' Beliefs about Self**

The pesticide educators in this study reported low to moderate science teaching efficacy beliefs on the *STEBI*. A significant negative correlation was found between the number of trainings provided each year and self-efficacy as measured by *STEBI*. Though not significant, inverse relationships were observed between number of trainings and both subscales—personal science teaching efficacy and science teaching outcome expectancy. Picture Adriana, Scott, and Sharron, each of whom conduct a staggering number of pesticide training sessions (300-500 per year). On many days, this means that each educator is conducting multiple training sessions out in fields or in migrant camps with farmworkers. Sharron's (health care) vignette provides an indication of the types of challenges that pesticide educators may face in educating farmworkers:

I did a pesticide training, and the boss showed up, of course. It was after work. He agreed to let the guys come. They were still on the clock. It was raining. We were in the mud, out standing in the rain. There was no overhang, and there's, like, 30 gentlemen out there, and the boss just staring at all of us. He didn't even get out of his truck. And I almost felt like it went from being what I was used to in outreach, where it was a very two-way communication - let's talk about it, let's figure out where the gaps are - um, to me having to almost lecture, is what it felt like. They were all standing there, they're still in dirty work clothes, and they're standing in the rain...I had to figure out a way to keep their interest... and then overcom[e] just the

pressure of they knew they were on the clock, and the boss would even, you know, “Hey, pay attention,” kind of thing, you know, “What are you doing?”

Sharron was not the only educator to relate obstacles in teaching farmworkers. Many educators discussed the challenge of engaging farmworkers at the end of a long day in the fields, describing how the men were tired and hungry. Educators like Sharron, Adriana, and Scott who provide many lessons each year may be more familiar with those challenges, leading them to doubt their abilities to effect change as teachers and to question that teaching can generally result in positive learning outcomes for farmworkers.

In contrast to the lower overall efficacy beliefs of the more-experienced pesticide educators found in this study, Ross’s (1998) synthesis of the self-efficacy literature indicated a correlation between greater experience and a decrease in general teaching efficacy and an increase in personal teaching efficacy. In other words, as teachers gained experience, they were more confident in their ability to facilitate student learning but became less confident in the effectiveness of teaching in general for effecting positive change in student outcomes.

As a group, the pesticide educators exhibited relatively little pedagogical discontentment. In general, they expressed contentment with their ability to generate pesticide lessons and revealed minimal discontentment with their knowledge of pesticides. A subset of pesticide educators in the study group (more than one-third) expressed discontentment with facilitating discussion. Most of these educators were not native Spanish speakers; they expressed concerns around communication when engaging farmworkers directly or using an interpreter while facilitating discussions. Dana describes her discontentment with using an interpreter: “I’ve taught many classes with a translator [sic],

but me not understanding what the translator is saying, I'm not certain that they are delivering it correctly.”

Adam (state agency) was the only pesticide educator to communicate some level of discontentment with his knowledge and abilities in all four areas examined (pesticide content knowledge, generating pesticide lessons, facilitating discussion, and teaching unfamiliar topics). His composite *STEBI* score, however, was the highest of all educators in the study group. On the *TBI*, Adam had the lowest numerical score and, thus, the most teacher-focused beliefs. These findings suggest that discontentment and efficacy are in fact different constructs. From these results, one might conclude that Adam will be receptive to learning new, more student-centered approaches to teaching through professional development and that he will have the efficacy necessary to implement newly learned techniques in the field (Blanchard et al., 2011).

### **Influence of Self-Efficacy and Pesticide Risk Beliefs on Teaching Beliefs**

Relationships between pesticide educators' teaching beliefs and their beliefs about content (i.e., pesticide risk) were found. Educators with more cautious beliefs about adverse health-related risks associated with pesticide exposure were more inclined to express learner-focused beliefs about teaching. These educators were typically employed by health care and advocacy organizations. Health care worker Ashley provides insight into this relationship:

[I]t's not about a test, it's not about memorizing something for a test, it's about learning something ...a skill that's gonna help them with their life, with their health and their safety. So I feel like if they're actively involved in the learning process, they're gonna take a lot more out of it.

Comments from health care worker Fabiola and from former farmworker coalition leader Marissa likewise suggest the need for farmworker engagement and buy-in for pesticide education that results in behavioral changes and critical thinking to prevent pesticide illness and injury.

An inverse relationship was found between self-efficacy and teaching beliefs. Educators who reported high levels of self-efficacy on the *STEBI*, who tended to come from state agencies, expressed more teacher-centered beliefs about pesticide education on the *TBI*. These findings might be interpreted to suggest that educators who perceive themselves to be experts in pesticide safety believe that they are able to “transfer to them [farmworkers] a skill that can be applicable to their daily lives” (Salvador). Despite its contradictions with the literature on positive relationships between self-efficacy and teaching practices (Kagan, 1992), this finding resonates with Settlage et al. (2009), who found that pre-service teachers’ over-confidence misaligned with their abilities and “blinded them to the self-doubt that might advance them professionally” (p. 119). Educators with high self-efficacy seem less likely to relinquish control in pesticide lessons to allow farmworkers to shape the direction and focus.

### **Conclusions and Implications**

Luft and Roehrig’s (2007) and Nespor’s (1987) conceptualizations of teaching beliefs proved to be useful in this study, revealing the relationships between pesticide educators’ beliefs about teaching, pesticides, and themselves. Pesticide educators were found to espouse similar teaching beliefs to formal science educators and to express teaching beliefs that correlated with beliefs about adverse health outcomes associated with pesticide exposure and with beliefs about self-efficacy. Nespor’s (1987) critical episodes surfaced throughout

educator interviews and provided insight into educator beliefs. Interestingly, critical episodes consisted not only of experiences as teachers and learners, as described by Nespor, but also of experiences working with pesticides in the field. This finding regarding the importance of critical episodes with content may have implications for the examination of how authentic science experiences influence classroom teachers' beliefs about science. Science education researchers have pushed for authentic science experiences for teachers (Chinn & Malhotra, 2002) with the idea that this experience would help teachers improve their science teaching. These informal science experiences of pesticide educators bring into question whether all authentic experiences are positive and what the role of prior experiences is in an informal setting.

The observation that teaching beliefs varied by institutional affiliation suggests that future research should examine differences among the institutions that provide pesticide education to farmworkers. This finding informs the application of Bandura's (1986) concept of reciprocal determinism to pesticide education; the pesticide educator's institution should be included as an environmental factor that serves to shape teaching practices and beliefs.

Findings from this study have implications for professional development for pesticide educators. Southerland et al. (2010) describe pedagogical discontentment as potentially affecting teachers' receptivity to change through professional development. Blanchard et al. (2011) have found promising results with middle and high school science and mathematics teachers, in which moderate to high levels of pedagogical discontentment relate to much higher adoption of new practices following professional development. High levels of self-efficacy and limited discontentment among some pesticide educators may necessitate

educator reflection, perhaps on video observations of their teaching practices, in order to prompt disequilibrium and openness to change. The most fruitful topics for professional development, based on study findings, would be aspects of pesticide content, particularly as it relates to specific crops and modes of action, as well as facilitating discussion and working with interpreters. Pesticide educators expressed the greatest discontentment with these topics.

This study has revealed the beliefs of a sample of pesticide educators. These beliefs are of great consequence given that educators' beliefs about teaching, pesticides, and themselves guide informal science educators as they serve at-risk farmworkers, who live and work in close proximity to pesticides. While science literacy *for all* is stressed in education (AAAS, 1990), science literacy for low-literacy farmworkers could, quite literally, be a matter of life or death. Pesticide educators are in a position to empower farmworkers with the scientific information that farmworkers need to maintain their safety and improve their lives (Barton, 2001).

As the first study of farmworker pesticide educators, this research provides baseline information on this group of informal science educators. Findings from this study may inform future efforts to develop professional development for science educators in other occupational settings.

**Chapter 5: An Institutional Perspective on Pesticide Education: A Mixed Methods  
Study of Farmworker Educators' Organizations, Personal Goals, and Context Beliefs**

## Abstract

Farmworkers are an at-risk population because they encounter pesticides in their living and working environments, they often experience language and literacy barriers, and they may have tenuous documentation status. Pesticide education for farmworkers is federally mandated by the Worker Protection Standard, but little is known about the individuals who provide pesticide education or their goals. Multiple organizations are involved in pesticide education in a variety of capacities, which range from enforcing federal regulations for training and housing to providing face-to-face lessons in the field. This mixed methods study examines a large portion (n=45) of the population of pesticide educators in a southeastern state, asking, *Who provides pesticide education for farmworkers? What are the goals of these individuals, and do these goals match those of the institutions for which the educators work? What are the constraints that pesticide educators face in achieving their goals?* Findings indicate that individuals from all institutions share goals to reduce exposure and ensure safety and health for farmworkers, regardless of the missions of their organizations. Pesticide educators identified time, farmworker basic needs, the physical setting, institutional missions, and training and curricular materials as shaping their teaching practices and restricting their goal attainment. This study suggests that the congruence of pesticide educators' personal goals provides a foundation for inter-institutional collaborations to meet the needs of this at-risk farmworker population.

The science education reform movement has prompted the examination of classroom teachers' beliefs about their science teaching environments, recognizing the importance of teacher beliefs for lasting and meaningful changes in science education (Lumpe, Haney, & Czerniak, 2000; Park, Hewson, Lemberger, & Marion 2010). In his social cognitive theory, Bandura (1986) asserts that beliefs, which are reciprocally determined by behavioral and environmental factors, are the best predictors of behavior. These beliefs guide teacher decision-making and problem-solving in the "ill-structured" and "entangled" context of most teaching environments (Nespor, 1987, p. 324).

Farmworker pesticide educators provide lessons on basic pesticide toxicology and safety to migrant and seasonal farmworkers, who provide the hand labor necessary to cultivate and harvest crops. A number of factors contribute to the highly complex and ill-defined nature of teaching environments for pesticide educators, including farmworkers' at-risk status (Donham and Thelin, 2006), the legal ramifications of pesticide education (Worker Protection Standard, 1992), and the variety of organizations through which these individuals operate. Pesticide educators' beliefs about these environments shape their teaching practices within them (Nespor, 1987).

### **Farmworkers: A Special Risk Population**

Donham and Thelin (2006) have identified migrant and seasonal farmworkers as a special risk population. These agricultural workers face cultural and linguistic barriers as they seek to maintain their safety and health within their working environments and when they attempt to access health care services. Farmworkers' temporary employment, migratory lifestyles, and tenuous documentation status (frequently as guest or undocumented workers)

contribute to their feeling powerless within these environments and their fear of reporting unsafe working conditions, thereby presenting additional risks to this group. Arcury and Quandt (1998) describe farmworkers as “disenfranchised,” citing large minority representation, low wages, long work hours, lack of transportation, and lack of health insurance as contributing to these individuals’ vulnerability. Low literacy levels and limited formal education among farmworkers exacerbate their at-risk status (Tamassia, Lennon, Yamamoto, & Kirsch, 2007).

