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Beliefs of science educators who teach pesticide risk to farmworkers

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Informal science educators play a key role in promoting science literacy, safety, and health by teaching pesticide toxicology to the large, at-risk Latino farmworker population in the United States (US). To understand the experiences of informal science educators and the nature of farmworker education, we must have knowledge of farmworker educators' beliefs, yet little is known about these beliefs and how beliefs about teaching, pesticide risk, and self-efficacy might influence teaching environments and practices and potentially inform the field of informal science education. In this exploratory, descriptive case study, we used questionnaires and interviews to investigate the teaching, pesticide risk, and self-efficacy beliefs of 19 farmworker educators in one southeastern US state, identifying salient personal, behavioral, and environmental factors that influence beliefs using Bandura's (1986) model of reciprocal determinism. We found that two distinct groups of farmworker educators emerged based on work affiliation. Health care and advocacy educators typically had more learner-focused beliefs, greater concern about pesticide risks, and lower self-efficacy. In contrast, state agency and Cooperative Extension/university educators expressed more teacher-focused beliefs, less cautious pesticide risk beliefs, and higher self-efficacy. Three factors emerged as important influences on these informal educators' beliefs: quantity of lessons provided, shared language with learners, and experience with handling pesticides. Study implications include recommendations for future work in informal science education research to explore the role of educators' authentic experiences with science, the significance of educators' institutional affiliations, and the prevalence of low self-efficacy among educators.

Keywords: informal science education, pesticides, self-efficacy, social cognitive theory, teacher beliefs

Introduction

> 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 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 - 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 overcome just the pressure of they knew they were on the clock, and the boss would even [say], "Hey, pay attention."
>
> Sharron, health care educator

In the above vignette, Sharron, a health care educator, provides a snapshot of what it is like teaching migrant and seasonal farmworkers about pesticide toxicology. Her story prompts questions about whether her experiences as an educator are similar to the experiences of others who provide farmworker pesticide education and the ways in which an examination of these educators might inform the field of informal science education.

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, environmental, and home exposure to pesticides. Although the transient nature of the farmworker population and the lack of a national monitoring system make determining the number of farmworkers in the nation difficult, one farmworker enumeration study estimated that there are more than 3 million migrant and seasonal farmworkers in the United States (US) (Larson & Plascencia, 1993). With immigrants comprising an estimated 77% of all farmworkers and with seventh grade being the highest education level completed by most farmworkers (United States Department of Labor (US DOL), 2005), pesticide education for farmworkers is an important area for informal education efforts. Because 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

Pesticide usage in the US is substantial. Although the total acreage of cropland has decreased, the number of acres treated with insecticides, herbicides, nematicides, fungicides, and growth regulators 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 during normal crop maintenance and harvesting activities and less commonly during pesticide application through drift from adjacent fields or unintentional treatment of fields where farmworkers are working (Mobed, Gold, & Schenker, 1992). Beyond occupational exposure among farmworkers, pesticide usage may negatively affect individuals whose properties are adjacent to cropland and the general public through environmental impacts, such as waterway contamination (Pait, De Souza, & Farrow, 1992).

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 (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. Literacy skills in both Spanish and English have been found to be limited among Latino adult learners in the US, 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 (US DOL, 2005).

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. 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.

Teacher Beliefs

Nearly two decades of science education research on teachers' beliefs has found that "teachers are creative, intelligent decision makers who hold complex systems of beliefs that influence how they view students, themselves, and science" (Bryan, 2012). Research provides evidence of a robust link between teachers' thinking, their knowledge and beliefs, and their inclination and/or ability to teach (Cohen & Ball, 1990; Cooney & Shealy, 1997; Gess-Newsome, 1999; Gregoire, 2003; Shulman, 1987; Smylie, 1988; Woodbury & Gess-Newsome, 2002). Teacher thinking is defined as teachers' knowledge and beliefs concerning teaching, teachers, learning, learners, schools, schooling, and subject matter. Teachers' knowledge, beliefs, and practices are shaped by professional and life experiences, the nature and extent of teacher preparation, and continued professional learning (Ball, 2000; Crawford, 2007; Fullan, 1991; Fullan & Hargreaves, 1996; Smith, 2005). Therefore, a study of farmworker education necessitates an understanding of the beliefs of teachers of farmworkers.