The majority of migrant and seasonal farmworkers are young and middle-aged Latino males (United States Department of Labor (US DOL), 2005). Mexico is the country of origin for 75% of hired farm laborers, with Central American countries accounting for an additional 2%. Literacy skills in both Spanish and English have been found to be limited among Latino adult learners in the United States, although literacy levels are higher in Spanish than they are in English (Tamassia, Lennon, Yamamoto, & Kirsch, 2007). The majority of foreign-born workers from Mexico and other countries neither speak nor read English. Most workers have completed no more than seven years of formal education (US DOL, 2005). Thus, educating this group of adults about pesticide risks involves special challenges due to both farmworker literacy issues and lack of formal education.

### **Pesticide Education: A Federal Mandate**

Federal law mandates that employers provide pesticide education for their farmworker employees. With the goal of reducing pesticide exposure and illness, the Worker Protection Standard requires that every five years farmworkers receive pesticide education that “the workers can understand [i.e., in a language they understand, most commonly

Spanish]...using nontechnical terms” and that allows workers to ask questions (Worker Protection Standard, 1992, §170.130). Sources of pesticide exposure, ways to prevent having a pesticide enter the body, health effects associated with exposure, and appropriate emergency responses are mandatory topics for pesticide education under the Worker Protection Standard. Although federal law mandates that educational efforts take place in a language understood by the worker audience (most commonly Spanish), literacy issues limit farmworkers’ understanding of educational materials.

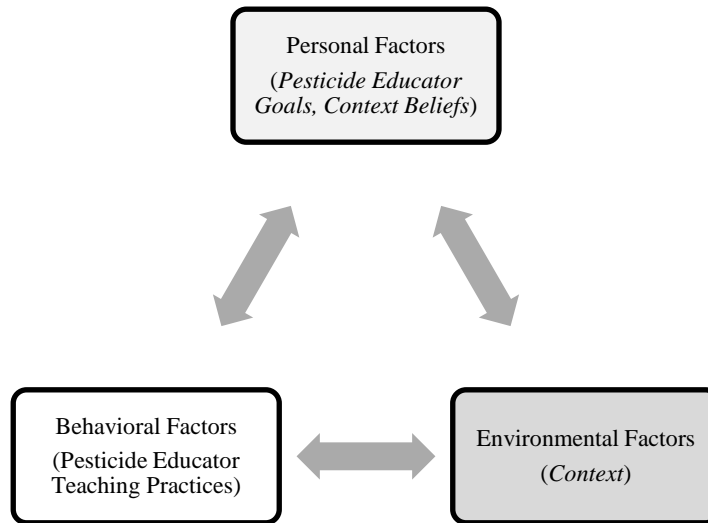
The latest study commissioned by the United States Environmental Protection Agency on the national implementation of the Worker Protection Standard concluded that it was unclear how many workers were receiving the mandated training (Larson, 2000). In the Southeast, work by Arcury, Quandt, Austin, Preisser, and Cabrera (1999) indicated that only approximately one-third of farmworkers in North Carolina had received pesticide education mandated by the Worker Protection Standard. Of the farmworkers who reported that they had received Worker Protection Standard education, the vast majority (nearly 85%) indicated that the lesson entailed watching an approximately one-hour video in Spanish. Most (75%) reported that a verbal presentation accompanied the video, but fewer than half of the workers reported that they were able to ask questions.

Face-to-face pesticide education provided by a pesticide educator is an alternative or a supplement to video-based lessons and may enhance implementation of Worker Protection Standard education requirements. Although the federal law places the onus of employee training on the employer (Worker Protection Standard, 1992), various organizations that provide health and education services to farmworkers throughout the United States may

engage in pesticide education. These organizations are thought to provide farmworker pesticide education as part of their delivery of health and education services, but no known studies specifically explore the organizations and individuals that engage in farmworker pesticide education apart from examining broadly the delivery of health services to farmworkers (Arcury & Quandt, 2007). Identified via the state farmworker health program website, farmworker services organizations in the study state include migrant and community health centers, the Migrant Head Start project, the Migrant Education Program, the Cooperative Extension Service, and advocacy groups. One agricultural southeastern state with a large number of migrant farmworkers was the focus for this study.

### **Theoretical Frameworks**

According to Bandura's social cognitive theory (1986), personal, behavioral, and environmental factors interact reciprocally to determine one another and explain human functioning (see Figure 5.1). The present study focuses on the environment of pesticide education, particularly the organizations through which educators operate, and its influence on pesticide educators' goals and beliefs about their teaching contexts. An understanding of pesticide educators' personal and environmental factors is important because these aspects shape behaviors, specifically teaching practices.



*Figure 5.1.* Reciprocal determinism applied to pesticide education, as described by Bandura (1986), with aspects of Ford’s (1992) Motivational Systems Theory in italics.

In his Motivational Systems Theory, Ford (1992) proposes a relationship between a person’s goals and contexts and his behavior, describing goals and contexts as “anchors that organize and provide coherence to the activities within a behavior episode” (p. 24). Recognizing that an individual operates as a “person-in-context” (p. 22), Ford asserts that personal goals provide direction to behavior and that the environment serves to facilitate or constrain activities toward that goal. Four categories of environments that may facilitate or hinder goal achievement are presented: the natural environment (i.e., natural world), the designed environment (i.e., human-made entities like buildings, tools, and books), the human environment (i.e., people), and the sociocultural environment (i.e., institutions and traditions). According to Ford, individuals may adopt personal goals from the individuals and institutions in their environments, but goals may not be imposed upon a person.

Ford (1992) proposes the notion of *capability beliefs* and *context beliefs* in characterizing motivation and behavior. Capability beliefs roughly correspond to Bandura's (1977) concept of self-efficacy and refer to individuals' evaluations of their skills to perform specific tasks effectively. In the case of pesticide education, a capability belief might appear as the individual belief that the pesticide educator can himself/herself teach a pesticide lesson in such a way that farmworkers gain knowledge of pesticide risks. Context beliefs relate to assessments of the responsiveness of an environment in which a specific task will occur. For example, a pesticide educator might believe that the agricultural field as a learning environment hinders his/her ability to teach effectively. Within this framework, in order to attain personal goals, individuals must operate within a responsive environment and must believe that the environment affords them the opportunity to achieve that goal. Ford agrees with Bandura (1986) that beliefs are more important than actual capabilities and contexts in the achievement of goals.

Using Ford's (1992) framework, Lumpe, Haney, and Czerniak (2000) identify 28 contextual factors that classroom teachers believe influence science teaching. These factors include professional development, state standards, science equipment and supplies, class size and length, funding, teacher support, administrative support, classroom environment, and curriculum materials. In the present study, Ford's "person-in-context" concept will guide an examination of pesticide educators' goals for pesticide education and perceived constraints in meeting those goals, recognizing the importance of the educators' context beliefs.

Despite their potentially critical role in supplying or complementing federally mandated pesticide education, pesticide educators are largely absent in the literature. These

poorly understood educators operate within a loose framework of a variety of farmworker service organizations, each with specific institutional missions. How pesticide educators envision their personal goals and the environmental factors that constrain and/or facilitate meeting those goals within the context of their organizations, however, is unknown. To understand the contextual influences on pesticide educators' beliefs in a large southeastern state, the research questions guiding this study are the following:

1. Who provides pesticide education for farmworkers and through what organizations?
2. What are the goals of pesticide educators, and do these goals reflect those of the institutions for which they work?
3. What are pesticide educators' beliefs about their teaching environments?  
What institutional and practical constraints do pesticide educators face?

### **Methods**

An explanatory mixed methods design was used in this study (Creswell & Plano Clark, 2007). In the quantitative phase of data collection, 45 pesticide educators completed a quantitative survey instrument, and then 19 pesticide educators were selected from the variety of organizations involved in pesticide education for semi-structured interviews. Thus, quantitative data was used to purposefully select participants for qualitative analyses, drawing upon the participant selection model (Creswell & Plano Clark, 2007). The criterion for participation in this study was current or previous involvement in the instruction of farmworkers on pesticide risks, including providing pesticide lessons directly to

farmworkers, administering farmworker pesticide programming, and enforcing federal mandates for pesticide education for farmworkers.

A link to an online questionnaire (available in English and Spanish) was circulated using farmworker service organizations' electronic subscription lists (i.e., listservs) for organizations listed on the statewide farmworker health program website. Additionally, questionnaires were distributed during pesticide educator workshops and at an annual conference sponsored by the state association for community health center workers involved in migrant farmworker health care. Participants who completed the questionnaire were asked to include their names and phone numbers if they were willing to be contacted for personal interviews.

All questionnaire respondents who indicated a willingness to participate in interviews were contacted. In order to ensure representation of the categories of institutions involved in pesticide education (i.e., health care, advocacy, state agencies, and Cooperative Extension Service/universities), personal contacts were made for their participation or referrals for pesticide educators meeting the study criterion. Pesticide educators from the Migrant Education Program and from Migrant Head Start declined to participate, citing that they were just beginning to offer pesticide education services.

The first author interviewed 19 participants. Each interview was between 30 minutes and 1.5 hours in duration. Interviews took place face-to-face when possible and via phone when travel distances prohibited face-to-face interviews. An audio recording was made of each interview, all of which were in English, and interviews were transcribed verbatim by a

third party. Approximately 275 single-spaced pages of transcriptions were yielded from interviews.

### **Data Sources, Collection, and Analyses**

**Pesticide educators' demographic information.** Forty-five participating pesticide educators answered demographic questions related to their personal characteristics, their experiences with farmworker pesticide education, their organization affiliations, and their experiences with pesticides (see Appendix A).

**Pesticide educators' goals in providing pesticide education.** Participants' goals in providing pesticide education were collected using both the questionnaire and semi-structured interviews as data sources. An open-ended question on the questionnaire allowed respondents to state their personal goals: What is your ultimate goal in providing pesticide education to farmworkers? The same question was asked of interviewees as the final interview question.

The first author referred to the mission statements and goals posted on institutional websites to develop a list of a priori codes. Initial codes included 'promote environmental quality' and 'foster a safe and healthy state.' Educators' responses to the personal goal questions were entered into ATLAS.ti version 6.2 and coded by the first author. Emerging codes from the data were identified in addition to initial codes. For example, emerging codes included 'motivate farmworkers to adopt safe behaviors' and 'reduce pesticide illness.'

**Pesticide educators' perceptions of environmental factors.** In answering questions regarding their beliefs about teaching, pesticide risks, and pedagogical discontentment during semi-structured interviews, pesticide educators described the environmental factors in

pesticide education in general and in their organizations in particular that shaped their beliefs and practices. The 28 contextual factors identified by Lumpe et al. (2000) were used as a priori codes for analyzing the educators' interviews (e.g., professional development, standards, equipment, supplies, class size, class length, funding, teacher support, administrative support, classroom environment, and curriculum materials). The first author coded the interviews using ATLAS.ti software and identified emerging codes. Examples of emerging codes are 'time' and 'weather.'

## **Findings**

### **Pesticide Educators and Associated Organizations**

**Key pesticide educator organizations.** Five types of organizations were found to participate in pesticide education for farmworkers: Cooperative Extension Service and other university personnel, farmworker advocacy groups, health care organizations, the Migrant Education Program and Migrant Head Start, and state agencies (see Table 5.1). The majority (n=23, 51%) of the 45 questionnaire respondents were associated with health care organizations. Migrant and community health centers were the most common place of employment for educators affiliated with health care organizations (n=15, 65%). The organizations that provide education for children of farmworkers or farmworkers who are minors (i.e., Migrant Head Start and Migrant Education Program) had the fewest representatives (n=3, 7%).