Teacher Efficacy Beliefs

"Efficacy beliefs are one of the most powerful variables predicting both teachers' behaviors in science classrooms and student achievement in science" (Cakiroglu, Capa-Aydin, & Wolfolk Hoy, 2012, p. 449). High self-efficacy among teachers has been associated with a number of teacher practices corresponding to positive impacts on students; these practices include greater persistence, more preparation, less criticism of students, and more risk taking (Gibson & Dembo, 1984; Kagan, 1992; 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 abilities 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. Educators in supportive environments were more likely to judge their teaching abilities positively.

More recently, however, concern has been raised over highly efficacious teachers. Settlage, Southerland, Smith, and Ceglie (2009) caution that, for those new to teaching, high self-efficacy can inhibit professional growth. They join Wheatley (2002) and the Southerland, Sowell, Blanchard, and Granger (2011) in arguing that self-doubt can facilitate teacher learning and improvement. The findings of Ross (1998), Kagan (1992), and Settlage et al. (2009) support the powerful influence of teachers' beliefs and thus the importance of the efficacy beliefs of farmworker educators.

Beliefs about Pesticide Risk

Studies of agricultural audiences suggest that the agricultural community does not necessarily perceive that pesticides pose a risk to maintaining health (Arcury, Quandt, & Russell, 2002; Wadud, Kreuter, & Clarkson, 1998). Further, research on farmworkers reveals their having many pesticide risk beliefs that undermine safety measures and increase health risks (Elmore & Arcury, 2001; Quandt, Arcury, Austin, & Saavedra, 1998). Preliminary work with pesticide educators indicates that these individuals espouse more cautious beliefs about pesticide risk than farmworkers (LePrevost, Blanchard, & Cope, 2011).

As noted by Gardner and Jones (2011), research on the role of risk in the science classroom, including science educators' perceptions of risk, has been quite limited (e.g., Covitt, Gomez-Schmidt, & Zint, 2005). Despite the paucity of research on risk as it pertains to science education, Gardner and Jones (2011) assert the importance of understanding educators' conceptualizations of risk, particularly within the context of science-technology-society curricula, as the lens through which science students will perceive risks and make future decisions. Given the potential influence of teachers' beliefs on farmworkers' perceptions of risk and future decision-making, it is particularly salient to understand informal educators' beliefs about pesticide risk.

Pesticide Education and Educators

No known studies explore the informal science educators who provide farmworker pesticide education. Arcury and Quandt (2007) studied the general delivery mechanisms of health services to farmworkers but did not examine education specifically. Generally, engaging occupational safety and health training has been found to enhance learning and reduce accidents and illness (Burke et al., 2006). Farmworker educators from multiple farmworker services organizations (e.g., migrant and community health centers, Cooperative Extension) are known to provide farmworker pesticide education as part of their delivery of health and education services, thus serving as informal science educators and pesticide risk communicators.

Theoretical Frameworks

We approached this exploratory study from the perspective that knowledge of teacher beliefs is essential to our understanding the experiences of informal science educators and the nature of farmworker education. This perspective is informed by Nespor (1987): "[T]o understand teaching from teachers' perspectives we have to understand the beliefs with which they define their work" (p. 323). Social cognitive theory contextualizes teacher beliefs, identifying factors that influence and, conversely, are influenced by these beliefs (Bandura, 1986). We use Bandura's (1986) model of reciprocal determinism to identify salient personal, behavioral, and environmental factors that shape teacher beliefs in farmworker education.

According to Bandura's (1986) social cognitive theory, personal, behavioral, and environmental factors interact reciprocally to determine one another and explain human functioning (see Figure 1). Among personal factors are cognition, attitudes, and beliefs. Bandura's model indicates that these teacher beliefs will determine behavior (e.g., informal science educators' teaching practices) and that behavior will likewise influence teacher beliefs. Bandura (1986) asserts that individuals' "behavior is better predicted from their beliefs than from the actual consequences of their actions" (p. 129). Further, environmental factors (e.g., the role of farmworkers as learners, the teaching context in the field or migrant camp) shape and are shaped by the teacher beliefs of informal science educators.

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 & 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'). Influencing teachers' self-efficacy are their assessments of past performance of a specific task or related tasks (Bandura, 1986; Ross & Bruce, 2007).

Given the importance established in the literature review, this study focuses on pesticide educator beliefs about teaching, pesticide risk, and ability to teach. Therefore, we expect this exploratory study to serve as a first step in describing informal science educators and the teaching of pesticide toxicology to farmworkers. This study heeds the call for "science educators to consider the sociocultural dimensions of teacher beliefs, particularly as they come to bear on equitable science instruction, or 'science for all,'" especially related to teaching those from culturally diverse backgrounds (Bryan, 2012, p. 490).

Research Questions

Farmworker educators hold the potential for enhancing knowledge of pesticide education for farmworkers, which emphasizes personal and environmental health, and improving our understanding of the role of informal science educators in occupational settings (Dierking et al., 2003), yet they remain largely absent from the literature. This descriptive, exploratory case study examined informal science educators of farmworkers in a southeastern state in the US to examine trends in beliefs about teaching, pesticide risk, and self-efficacy using Bandura's (1986) model of reciprocal determinism. Therefore, we asked:

1. What are farmworker educators' beliefs about teaching, pesticide risk, and self-efficacy?
2. What are the salient factors for farmworker educators using Bandura's model of reciprocal determinism?

Methods

This research study engaged 19 farmworker educators in a southeastern US state with a large farmworker population and an established and diverse farming industry.

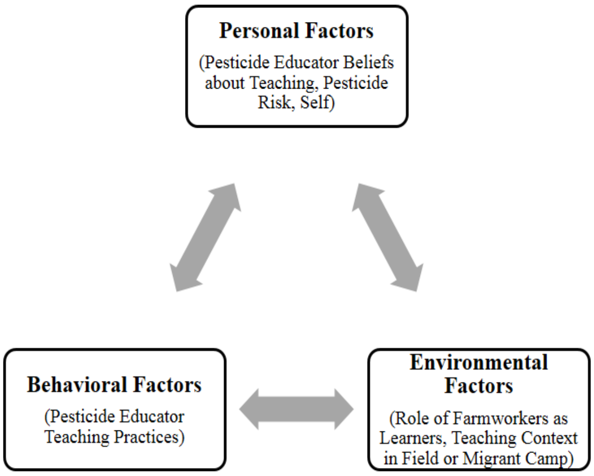

Figure 1. Reciprocal determinism, as described by Bandura (1986), applied to pesticide education

Participants

All identified farmworker educators in the state (n = 100) were asked to participate in this study based on their current or previous involvement in the instruction of farmworkers on pesticide risks. Their roles included providing pesticide lessons directly, administering farmworker pesticide programming, and enforcing federal mandates for pesticide education for farmworkers. Participants were solicited through farmworker services listservs, curriculum workshops, and e-mail. Nineteen of the farmworker educators identified in the state (19% of the total educator population) agreed to participate in this study. Table 1 provides a description of the participants.

Data Sources and Analyses

Questionnaire: Farmworker educators' demographic information and experiences

Participating farmworker educators answered demographic questions related to their personal characteristics (gender, country of origin, ethnicity, and proficiency in Spanish), education levels, and organization affiliations. Additionally, questions related to experiences with handling pesticides and with farmworker pesticide education were asked. Demographic and experience questions comprised 16 items of a 59-item questionnaire. The first author used her extensive knowledge of farmworker pesticide education to identify the categories in Table 1, and no additional variables outside of these emerged during data collection and analysis.