**Demographics of pesticide educators.** Clear demographic differences exist in comparing the employees of those organizations that provide pesticide education. Of the total number of pesticide educators in the study (n=45), those who self-identified as Latino

ethnicity were most prevalent in health care organizations (74% of health care workers) and farmworker advocacy groups (57% of advocates). European American educators predominated among Cooperative Extension Service and other university personnel (80%), Migrant Education Program and Migrant Head Start staff (100%), and state agency employees (71%). Health care workers and advocates generally had lower levels of education; educators had high school diplomas (20%) and some college experience or an associate's degree (30%). The Cooperative Extension Service and other university personnel had the highest percentage of educators (80%) who had field experience as workers or handlers, meaning these educators had worked in agricultural fields sprayed with pesticides or had mixed, loaded, or applied pesticides. Overall, pesticide educators across all institutions were more likely to be female (58%), report Latino ethnicity (51%), hold a bachelor's degree (38%), and have no worker (71%) or handler (84%) experience.

In addition to representing a large percentage of the pesticide educators who participated in this study (more than 50%), pesticide educators associated with health care organizations provided significantly more ( $p = 0.032$ ) pesticide lessons in a year than educators in other organizations. Pesticide educators associated with the Cooperative Extension Service or university, the Migrant Education Program or Migrant Head Start, and state agencies provided (individually) no more than 10 pesticide lessons each year. In contrast, eleven pesticide educators from health care organizations reported delivering 100 or more lessons. Therefore, the vast majority of pesticide lessons were provided by health care workers.

Table 5.1

*Organizations Providing Pesticide Education and Characteristics of Pesticide Educators*

<b>Organization</b>	<b>N</b>	<b>Percentage of Total (n=45)</b>
<b>Cooperative Extension Service/University</b>	<b>5</b>	<b>11%</b>
<i>Male</i>	2	
<i>Female</i>	3	
<i>White/European American</i>	4	
<i>Multiple Ethnicities</i>	1	
<i>Graduate/Professional Degree</i>	5	
<i>Worker Experience</i>	4	
<i>Handler Experience</i>	4	
<b>Farmworker Advocacy Organization</b>	<b>7</b>	<b>16%</b>
<i>Male</i>	3	
<i>Female</i>	4	
<i>Latino/Hispanic</i>	4	
<i>White/European American</i>	1	
<i>Multiple Ethnicities</i>	2	
<i>High School Diploma</i>	2	
<i>Bachelor's Degree</i>	4	
<i>Graduate/Professional Degree</i>	1	
<i>Worker Experience</i>	3	
<i>Handler Experience</i>	0	
<b>Health Care Organization</b>	<b>23</b>	<b>51%</b>
<i>Male</i>	10	
<i>Female</i>	13	
<i>Latino/Hispanic</i>	17	
<i>White/European American</i>	6	
<i>High School Diploma</i>	4	
<i>Some College/Associate's Degree</i>	9	
<i>Bachelor's Degree</i>	7	
<i>Graduate/Professional Degree</i>	3	
<i>Worker Experience</i>	4	
<i>Handler Experience</i>	2	
<b>Migrant Education Program/Migrant Head Start</b>	<b>3</b>	<b>7%</b>
<i>Male</i>	0	
<i>Female</i>	3	
<i>Latino/Hispanic</i>	0	
<i>White/European American</i>	3	
<i>Bachelor's Degree</i>	2	
<i>Graduate/Professional Degree</i>	1	
<i>Worker Experience</i>	0	
<i>Handler Experience</i>	0	

Table 5.1 Continued

<b>State Agency</b>	<b>7</b>	<b>16%</b>
<i>Male</i>	4	
<i>Female</i>	3	
<i>Latino/Hispanic</i>	2	
<i>White/European American</i>	5	
<i>Bachelor's Degree</i>	4	
<i>Graduate/Professional Degree</i>	3	
<i>Worker Experience</i>	2	
<i>Handler Experience</i>	1	
<b>Overall Totals</b>	<b>45</b>	
<i>Male</i>	19	42%
<i>Female</i>	26	58%
<i>Latino/Hispanic</i>	23	51%
<i>White/European American</i>	19	42%
<i>Multiple Ethnicities</i>	3	7%
<i>High School Diploma</i>	6	13%
<i>Some College/Associate's Degree</i>	9	20%
<i>Bachelor's Degree</i>	17	38%
<i>Graduate/Professional Degree</i>	13	29%
<i>Worker Experience</i>	13	29%
<i>Handler Experience</i>	7	16%

*Note.* To help protect the anonymity of the participants, characteristics were disaggregated from individuals.

## **Pesticide Educators' Goals**

Pesticide educators exhibited congruence in their personal goals for providing pesticide education, regardless of their institutional affiliations and their institutions' mission statements. Of the 37 pesticide educators who provided a personal goal statement, 30 described the personal goal of promoting the safety and health of farmworkers, their families, and the agricultural community (see Table 5.2 for exemplary quotations). More than 84% of pesticide educators in the study group shared this goal. As Ruth, a Cooperative Extension Service/university employee, succinctly stated, "I just want people to be safe and healthy." Pesticide educators sought to foster safe working and living environments for farmworkers and their families, and educators endeavored to maintain and improve farmworker health.

Mitigating pesticide exposure was mentioned by 11 of the 37 pesticide educators who provided goal statements. Reduction of pesticide exposure was discussed in conjunction with safety and health by 7 of the educators: "[My goal is] to make sure that there are less and less exposures to pesticides for farmworkers, which means that they're going to be healthier" (Scott, health care worker). More than 90% of pesticide educators in the study group (i.e., 34 out of 37) had personal goals that encompassed promoting safety and health or reducing exposure.

Table 5.2

*Pesticide Educator Personal Goal Codes, Occurrence, and Exemplary Statements*

<b>Code</b>	<b>N</b>	<b>Exemplary Goal Statements</b>
Safety and Health Promotion	30	<ul style="list-style-type: none"> <li>• “[My goal is] to educate them so they can protect themselves and work and live healthy lives.” (HC)</li> <li>• “I want them to learn to protect themselves—because the grower never will—so they can go back to Mexico healthy and happy to see their families.” (A)</li> <li>• “[My goal is to] keep them safe, to make sure that they can do their job and do it safely, to make sure they know how to identify symptoms in coworkers if they happen to have a problem, and in case there is a problem, know how to respond to the problem...” (SA)</li> <li>• “The most important thing is for the workers to be safe and to know the dangers of pesticides. I can help them, and they can help others.” (HC)</li> <li>• “[My goal is] that I can keep people that are involved with pesticides healthy, safe, and that they understand the processes involved in keeping themselves safe.” (CES/U)</li> </ul>
Exposure Prevention	11	<ul style="list-style-type: none"> <li>• “The goal is [for farmworkers] to learn the present behavior that helps them to be less affected by the risk of exposure to these chemicals.” (SA)</li> <li>• “[My goal is] to limit pesticide exposure—both take-home and in the workplace” (A)</li> <li>• “My goal is to make sure that the farmworkers know how to protect themselves against exposure so that they don’t get sick or cause a member of their family to get sick.” (HC)</li> <li>• “Through providing training to farmworkers in scouting and IPM, I hope to help the Christmas tree industry reduce the use of insecticides and thereby reduce worker exposure to pesticides.” (CES/U)</li> </ul>
Farmworker Rights and Protections	5	<ul style="list-style-type: none"> <li>• “Our goal is to inform farmworkers about the obligations of their employers to provide a safe working environment (including pesticide education and protective gear), their rights as agricultural workers, and the measures they can take to protect themselves in the all too common event that their employer does not comply with the law and their work environments are unsafe.” (HC)</li> <li>• “To communicate, in an effective way...the existence of the regulations that promote a safe use of pesticides.” (SA)</li> <li>• “We want to make sure that workers know what their rights are, workers know how to recognize when something is not being done the right way, and they know what they should do when that happens.” (A)</li> </ul>

Table 5.2 Continued

Protection of Environment	3	<ul style="list-style-type: none"> <li>• “[My goal is] to reduce exposure of pesticides to individuals and to the environment” (HC)</li> <li>• “[My goal is to] improve the impact of agriculture on the environment...” (CES/U)</li> </ul>
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*Note.* *n* = number of goal statements coded in this category; SA = state agency; CES/U = Cooperative Extension Service/university; HC = health care; A = advocacy.

Educators described two general approaches to reducing exposure and promoting health and safety—increasing farmworkers’ awareness of pesticide hazards (n=11) and increasing farmworkers’ adoption of safe behaviors (n=13). This goal statement from a health care worker reflects the perspective that farmworkers should know their occupational risks, the dangers of pesticides, and the chemicals to which they are exposed: “[My goal is] to prepare the farmworkers with information about pesticides, their use, and handling and control in order to protect their physical integrity.” Ruth’s (Cooperative Extension Service/university) discussion of her personal goals is reflective of the viewpoint that farmworker understanding of safe behaviors and actions to take in case of exposure will keep them safe and healthy:

I want people to understand that even though pesticides can have long-term and short-term health effects that pesticides can be used safely and it’s the behaviors and the practices that we choose or choose not to do that have an effect on what our risk is, and so if we can educate people to understand the things that they need to do, what they need to do to change their behavior to be able to safely be in an environment that uses pesticides, then we’re able to decrease their risk and help them be safer and healthier.

One educator described her goal to “motivate” farmworkers in the adoption of these behaviors that limit farmworker exposure to pesticides.

Some educators’ personal goals represented goals unique to particular institutions, such as focusing on farmworkers’ rights (n=5) or protecting of the environment (n=3). These specific goals, however, were not universally reflected in the statements of all educators

associated with these institutions. Additionally, pesticide educators affiliated with other institutions expressed goals that aligned with goals unique to institutions other than their own. With an institutional goal of empowerment and protection of farmworker rights, Alicia, an advocate, describes her personal goals:

We want to make sure that workers know what their rights are, workers know how to recognize when something is not being done the right way, and they know what they should do when that happens. From the education standpoint, I think that our main goal is just to make sure that people know when something is wrong and are prepared and equipped to act.

Farmworkers' knowledge of their rights and empowerment were not only sought by the advocate Alicia but also by three health care workers and one state agency employee. The other advocates did not discuss farmworker rights in their personal goal statements.

Two of the five Cooperative Extension Service/university staff, Dana and Joe, included improving "the impact of agriculture on the environment" in their personal goal statements (Joe). The Cooperative Extension Service indicates an organizational commitment to "environmental quality" in its goals and objectives. One health care worker, Fabiola, also sought to "reduce exposure of pesticides to individuals and to the environment." Though environmental protection is a specific goal of Cooperative Extension, as well as the state agencies, the goal was neither universally evident in Cooperative Extension employees' personal goal statements nor restricted to educators from this specific institution. In the case of both environmental protection and farmworker empowerment, institutional goals were not

always evident in personal goals and were not exclusive to individuals with the particular affiliation.

### **Pesticide Educators' Context Beliefs**

**Time.** “And it’s one of the barriers; the time and the hours” (Salvador). Described by nearly one-third (n=6) of the pesticide educators who participated in interviews, time was one of the most widespread contextual factors that pesticide educators described as constraining their teaching. The way that the constraint of time was experienced by the educators, however, varied according to the type of institution with which the educator was affiliated. Two health care workers described the federal Worker Protection Standard training requirements for workers as limiting the extent to which their pesticide lessons can be student-centered and student-directed within the allotted time frame:

I think what happens is that there’s so much that needs to be shared about pesticides, and we know our EPA has 11 points that we have to get. Well, it may be that you can’t get through 11 points on a real good dialogue session where people are discovering point number one, right. So...there is this limited time to have this prescribed lesson plan put in there. So when it’s prescribed like that, you’re limited by time. When it’s not prescribed, then you can pretty much let time be flexible and allow people who are enjoying the conversation to spend more time analyzing different components [that are of interest to them]... And so then sometimes time can be a constraint. (Fabiola)

Sharron, also a health care worker, similarly reported using the training criteria, rather than student input, to guide the flow of topics discussed in more formal pesticide lessons. For

these health care workers, meeting all of the Worker Protection Standard criteria in a limited amount of time necessitated their taking a more teacher-focused approach.

State agency (Adam) and Cooperative Extension Service (Janet) pesticide educators revealed that their decisions about when to move from one topic to the next depended on time. Participating in more formal lessons, Janet described how the scheduled time frame influences her teaching decisions:

I have a certain time frame that I'm supposed to stay within because there are other speakers or...just how a thing is scheduled and, so, it depends on how much information there is and I think what the things that need to be covered. (Janet)

Adam suggested that he might have to move on to another farmworker or lesson if the farmworker he is teaching is unable to learn within the specified time frame.

Alicia, an advocate, described the considerable amount of time that it takes for “relationship development” with farmworkers to gain their respect and trust as taking “more than one season.” She states that it takes “going and sitting and talking with them on outreach and listening to their problems, all kinds of problems” to build relationships with farmworkers. This time commitment for relationship development limits the number of farmworkers that Alicia can reach.

**Farmworker basic needs.** Six pesticide educators described their perceptions of farmworker “basic needs” as influencing teaching decisions (Maslow, 1943). Basic needs reflected both physiological needs and safety needs as represented by Maslow (1943). For example, educators’ perception of the tiredness of their learners was a frequent consideration for pesticide educators (n=5):

I think that they can be tired, especially after coming from the fields... what we would do is go out to their homes after they had worked all day, so sometimes I kind of wondered...what is the best way to approach it, right? (Sharron, health care worker)

These educators also described the distracted conditions they encountered in farmworkers' homes or camps after the workers had spent the day in the fields: "they're eating or they are just rushing, you know, counting little tags to see how much money they're gonna make per bucket of sweet potatoes" (Marissa, advocate). In addition to being "tired" and "hungry" (Adriana, health care worker), the farmworkers "gotta thousand other things on their minds" (Ruth, Cooperative Extension Service/university employee) with which educators must compete in order to engage farmworkers and enhance farmworker knowledge of pesticide concepts.

The advocate Alicia was the only educator to address safety needs (Maslow, 1943) that farmworkers have as shifting the focus of her discussions with farmworkers away from pesticides:

It's hard to focus just on one theme or one issue in conversations with workers just because there are so many, and for workers, they're all extremely connected, like...a person's exposure is increased the longer they are walking around with residues on their skin and clothes. Well, that has a lot to do with...the quality of their [employer-provided] housing. Um, so yeah, all of these things come into play in our conversations.

Alicia states that immigration is the “biggest priority” for farmworkers as they are concerned with their documentation status (frequently as undocumented or guest workers). These global concerns distract farmworkers’ attention during lessons and shape the course of discussions.

**Institutional missions.** The institutional missions of the state agencies to carry out regulatory mandates were perceived by both educators affiliated with the state agencies (n=2) and an educator associated with another organization as restricting the activities of the state agency pesticide educators. Renee, a state agency educator, described her role as a pesticide educator as consisting of “enforcement primarily and education secondarily.” A second state agency educator Bridget revealed that most of her pesticide lessons take place within the context of compliance “only because we [at the state agency] don’t actually get the opportunity to get on the farms any other way.” Alicia, an advocate, described her frustration that the role of the state agencies does not allow for their educators to engage in advocacy and farmworker empowerment:

I feel like a lot of the people who are doing the training are coming from agencies where they’re not really allowed to agitate. They’re not really allowed to encourage workers to act on their own behalf, aside from just kind of like personal behaviors, and I feel like when so many of the people who are the conveyors of information have their hands tied that way, it’s really a struggle to make any meaningful change.

The roles of state agency educators were limited by their institution’s scope and mission.

**Physical setting.** Three pesticide educators revealed the ways in which the physical setting of pesticide lessons influences their teaching practices. Health care worker Fabiola

relayed how the setting influences the materials that she utilizes: “The reality is that you might be in the middle of a field and you’re gonna have to pick up a twig and make it into something [to demonstrate pesticide concepts] and start doing pesticide education right there, you know.” She goes on to state that pesticide educators “cannot depend on the PowerPoint, the copier..., the handout..., the really slick-looking kind of...educational material or prop.” With many trainings occurring outside, Salvador and Sharron explained the influence of the weather on the delivery and effectiveness of pesticide education. Salvador (state agency) delineated “heat or conditions of cold in the mountains” as considerations when one is “teaching outside under the trees.” Sharron (health care worker) revealed how her teaching decisions had to be flexible in this environment: “You didn’t know what the weather would be like. You didn’t know what the conditions around you were gonna be like, so it was just about being adaptable.” The locations of trainings in the field or in migrant camps were contextual factors identified by these three educators.

**Training and curricular materials.** Two pesticide educators indicated that training and curriculum materials developed for them by others would improve their teaching of farmworkers. State agency educator Lisa stated that “better tools” should be made available because she has not had access to “adequate training materials.” Chris, who works with the Cooperative Extension Service/university, described a need for training: “As an organization, we need more training to be able to communicate with them [farmworkers] in a way to keep them safe and [create] a more comfortable setting for Latinos.” These two pesticide educators believed that a lack of resources in the form of curricular materials and professional development were currently constraining their teaching.

## Discussion

This mixed methods study explored the organizations that and individuals who provide pesticide education to farmworkers, focusing on educators' goals and their beliefs about the environment in which they pursue those goals. Pesticide educators were found to provide pesticide education for farmworkers through five types of organizations: the Cooperative Extension Service and the university, farmworker advocacy groups, health care organizations, the Migrant Education Program and Migrant Head Start, and state agencies.

The Migrant Education Program and Migrant Head Start, however, play a relatively small role in providing pesticide education at this time. Few educators in this study (n=3, 7%) operate through these migrant education organizations, and the educators affiliated with these organizations provide few lessons. Informal discussions with these educators, however, revealed an interest in expanding their involvement in pesticide education in the future (personal communication, June 9, 2010).

Findings indicate that health care organizations, particularly migrant and community health centers, provide the vast majority of pesticide lessons for farmworkers in the state. Many pesticide educators in the state (more than 50% of the study group) are affiliated with health care organizations, and these educators deliver large numbers of lessons each year. After health care organizations, farmworker advocacy groups offered the greatest number of trainings each year. The educators affiliated with both health care and advocacy institutions were more similar in ethnicity and education level to the target farmworker audience than educators affiliated with other groups. The majority of educators from the health care organizations (nearly 75%) were self-identified as Latino/Hispanic ethnicity, and the

majority of health care workers had completed no more than an associate's degree or some college.

Though they provide far fewer pesticide lessons to farmworkers, a higher percentage (80%) of Cooperative Extension Service employees had experience working in the field. Few health care workers (22%) had such real-world experience, raising the question of how this lack of experience might limit these educators' ability to deliver relevant and practical pesticide lessons. Authentic experiences with science are considered necessary or desirable in secondary science teaching (e.g. Chinn & Malhotra, 2003) and can lead to more learner-centered science teaching that matches national reform goals (Blanchard, Southerland, & Granger, 2009). Dubner et al. (2001) assert that teachers "who have experience in the practice of science, and in the use of science in the 'real world,' can better communicate the concepts and value of science to their students" (p. 3.6.3). A focus for future work might be the extent to which educator demographics and field experience shape educator practices and influence farmworker receptivity to and learning of pesticide messages.

Regardless of their institutional affiliations, the pesticide educators in this study exhibited personal goal congruence. More than 90% expressed the common goals that through pesticide education they should reduce pesticide exposure and promote the safety and health of farmworkers, their families, and the agricultural community at large. Educators' personal goal statements indicated that reduction of pesticide exposure was the means by which to promote safety and health, focusing on increasing farmworkers' knowledge of pesticide risks and their adoption of safe behaviors. Unique institutional goals related to protecting the environment and empowering farmworkers to exercise their rights

were neither universally adopted by individual educators within these organizations nor exclusive to individuals within the organizations.

Findings resonate with Ford's (1992) position that personal goals may be shaped by the individuals and institutions in a person's environment and that goals may not be imposed on individuals. Pesticide educators' personal goals in this study differed at times from goals of their affiliated institutions, indicating that institutional affiliation did not determine their goals. Despite educators' describing their roles differently according to their institutional affiliation (e.g., state agency personnel as 'regulators' before 'educators'), these individuals expressed goals with similar content. Indeed, findings from this study reveal that few substantive differences exist in pesticide educators' personal goals and that these goals transcend defined institutional goals and prescribed roles.

Pesticide educators described time, farmworker basic needs, specific institutional missions, the physical setting, and training and curricular materials as contextual factors that they believe influence their teaching. Several of these contextual factors specified by pesticide educators about their informal science teaching environments parallel the factors identified by Lumpe et al. (2000) in their study of classroom teachers' beliefs about the factors that influence science teaching. The factors of 'professional development' and 'curriculum materials' transferred directly from the formal science classroom to the informal pesticide lesson; two pesticide educators described a need for more training for themselves and enhanced curricular materials in order to improve their teaching of farmworkers.

Both classroom science teachers and pesticide educators included the physical environment in describing their context beliefs, although the physical settings for pesticide

education (e.g., migrant camps, the field) lie in stark contrast to the typical science classroom. Whereas classroom teachers specified the classroom environment, supplies, and equipment among contextual factors, pesticide educators described their teaching materials (designed environment) and the weather (natural environment) in their context beliefs about the physical setting of lessons. These findings suggest the universality of certain environmental factors that influence science teaching and that often create dilemmas for teachers (Abrams, Southerland, & Silva, 2007; Anderson & Helms, 2001). These environmental factors include professional development, curricular materials, and the physical setting—whether that teaching occurs with kindergarten through twelfth grade students in traditional classrooms or with migrant farmworkers in a tobacco field.

Other context beliefs expressed by the pesticide educators in this study reflect a distinctive pesticide education milieu. Whereas classroom teachers are guaranteed a specified amount of time each school year with their students, pesticide educators must seek out opportunities to engage with farmworkers in their camps at the end of the work day, at farm owner/operator-sponsored field days, and in the van while providing transportation to local clinics for medical or dental appointments. In trying to reach “the unreachable population” (Joe, Cooperative Extension Service/university), the educator finds time to be a constraint. Salvador, a state agency employee, elaborated on the factors that contribute to the prevalent context belief that time is a hindrance:

We have to consider the training. The training is being given for probably 10-percent of the total amount of workers in [this state] every year. It could be also given before in this state or other states, but most likely they don't have much training in that

regard. Another issue is the turnover of working; getting in and out of the job is really high. So they need to be trained, you know, they need to be reached every year as much as possible... It's kind of a complicated job because in [our state] the geographical area is pretty big. We're talking about 20,000 farms, greenhouses, and nurseries... But the time is spent so much in [getting to] the geographical locale you are going to reach some of those ones.

Educators described their experiences with time in different ways, largely according to the institutions through which they provide pesticide education.

The health workers described the federal Worker Protection Standard training criteria, which might be compared to the *National Science Education Standards* (NRC, 1996), as hindering their ability to use student-focused approaches to teaching pesticide lessons within the limited amount of time that they have with farmworkers in formal trainings. These health care workers typically reach a particular group of farmworkers in a migrant camp once or twice each growing season. Farmworker understanding of the required pesticide concepts is central in maintaining their safety and health, and health care workers believe they must resort to teacher-directed methods to accomplish this goal in one or two sessions. State agency and Cooperative Extension Service personnel similarly expressed time as dictating their teaching decisions during formal trainings, preventing them from relying on farmworker feedback. An educator's perception of 'time' has been identified as one of the factors that is likely to move a traditional lesson to being less learner-centered (Blanchard et al., 2009). These teacher-centered practices contrast with recommendations made by organizations such

as the American Association for the Advancement of Science (AAAS, 1993) and the *National Science Education Standards* (NRC, 2000) for more learner-centered strategies.

Advocate Alicia emphasized the importance of “relationship development” in farmworker pesticide education. With the geographical distribution and large number of farmworkers in the state (estimated at 86,000 by the state farmworker health program), the extensive amount of time required (more than one growing season) to build relationships of mutual respect and trust limits the breadth of Alicia’s reach and her impact. Though they express and perceive the constraint of time in different ways, nearly one-third of pesticide educators have context beliefs about time that shape the decisions they make in meeting both their institutional information-delivery goals and striving for their personal goals of farmworker safety and health.

The farmworker basic needs that pesticide educators enumerated in their context beliefs speak to the highly political nature of pesticide education. The physiological needs (Maslow, 1943) for sleep and food that educators revealed in interviews exist because of the fact that many of the pesticide lessons provided by health care workers take place in migrant housing at the end of the work day. Clearly, this occupational training is much different than that in other industries, as pointed out by Sharron: “Most jobs have some risks, but for most other jobs there’s big signs and there’s postings and people know what they’re dealing with, and I don’t think that they’re [farmworkers are] always given the information.” Although employers are required to provide pesticide education by federal law, pesticide educators are providing required or supplemental training outside of the farmworker workplace, in an informal, ‘low-tech’ environment in the field or migrant camp. In combination with more

global safety issues, these physiological needs contribute to a highly complex teaching environment for pesticide educators.

As Alicia, an advocate, explained, overarching, systemic issues related to farmworker safety (Maslow, 1943) preoccupy farmworkers and shape their ability to respond to pesticide education. Because many farmworkers are undocumented or guest workers using visas, immigration is a considerable source of concern for farmworkers. In providing pesticide education, educators find themselves in politicized and complex environments, requiring them to rely upon their beliefs to guide their practices (Nespor, 1987). In this ever-shifting teaching context, pesticide educators reflect on what they are doing in the particular context, making changes in the moment: what Dewey (1910) and Schön (1988) called “reflection-in-action.” A review of a body of literature (Keys & Bryan, 2001) shows that classroom curriculum reform efforts are shaped and altered by teachers’ beliefs and understandings of the local context. This study suggests that these factors are similarly at work in the informal setting of pesticide education, and perhaps all informal settings.

In analyzing educators’ context beliefs, Kegan and Lahey's (2001) construct of *competing commitments* emerges as a lens through which to understand the conflict that educators face in providing pesticide education within complex environments. Perceiving that time is limited, educators' commitments to covering the established training criteria and to allowing farmworkers to guide the lesson frequently come into conflict. Educators believe that covering the 11 points is important but also realize that farmworkers must construct their own meaning for farmworker learning and adoption of safe behaviors. Educators have competing commitments in relation to meeting farmworkers' interests and safety needs (to

include discussions of immigration, housing, etc.) on the one hand and to achieving their specific objective of enhancing knowledge of pesticides on the other. Ultimately, in practice, pesticide educators must adopt one commitment to the detriment of fully addressing others.

### **Conclusions and Implications**

The relationships between the different educators and institutions involved in pesticide education may be tenuous at times, as reflected in Alicia's quotation: "I feel like when so many of the people who are the conveyors of information [from state agencies] have their hands tied that way, it's really a struggle to make any meaningful change." In addition to Alicia's frustration with the state agencies, other educators revealed tensions between organizations involved in farmworker pesticide education; some frustrations were expressed off the record. Joe expressed aggravation with pesticide educators who do not have practical field experience yet who "claim that they are effective educators." Findings from this study suggest that Cooperative Extension Service/university employees, like Joe, are more likely than educators from other organizations to have experience with pesticides in the field. Salvador, from a state agency, suggested that building "rapport and friendship and collaboration" with the other entities involved in farmworker pesticide education was challenging. Perhaps this engagement is challenging as the result of health care workers' and advocates' perceptions that the state agency educators' "hands [are] tied" (Alicia, advocate).

In interviews and informal conversations, several pesticide educators expressed dissatisfaction with the current state of pesticide education. Joe put forth a question that suggests his concern that current education efforts are insufficient: "I think one good question would be 'Are we being effective collectively in pesticide education? Are we—put

together all the pesticide education—are we really making a difference?’’ This general dissatisfaction may signify receptivity to exploring new approaches to pesticide education and forging new relationships with outside institutions. With recognition of their common goal (and the constraints that particular institutions face in accomplishing this goal), future inter-institutional collaborations may serve to promote the safety and health of farmworkers and their families, in alignment with the personal goals of the individuals who provide pesticide education. Given the shared goals of safety and health and exposure reduction, a future of greater collaboration among the various institutions that provide pesticide education to farmworkers not only seems possible but also appears to be an appropriate strategy for enhancing farmworker education.

An institutional perspective on the state of pesticide education indicates that through collaboration, institutions could collectively address the factors that educators perceive as influencing their teaching decisions. By pooling their resources and their influence, individuals might lobby for a greater number of pesticide educators to reach the large and dispersed farmworker population, documenting more carefully who has received training. Additionally, these institutions could focus greater attention on the significant issues for migrant farmworkers related to immigration policy. Building relationships with farm owner/operators could facilitate on-site occupational training and a farm culture that promotes safety and health in more comprehensive ways. As Ruth says, ‘‘There are a lot of opportunities with growers and farmworker educators to be partners, and we just have to do more to build those bridges, to make sure it happens, and to make sure that we really are doing best practice in pesticide education in [our state].’’

## **Chapter 6: Conclusions**

*I did a pesticide training, and the boss showed up, of course. It was after work. He agreed to let the guys come. They were still on the clock. It was raining. We were in the mud, out standing in the rain. There was no overhang, and there's, like, 30 gentlemen out there, and the boss just staring at all of us. He didn't even get out of his truck. And I almost felt like it went from being what I was used to in outreach, where it was a very two-way communication - let's talk about it, let's figure out where the gaps are - um, to me having to almost lecture, is what it felt like. They were all standing there, they're still in dirty work clothes, and they're standing in the rain...I had to figure out a way to keep their interest... and then overcom[e] just the pressure of they knew they were on the clock, and the boss would even, you know, "Hey, pay attention," kind of thing, you know, "What are you doing?" (Sharron, health care worker)*

Sharron's vignette provides a 'critical episode' (Nespor, 1987) of her teaching of migrant and seasonal farmworkers. In reading Sharron's story, questions emerge about Sharron as a pesticide educator and the state of pesticide education for migrant and seasonal farmworkers. What are Sharron's teaching beliefs? What are Sharron's beliefs about pesticide risk? What are her self-efficacy beliefs? How do these pesticide risk and self-efficacy beliefs shape her teaching beliefs? What are her personal goals? What contextual factors does she identify as constraining her attempts to attain her personal goals?

This dissertation investigated the nature of pesticide educators in a southeastern state. Drawing on quantitative and qualitative methods, the studies contained within this body of

work characterize the personal beliefs—including pesticide risk, self-efficacy, and teaching beliefs—of pesticide educators, as well as pesticide educators’ personal goals and their beliefs about the environments in which they pursue these goals. The research allowed for the creation of a profile of the organizations that and individuals who provide pesticide education to migrant and seasonal farmworkers in a highly agricultural state.

### **Development of the Pesticide Risk Beliefs Inventory**

In order to facilitate the characterization of pesticide educators’ beliefs about the content of pesticide lessons (i.e., pesticide risk), this study developed and tested with pesticide educators (n=43) the *Pesticide Risk Beliefs Inventory (PRiBI)*. Based on the mental models framework for risk communication (Morgan, Fischhoff, Bostrom, & Atman, 2002), the inventory was the first attempt to quantitatively assess mental models of pesticide risks. Testing confirmed the reliability, validity, and overall psychometric strength of the *PRiBI*. For the test group, pesticide educators’ pesticide risk beliefs aligned with an expert perspective and suggested the need for professional development to focus on the utility of chemical properties of pesticides, including chemical families and ingredients, in identifying pesticide risks (see Chapter 3 for full details of the *PRiBI* development).

This inventory holds promise for exploring beliefs about pesticide risks for a variety of other audiences in traditional and informal teaching contexts—students, secondary science teachers, college science professors, the agricultural labor force, and the general public. The inventory could be used to compare beliefs among different groups or to prepare relevant risk communication materials, professional development sessions, and formal and informal science lessons. By using this inventory, scientists and science educators may pre-assess

beliefs as well as post-assess the effectiveness of risk communications in addressing misconceptions, filling knowledge gaps, and expanding expert-like beliefs.

### **Pesticide Educators' Personal Beliefs**

#### **Pesticide Educators' Beliefs about Pesticide Risk**

A sample of pesticide educators (n=19) demonstrated general agreement with expert beliefs on the *PRiBI*. On each of the four subscales (related to chemical properties, physical properties, routes of entry, and adverse health outcomes of pesticides), educators provided responses that aligned with expert models of pesticide risk derived from the scientific literature and consultations with pesticide toxicologists. Interestingly, educators who had experience mixing, loading, or applying pesticides had lower composite scores on the *PRiBI*, specifically on the routes of entry and adverse health outcomes subscales, than those educators who had not had experiences working with pesticides in this capacity. Although individuals who had experience handling or applying pesticides exhibited expert-like beliefs, their pesticide beliefs were less cautious than those educators who had not had field experiences with pesticides.

Semi-structured interviews with pesticide educators served to confirm quantitative findings and to explicate the finding that field experience with pesticides corresponds to less cautious pesticide risk beliefs. Critical episodes (Nespor, 1987) with pesticides (e.g., observing a chemical sales representative drinking pesticides and working in the fields without protective clothing as a graduate student) functioned in shaping the beliefs of pesticide educators with field experiences. Regardless of experience, pesticide educators were able to describe basic pesticide risks when they were asked to describe what, if any,

risks that pesticides pose to farmworkers. Interestingly, cancer and infertility were among the most common explicitly mentioned health outcomes of pesticide exposure despite educators' generally providing equivocal responses to items on the *PRiBI* regarding concern with these outcomes. Thus, the combination of quantitative and qualitative data sources proved to be useful in capturing the full range of pesticide risk beliefs of pesticide educators and in triangulating data, gaining insights into pesticide educator beliefs through several different sources (Stake, 1995).

In general, beliefs concerning pesticide risk were accurate, matching expert views. Individuals who had direct experience handling or applying pesticides were more likely to work for the Cooperative Extension Service or a university and were less cautious in their assessments of pesticide risk. These educators, however, still expressed expert-like beliefs. Those educators who expressed greater concern with the health risks of pesticides tended to be affiliated with health care and advocacy groups and tended to be demographically more similar to migrant and seasonal farmworkers (see Chapter 5).

### **Pesticide Educators' Beliefs about Self**

The pesticide educators in this study reported low to moderate science teaching efficacy beliefs on the *Science Teaching Efficacy Beliefs Instrument (STEBI)* (Riggs & Enochs, 1990). Educators who provided more pesticide trainings each year expressed significantly lower levels of self-efficacy. This reduced self-efficacy found among health care workers and advocates, who provide the most pesticide lessons and frequently deliver trainings in migrant camps at the end of the work day, might be explained by educators'

perceptions of the challenges associated with engaging farmworkers when they are tired and hungry (see Chapter 5 for a discussion of perceived farmworkers' basic needs).

As a group, the pesticide educators exhibited relatively little pedagogical discontentment during semi-structured interviews. They expressed contentment with their ability to generate pesticide lessons but revealed some, albeit limited, discontentment with their knowledge of pesticides. For one-third of pesticide educators in the study group, facilitating discussion was seen as problematic. Most of these educators were not native Spanish speakers; they expressed a concern with engaging farmworkers directly or using an interpreter while facilitating discussions. The findings assist in the identification of topics for professional development for pesticide educators. Specifically, pesticide content, facilitating discussion, and working with interpreters would be apt focus areas.

### **Pesticide Educators' Teaching Beliefs**

In the *Teacher Belief Interview* (Luft & Roehrig, 2007), the majority of pesticide educators expressed *transitional* and *instructive* teaching beliefs. Pesticide educators' teaching decisions, that is, were largely determined by their interactions with farmworkers or by what they thought was best for farmworkers. Advocates and health care workers, who were found to be more similar to the farmworker audience (see Chapter 5), were more student-centered in their teaching beliefs than their counterparts at the Cooperative Extension Service or university and state agencies. Educators with more cautious beliefs about health-related risks associated with pesticide exposure were more inclined to express learner-focused beliefs about teaching. During interviews, educators with learner-centered beliefs, who came from health care and advocacy organizations, emphasized the importance of

farmworker engagement and buy-in for pesticide education to result in behavioral changes and critical thinking for the prevention of pesticide illness and injury.

An inverse relationship was found between self-efficacy and teaching beliefs. Educators who reported high levels of self-efficacy on the *STEBI*, who tended to come from state agencies, expressed more teacher-centered beliefs about pesticide education on the *TBI*. Educators with high self-efficacy seem less likely to relinquish control in pesticide lessons to allow farmworkers to shape the direction and focus. These educators sought to transfer their perceived expert knowledge to their students.

In summary, health care workers and advocates expressed student-centered teaching beliefs. These educators tend to have more cautious beliefs about the adverse health outcomes associated with pesticide exposure and lower levels of self-efficacy. In contrast, Cooperative Extension Service/university educators had more experience with pesticides, less cautious pesticide risk beliefs, and teacher-focused teaching beliefs. State agency educators had especially high levels of self-efficacy and had teacher-focused beliefs.

### **Pesticide Educators as Persons-In-Context**

#### **Pesticide Education Organizations and Educator Demographics**

The pesticide educators in this study (n=45) were found to provide pesticide education for farmworkers through five types of organizations: the Cooperative Extension Service and the university, farmworker advocacy groups, health care organizations, the Migrant Education Program and Migrant Head Start, and state agencies. The Migrant Education Program and Migrant Head Start, however, play a relatively small role in providing pesticide education at this time. Findings indicate that health care organizations,

particularly migrant and community health centers, deliver the vast majority of pesticide lessons for farmworkers in the state (see Chapter 5 for summary table).

The educators affiliated with both health care and advocacy institutions were more similar in ethnicity (nearly 75% Latino in health care organizations) and education level (majority in health care organizations completed no more than associate's degree) to the target farmworker audience than educators affiliated with other groups. Though they provide far fewer pesticide lessons to farmworkers, a higher proportion (i.e., four out of five) of Cooperative Extension Service employees had experience working in the field. Few health care workers (i.e., five of twenty-three) had such real-world experience.

In summary of findings from Chapters 4 and 5, the pesticide educators who provide the most pesticide lessons in this southeastern state are more likely to articulate farmworker-centered teaching beliefs, to express low to moderate teaching efficacy beliefs, and to exhibit more cautious pesticide risk beliefs, especially regarding health effects and routes of entry of pesticides. These educators more closely resemble their audience in terms of ethnicity but frequently lack field experiences with pesticides. Interestingly, having field experiences correlated to less cautious attitudes toward pesticide risks, a finding that serves a reminder that not all authentic experiences are necessarily appropriate for achieving desired educational results.

### **Pesticide Educators' Personal Goals**

Regardless of their institutional affiliations, the pesticide educators in this study exhibited personal goal congruence. More than 90% expressed the common goals that through pesticide education they should reduce pesticide exposure and promote the safety

and health of farmworkers, their families, and the agricultural community at large. Educators' personal goal statements described the reduction of pesticide exposure as the means by which to promote safety and health, focusing on increasing farmworkers' knowledge of pesticide risks and their adoption of safe behaviors. Unique institutional goals related to protecting the environment and empowering farmworkers to exercise their rights were neither universally adopted by individual educators within these organizations nor exclusive to individuals within the organizations.

### **Pesticide Educators' Context Beliefs**

Pesticide educators described time, farmworkers' basic needs, specific institutional missions, the physical setting, and training and curricular materials as contextual factors that they believe influence their teaching (Ford, 1992). Educators described their experiences with time in different ways, largely according to the institutions through which they provide pesticide education. With the geographical distribution and large number of farmworkers in the state, nearly one-third of pesticide educators have context beliefs about time that shape the decisions they make in striving for their goal of farmworker safety and health. Health workers described the federal Worker Protection Standard training criteria as limiting their ability to use student-focused approaches to teaching pesticide lessons within the limited amount of time that they have with farmworkers in formal trainings. State agency and Cooperative Extension Service personnel similarly expressed time as dictating their teaching decisions during formal trainings, preventing them from relying on student feedback. An advocate emphasized the importance of time for "relationship development" in farmworker pesticide education.

Farmworkers' basic needs (Maslow, 1943) that pesticide educators enumerated in their context beliefs speak to the highly political nature of pesticide education. Both physiological needs of sleep and food and global safety needs, such as immigration and migrant housing, influence farmworker receptivity to pesticide messages and shape the form and content of pesticide lessons. In providing pesticide education, educators find themselves in politicized and complex environments, requiring them to rely upon their beliefs to guide their teaching practices (Nespor, 1987).

Educators' general dissatisfaction with the current state of farmworker pesticide education may signify receptivity to exploring new approaches to pesticide education and forging new relationships with outside institutions. In the last known study of Worker Protection Standard education implementation in the Southeast, as few as one-sixth of the farmworkers received pesticide education in which they were able to ask questions, and those questions were based on the viewing of one video (Arcury, Quandt, Austin, Preisser, and Cabrera, 1999). With recognition of their common goal (and the constraints that particular institutions face in accomplishing this goal), future inter-institutional collaborations may serve to promote the safety and health of farmworkers and their families, in alignment with the personal goals of the individuals who provide pesticide education. Through the shared goals of safety and health and exposure reduction, a future of greater collaboration among the various institutions that provide pesticide education to farmworkers is possible.

### **Connections between Informal and Formal Science Beliefs & Contexts**

This dissertation revealed the extent to which research from traditional science teaching settings may be applicable to the informal pesticide education context. Luft and

Roehrig's (2007) and Nespor's (1987) conceptualizations of teaching beliefs proved to be useful in this study, revealing the relationships between pesticide educators' beliefs about teaching, pesticides, and themselves. The majority of pesticide educators' teaching beliefs were *transitional* and *instructive*. Pesticide educators, as informal science educators, therefore exhibited similar beliefs to beginning secondary science teachers (Luft, Fletcher, & Fortney, 2005).

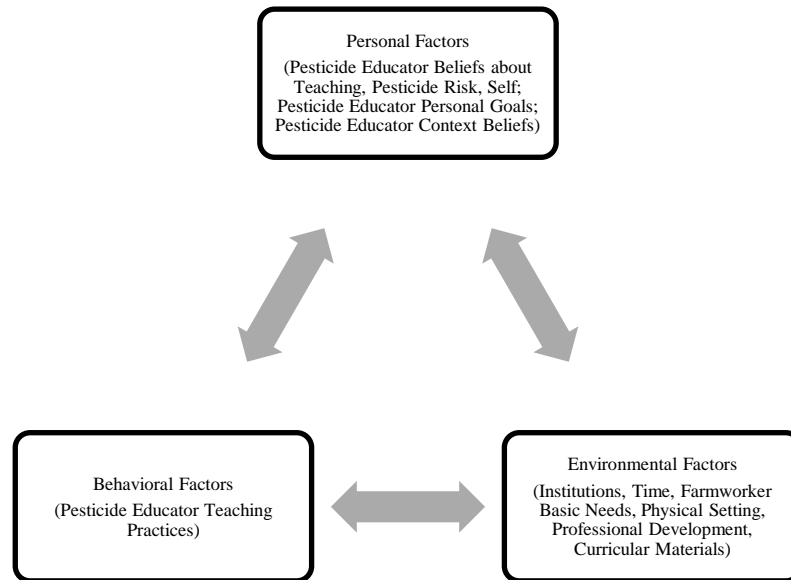
The personal science teaching efficacy subscale of the *STEBI* correlated negatively with student-centered beliefs measured by the *TBI*. As personal science teaching efficacy increased, educators expressed more teacher-centered beliefs about teaching. Despite its contradictions with the literature on positive relationships between self-efficacy and teaching practices (Kagan, 1992), this finding resonates with Settlage, Southerland, Smith, and Ceglie (2009), who found that pre-service teachers' over-confidence misaligned with their abilities and "blinded them to the self-doubt that might advance them professionally" (p. 119). For science educators in formal and informal teaching settings, a moderate amount of self-doubt (Wheatley, 2002) appears to have benefits.

Several of the context beliefs (Ford, 1992) specified by pesticide educators about their informal science teaching environments parallel the factors identified by Lumpe, Haney, and Czerniak, (2000) in their study of classroom teachers' beliefs about the factors that influence science teaching. The factors of professional development and curriculum materials transferred directly from the formal science classroom to the informal pesticide lesson. Both classroom science teachers and pesticide educators included the physical environment in describing their context beliefs, although the physical settings for pesticide

education included both the designed environment, as was described by classroom teachers, and the natural environment (e.g., weather). These findings suggest the universality of certain environmental factors that often create dilemmas for teachers (Abrams, Southerland, & Silva, 2007; Anderson & Helms, 2001). In an ever-shifting teaching context, pesticide educators and traditional teachers reflect on what they are doing in the particular context, making changes in the moment: what Dewey (1910) and Schön (1988) called “reflection-in-action.” A review a body of literature (Keys & Bryan, 2001) shows that classroom curriculum reform efforts are shaped and altered by teachers’ beliefs and understandings of the local context. This study suggests that these factors are similarly at work in the informal setting of pesticide education, and perhaps all informal settings.

### **An Analysis of Theoretical Models and Instruments**

Bandura’s (1986) social cognitive theory proved to be a useful construct for exploring and integrating pesticide educators’ beliefs about themselves, the content matter of pesticide lessons, the practice of educating farmworkers, and teaching contexts for pesticide education. This study allowed for the identification of personal and environmental factors for a pesticide education-specific model of reciprocal determinism (see Figure 6.1). Interestingly, the educators’ beliefs, all personal factors, seem to reciprocally determine one another, mirroring the relationship between personal, environmental, and behavioral factors.



*Figure 6.1.* A pesticide education-specific model of reciprocal determinism, originally described by Bandura (1986).

Study findings also expanded understandings of ‘critical episodes’ in Nespor’s (1987) teacher beliefs framework. Pesticide educators’ critical episodes consisted not only of experiences as teachers and learners, as described by Nespor, but also of experiences working with pesticides in the field. This finding regarding the importance of critical episodes with content may have implications for the examination of how authentic science experiences influence classroom teachers’ beliefs about science.

Luft and Roehrig’s (2007) conceptualization of and instrument for teacher beliefs were relevant to the informal science education context, allowing for the elucidation of connections between teaching beliefs and other personal beliefs. The first author’s experience with farmworker pesticide education and her knowledge of the pesticide educators who participated in interviews facilitated the adaptation of the *TBI* coding scheme

to reflect the content and context of pesticide education. The application of a numerical score to the *TBI* codes enabled the examination of the correlation of teaching beliefs with educators' self-efficacy and pesticide risks beliefs (see Chapter 4 for adapted *TBI* items).

Findings related to pesticide educators' personal goals corroborate Ford's (1992) position that personal goals may be shaped by the individuals and institutions in a person's environment but that goals may not be imposed on individuals. Institutional affiliation did not determine pesticide educators' personal goals in this study. Despite educators' describing their roles differently according to their institutional affiliation (e.g., state agency personnel as 'regulators' before 'educators'), educators expressed similar goals. Findings from this study reveal that few substantive differences exist in pesticide educators' personal goals and that these goals transcend defined institutional goals and prescribed roles.

### **Limitations of this Study**

A limitation of this study is the lack of the Migrant Education Program and Migrant Head Start perspective in the qualitative data. Pesticide educators from the Migrant Education Program and Migrant Head Start who participated in quantitative data collection declined to engage in interviews, citing that they were just beginning to offer pesticide education services. Few questionnaire respondents in this study operated through these organizations, and the educators affiliated with these organizations provided few lessons. Although the Migrant Education Program and Migrant Head Start play a relatively small role in providing pesticide education at present, the involvement of these organizations may increase over time.

Although observations of pesticide educators' delivering pesticide lessons were a proposed part of this study, observational data is not a part of this dissertation. Because of excessive rainfall in the eastern part of the state, the growing season was shortened, and the migrant workers moved to other locations—another state or their home countries—earlier than anticipated. As a result, several trainers who had planned to participate in observations cancelled. Consequently, the dissertation does not provide an examination of the relationship between pesticide educator beliefs and practices. This barrier to data collection, however, provides insight into the assertion made by the pesticide educators in this study that the natural environment serves as a constraint to pesticide education.

This dissertation does not encompass farmworker learning. Therefore, the influence of certain pesticide educator characteristics, for example field experience with pesticides and Latino ethnicity, on farmworker learning is not clear from this study. The low literacy levels and limited formal education among migrant farmworkers make traditional assessments inappropriate for use with this population (Tamassia, Lennon, Yamamoto, & Kirsch, 2007; United States Department of Labor, 2005).

### **Implications for Future Research and Policy**

In order to complete a pesticide education-specific model for reciprocal determinism (Bandura, 1986), future work should explore pesticide educators' behavioral factors, including the extent to which pesticide educators' personal beliefs, personal goals, and context beliefs correlate with their teaching practices. The influence of teacher beliefs and practices on farmworker learning is also critical in future research to determine if and how pesticide education enhances farmworkers' knowledge and abilities to maintain health and

safety for themselves and their families. An investigation of farmworker learning will first require research on appropriate assessment techniques for a population with low literacy levels and limited experience with formal education.

According to one state agency educator, only 10% of farmworkers in this southeastern state receive pesticide education each year. The standard procedure in pesticide education is providing video-based lessons (Larson, 2000; Arcury et al., 1999): “They’re being given a video and that’s all they’re getting and they’re not having the opportunity to maybe fully understand it or to ask the questions. I think maybe they’re getting the gloss but they’re not getting the meat” (Ruth, Cooperative Extension Service/university). With the diffuse geographical distribution and the large number of farmworkers, pesticide educators, who provide an alternative or supplement to this video-based training, are hindered by time—time to reach the farms and migrant camps, time to spend with farmworkers at the end of a long work day, and time to allow farmworkers to guide lessons by their questions and interests. Increasing the number of pesticide educators is necessary to reach a greater percentage of farmworkers each year and to ensure that pesticide lessons meet farmworker needs.

In order for pesticide educators to reach the large and diffuse farmworker population and to explore opportunities for partnerships, the organizations involved in pesticide education could collaborate on the basis of their shared goals of promoting safety and health and reducing pesticide exposure. This study suggests the potential benefits of partnerships between the farmworker-focused health care workers and advocates, who have demographic similarities to the farmworker population and thus cultural capital (Bourdieu, 1986), and the

broader-focused Cooperative Extension Service, who have practical experience with pesticides. Given that their broader audience includes farmers, the Cooperative Extension Service can facilitate opportunities for health care workers and advocates to collaborate with farm owner/operators to provide on-site occupational trainings, which ultimately also benefit farmers on whom the onus of pesticide education is placed. Only through the recognition of shared goals and a commitment to forging new alliances will pesticide educators be able to redefine the status quo and inspire meaningful change in farmworker pesticide education.

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\*References blinded to protect the anonymity of study participants.

## **Appendices**

**Appendix A: Demographic Form**

## **Survey of Pesticide Educators**

Please select the best response(s) to each of the following items. Please answer each question as it relates to your personal experiences and not to your organization. You should be able to complete this survey in approximately 15 minutes. Thank you for taking the time to complete this survey. Your responses will be used to improve train-the-trainer workshops and farmworker pesticide education materials. When you complete this survey, your name will be entered into a drawing for a \$30 Visa gift card.

1. Name (Optional but required for entry into gift card drawing):

\_\_\_\_\_

2. Phone number (Optional but required for entry into gift card drawing):

\_\_\_\_\_

3. Please indicate your age in years. \_\_\_\_\_

4. Please indicate your gender.     Male     Female

5. Please indicate your race/ethnicity.

White/European American

African American

Latino/Hispanic

Native American

Asian

Pacific Islander

Other: \_\_\_\_\_

6. Please indicate your country of origin: \_\_\_\_\_

7. Please indicate whether you currently provide pesticide training to farmworkers.     Yes     No

8. Please indicate the approximate number of farmworker pesticide trainings that you provide in a year.

\_\_\_\_\_

9. Please indicate the number of years that you have been involved in providing pesticide training for farmworkers. \_\_\_\_\_

10. Please indicate which of the following activities you have done. (Check all that apply.)

- Worked in fields sprayed with pesticides
- Mixed or loaded pesticides
- Applied pesticides
- Provided pesticide training to farmworkers
- Provided pesticide training to pesticide safety trainers
- Developed pesticide safety education materials
- Developed policies regarding pesticides
- Enforced regulations regarding pesticides

11. Please indicate your highest level of education completed.

- Some school
- High school
- Some college/Associate's degree
- Bachelor's degree (4 years)
- Graduate/Professional degree (more than 2 years after Bachelor's degree)

12. Please select the type of organization through which you currently provide farmworker pesticide training.

- Farmworker advocacy organization
- Migrant and community health center
- Cooperative Extension Service
- Migrant Education Program
- Migrant Head Start
- State agency (Department of Labor, Department of Agriculture, Department of Health and Human Services)
- Other: \_\_\_\_\_

13. What is your job title? \_\_\_\_\_

14. Please select the languages that you use to deliver farmworker pesticide trainings. (Check all that apply.)

English

Spanish

Other: \_\_\_\_\_

15. What is your ultimate goal in providing pesticide education to farmworkers?

16. If you would be willing to be contacted for follow-up questions, please include your name, phone number, and email address.

**Encuesta para Educadores de Pesticidas**

Seleccione la(s) mejor(es) respuesta(s) para cada una de las siguientes preguntas. Por favor responda a cada pregunta de acuerdo a como aplique a su experiencia personal y no a su organización. Completar la encuesta le tomará aproximadamente 15 minutos. Muchas gracias por su tiempo al contestar esta encuesta. Sus respuestas serán utilizadas para mejorar los talleres de capacitación al educador y los materiales educativos sobre pesticidas para trabajadores del campo. Al terminar esta encuesta, su nombre entrará en un sorteo para ganar una tarjeta de regalo de Visa por \$30.

1. Nombre (Opcional, pero se requiere para participar en el sorteo de la tarjeta de regalo):

\_\_\_\_\_

2. Teléfono (Opcional, pero se requiere para participar en el sorteo de la tarjeta de regalo):

\_\_\_\_\_

3. Indique su edad en años. \_\_\_\_\_

4. Indique su género (sexo). \_\_\_\_ Masculino \_\_\_\_ Femenino

5. Please indicate your race/ethnicity.

\_\_\_\_ Blanco/Americano Europeo

\_\_\_\_ Afro Americano

\_\_\_\_ Latino/Hispano

\_\_\_\_ Nativo Americano (Indio)

\_\_\_\_ Asiático

\_\_\_\_ Nativo de las Islas del Pacifico

\_\_\_\_ Otro: \_\_\_\_\_

6. Indique su país de origen: \_\_\_\_\_

7. Indique si usted actualmente da entrenamiento sobre pesticidas a trabajadores del campo.

\_\_\_\_ Sí \_\_\_\_ No

8. Indique aproximadamente el número de entrenamientos sobre pesticidas que usted proporciona a trabajadores del campo en un año. \_\_\_\_\_

9. Indique el número de años que usted ha estado involucrado en dar entrenamientos sobre pesticidas a trabajadores del campo. \_\_\_\_\_

10. Indique cuál de las siguientes actividades usted ha realizado. (Marque todas las respuestas que apliquen.)

Ha trabajado en campos que fueron rociados con pesticidas

Ha mezclado, cargado o manejado pesticidas

Ha aplicado pesticidas

Ha proporcionado capacitación sobre pesticidas a trabajadores del campo

Ha proporcionado capacitación sobre pesticidas a entrenadores de seguridad en el manejo de pesticidas

Ha desarrollado materiales educativos sobre seguridad en el manejo de pesticidas

Ha desarrollado políticas en relación a pesticidas

Ha impuesto o hecho cumplir normas sobre pesticidas

11. Indique el nivel más alto de educación que usted ha completado.  Algo de escuela

Preparatoria (11-12 años)

Algo de universidad/Certificado de asociado o carrera técnica

Graduado de la universidad (4 años)

Maestría o Doctorado (más de 2 años después del grado universitario)

12. Indique el tipo de organización a través de la cual usted actualmente proporciona capacitación sobre pesticidas a trabajadores del campo.

Organización para la defensa de los trabajadores del campo

Centro de salud comunitario (Community health center)

Servicio de Extensión Cooperativa (Cooperative Extension Service)

Programa de Educación para Migrantes (Migrant Education Program)

Head Start Migrante (Migrant Head Start)

Agencia estatal (Departamento de Trabajo, Departamento de Agricultura, Departamento de Salud y Servicios Humanos)

Otro: \_\_\_\_\_

13. ¿Cuál es su puesto de trabajo actual? \_\_\_\_\_

14. Seleccione los idiomas que usted usa al impartir las capacitaciones sobre pesticidas a los trabajadores del campo. (Marque todas las respuestas que apliquen).

\_\_\_\_ Inglés

\_\_\_\_ Español

\_\_\_\_ Otro: \_\_\_\_\_

15. ¿Cuál es su objetivo final al proporcionar educación sobre pesticidas a trabajadores del campo?

16. Si usted está dispuesto a ser contactado para unas preguntas de seguimiento, por favor indique su nombre completo, teléfono y correo electrónico.

**Appendix B: *Pesticide Risk Beliefs Inventory***

<i>Pesticide Risk Beliefs Inventory</i>	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1. I can determine if a pesticide is dangerous by its smell.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. When I am working with a pesticide, I am worried about having the pesticide enter my body when I breathe.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. I can determine if a pesticide is dangerous by reading its chemical label.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. When I am working with a pesticide, I am not worried about getting cancer in the future.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. I can determine if a pesticide is dangerous by seeing whether it is a powder, liquid, or granule.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. When I am working with a pesticide, I am worried about having a recurrent problem with my skin.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. When I am working with a pesticide, I am not concerned about covering my nose.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. When I am working with a pesticide, I am not worried about having the pesticide enter my body through my skin.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. When I am working with a pesticide, I am worried about having to go to the emergency room.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. I can determine if a pesticide is dangerous by its color.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. When I am working with a pesticide, I am concerned about covering my skin.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

12. I can determine if a pesticide is dangerous by knowing the family of chemicals that the pesticide belongs to.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. I can determine if a pesticide is dangerous by knowing its ingredients.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. When I am working with a pesticide, I am not worried about having the pesticide enter my body through my eyes.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15. I worry that working with pesticides will reduce my chance to have children.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16. I am worried about having a pesticide enter my body when I eat or drink after working with pesticides.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17. When I am working with a pesticide, I am not worried about having difficulty breathing.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18. When I am working with a pesticide, I am not worried about being poisoned.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19. I can determine if a pesticide is dangerous by its taste.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<i>Inventario de Creencias Sobre los Riesgos con Pesticidas</i>	Completa-mente en desacuerdo	No estoy de acuerdo	Un tanto en desacuerdo	Un tanto en acuerdo	De acuerdo	Completa-mente de acuerdo
1. Puedo determinar si un pesticida es peligroso por su olor.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Cuando estoy trabajando con un pesticida, me preocupa que el pesticida entre a mi cuerpo cuando respiro.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Puedo determinar si un pesticida es peligroso leyendo su etiqueta sobre los químicos que contiene.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Cuando trabajo con un pesticida, no me preocupa sufrir de cáncer en el futuro.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Puedo determinar si un pesticida es peligroso observando si es en polvo, líquido, o granulado.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. Cuando trabajo con un pesticida, me preocupa tener constantes problemas en la piel.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Cuando trabajo con un pesticida, no me preocupo por taparme o cubrirme la nariz.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. Cuando trabajo con un pesticida, no me preocupa que el pesticida entre a mi cuerpo a través de mi piel.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. Cuando trabajo con un pesticida, me preocupa tener que ir a la sala de emergencias de un hospital.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. Puedo determinar si un pesticida es peligroso por su color.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. Cuando trabajo con un pesticida, me preocupo por cubrirme la piel.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. Puedo determinar si un pesticida es peligroso si sé cual es la familia o el grupo de químicos a que pertenece el pesticida.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

13. Puedo determinar si un pesticida es peligroso si sé cuales son sus ingredientes.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. Cuando trabajo con un pesticida, no me preocupa que el pesticida entre a mi cuerpo por mis ojos.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15. Me preocupa que trabajar con pesticidas reduzca mis probabilidades de tener hijos.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16. Me preocupa que un pesticida pueda entrar a mi cuerpo cuando como o bebo algo después de haber trabajado con pesticidas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17. Cuando trabajo con un pesticida, no me preocupa tener dificultades para respirar.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18. Cuando trabajo con un pesticida, no me preocupa envenenarme o intoxicarme.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19. Puedo determinar si un pesticida es peligroso por su sabor.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**Appendix C: Modified *Science Teaching Efficacy Beliefs Instrument***

<i>Modified Science Teaching Efficacy Beliefs Instrument</i>	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1. When a farmworker learns more during a pesticide lesson, it is often because the teacher put forth a little extra effort.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. I am continually finding better ways to teach about pesticides.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Even when I try really hard, I do not teach pesticides as well as I do most topics.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. When farmworkers learn more about pesticides, it is often due to their teacher's having found a more effective approach.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. I know the steps necessary to teach pesticide concepts effectively.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. I am not very effective in overseeing hands-on activities during pesticide lessons.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. If farmworkers are not understanding pesticide concepts, it is most likely due to ineffective teaching.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. I generally teach pesticides ineffectively.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. A farmworker's lack of pesticide knowledge can be overcome by good teaching.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. The low pesticide understanding of some farmworkers cannot generally be blamed on teachers.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11. When a farmworker who understands little about pesticides progresses, it is usually due to extra attention given by the teacher.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. I understand pesticide concepts well enough to be effective in teaching farmworkers.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. Increased effort in pesticide teaching produces little change in some farmworkers' understanding of pesticides.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. The teacher is generally responsible for the learning of farmworkers.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15. Farmworkers' learning of pesticides is directly related to their teacher's effectiveness in teaching pesticides.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16. I find it difficult to explain pesticide concepts to farmworkers.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17. I am typically able to answer farmworkers' questions about pesticides.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18. I wonder if I have the necessary skills to teach about pesticides.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19. Effectiveness in teaching pesticides has little influence on the learning of farmworkers who have little interest in learning.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20. Given a choice, I would not invite a researcher to evaluate my pesticide teaching.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

21. When a farmworker has difficulty understanding a pesticide concept, I am usually unsure how to help the farmworker understand better.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
22. When teaching about pesticides, I usually welcome questions from farmworkers.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
23. I do not know what to do to motivate farmworkers to learn about pesticides.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
24. Even teachers with strong abilities to teach about pesticides cannot help some farmworkers to learn about pesticides.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<i>Instrumento de Eficacia en la Enseñanza de las Ciencias (STEBI) Modificado</i>	Completa-mente en desacuerdo	No estoy de acuerdo	Inseguro	De acuerdo	Completa-mente de acuerdo
1. Cuando un trabajador del campo aprende más durante una clase sobre pesticidas, por lo general es porque el maestro se esforzó un poco más.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2. Estoy continuamente buscando mejores maneras de enseñar sobre los pesticidas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3. Aún cuando hago mi mejor esfuerzo, no enseño sobre pesticidas tan bien como lo hago sobre otros temas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4. Cuando los trabajadores del campo aprenden más sobre pesticidas, por lo general es porque sus maestros han encontrado una manera más efectiva para enseñar.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5. Conozco los pasos necesarios para enseñar los conceptos sobre pesticidas eficazmente.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6. No soy muy eficiente supervisando actividades prácticas durante las clases sobre pesticidas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7. Si los trabajadores del campo no están entendiendo los conceptos sobre pesticidas, lo más probable es que sea debido a que se está utilizando un modo de enseñar ineficaz o incompetente.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
8. Por lo general yo enseño sobre pesticidas de manera ineficaz.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
9. La falta de conocimiento sobre pesticidas de un trabajador del campo puede ser superada por medio de una buena enseñanza.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10. El poco entendimiento sobre pesticidas en algunos trabajadores del campo no puede ser generalmente responsabilidad de los maestros.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11. Cuando un trabajador del campo que entiende muy poco sobre pesticidas progresa, es por lo general debido a la atención adicional proporcionada por su maestro.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12. Entiendo los conceptos sobre pesticidas lo suficientemente bien para ser eficaz en mi enseñanza a los trabajadores del campo.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. Poner más esfuerzo en la enseñanza sobre pesticidas produce un cambio mínimo en el entendimiento que tienen algunos trabajadores del campo sobre los pesticidas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. El maestro es generalmente la persona responsable del aprendizaje de los trabajadores del campo.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
15. Lo que los trabajadores del campo aprenden sobre los pesticidas está directamente relacionado con la efectividad del maestro en enseñar sobre pesticidas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
16. Encuentro difícil explicarle a los trabajadores del campo los conceptos sobre los pesticidas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
17. Por lo general, soy capaz de responder a las preguntas que me hacen los trabajadores del campo sobre los pesticidas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
18. Me pregunto si cuento con las habilidades necesarias para enseñar sobre pesticidas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
19. La efectividad en la enseñanza sobre pesticidas influye muy poco el aprendizaje de los trabajadores del campo que tienen poco interés en aprender.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
20. Si pudiera elegir, no invitaría a un investigador a evaluar mi modo de enseñar sobre los pesticidas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

21. Cuando un trabajador del campo tiene problemas entendiendo un concepto sobre pesticidas, por lo general no sé cómo ayudarlo(a) a entender mejor el concepto.	○	○	○	○	○
22. Cuando enseño sobre pesticidas, las preguntas de los trabajadores del campo son bien recibidas.	○	○	○	○	○
23. No sé qué hacer para motivar a los trabajadores del campo a aprender sobre los pesticidas.	○	○	○	○	○
24. Aun maestros con grandes habilidades para enseñar sobre pesticidas no pueden ayudar a algunos trabajadores del campo a aprender sobre pesticidas.	○	○	○	○	○