Table 1. Description of Study Participants

Pseudonym	**Gender**	**Affiliation**	**Country of Origin**	**Ethnicity***	**Highest Level Education**	**Avg. No. Lessons Yearly**	**Handled/ Applied Pesticides**	***PRiBI* Score**
Alicia	Female	A	USA	Multiple*	Bachelor's	13	No	110
Lata	Female	A	USA	Multiple	Bachelor's	<1	No	93
Marissa	Female	A	Puerto Rico	Latino*	Graduate	3	No	104
Chris	Male	CE/U	USA	EA*	Graduate	10	Yes	91
Dana	Female	CE/U	USA	EA	Graduate	1	Yes	90
Janet	Female	CE/U	USA	EA	Graduate	<1	Yes	80
Joe	Male	CE/U	USA	EA*	Graduate	3	Yes	72
Ruth	Female	CE/U	USA	EA	Graduate	1	No	85
Ashley	Female	HC	USA	EA*	Bachelor's	15	No	97
Adriana	Female	HC	Mexico	Latino*	Some College	500	No	95
Fabiola	Female	HC	Peru	Latino*	Bachelor's	3	No	82
Isabel	Female	HC	Mexico	Latino*	High School	180	No	89
Scott	Male	HC	USA	EA*	Bachelor's	450	Yes	95
Sharron	Female	HC	USA	EA*	Bachelor's	300	No	104
Adam	Male	SA	USA	EA*	Bachelor's	2	Yes	76
Bridget	Female	SA	USA	EA*	Bachelor's	2	No	89
Lisa	Female	SA	USA	EA*	Bachelor's	2	No	94
Renee	Female	SA	USA	EA*	Graduate	4	Yes	86
Salvador	Male	SA	Mexico	Latino*	Graduate	<1	No	78

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

Questionnaire: Pesticide Risk Beliefs Inventory

The *Pesticide Risk Beliefs Inventory* (*PRiBI*; LePrevost et al., 2011) was administered to the farmworker educators as part of the aforementioned questionnaire to assess the extent to which individuals' beliefs regarding pesticide risks reflected lay and expert conceptualizations of pesticide hazards. The *PRiBI* was designed to capture individuals' mental models for risk associated with pesticides (Morgan, Fischhoff, Bostrom, & Atman, 2002). Morgan et al. (2002) described the role of mental models in making inferences about risk: "…for most risks, people have at least some relevant beliefs…. They will assemble their fragmentary beliefs into a 'mental model,' which they will then use to reach their conclusions" (p. 21). The term 'belief' reflects the terminology employed in a mental models approach and therefore is used in the *PRiBI* (LePrevost et al., 2011) and throughout this manuscript.

The *PRiBI* contains 19 Likert-type items with six-point scales. 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., cancer or difficulty breathing).

For the purpose of scoring and analyzing the *PRiBI* data, the response "strongly disagree" corresponds to a score of 1 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 belief regarding pesticide risk.

Questionnaire: Modified *STEBI*

The *Science Teaching Efficacy Beliefs Instrument* (*STEBI*; Riggs & Enochs, 1990) has been used with elementary teachers, as well as 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 mathematics teachers (Wenner, 2001). This instrument has also been utilized to assess the efficacy of teachers in informal settings (Carrier, 2009). To assess the farmworker 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 farmworker educators. One item related to parents was deemed irrelevant and omitted. As for the original *STEBI*, a response of "strongly disagree" corresponds to a score of 1 and "strongly agree" corresponds to 5. For reverse-coded items, "strongly disagree" corresponds to a numerical score of 5 and so forth. Individuals' PSTE and STOE scores, as well as their composite scores, were calculated by summing responses.

Interviews

The first author interviewed each of the 19 participants. Each interview lasted 30 to 90 minutes and took place face-to-face when possible and via phone when travel distances were prohibitive. An audio recording was made of each interview, and interviews were transcribed verbatim by a third party, yielding 275 single-spaced pages of interview transcriptions. The first author had both professional and personal knowledge of the participants from her work as a toxicologist working 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 farmworker educators in order to understand their beliefs about teaching pesticide concepts to farmworkers. Although this protocol has also been used with in-service (e.g., Luft et al., 2011) and college science teachers (e.g., Addy & Blanchard, 2010), this study is the first employing the *TBI* to assess the teaching beliefs of informal science educators. 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). 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. See Table 2 for descriptions of the five belief categories provided by Luft and Roehrig (2007) and exemplary quotations from the study group for each of the five categories.

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).

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 correspondences, in-person interactions, and observed pesticide lessons. These field notes were not coded per se, but we utilized them to enhance our understanding of the beliefs of the educators in this study.

Results and Discussion

This descriptive, exploratory case study investigated the beliefs of farmworker educators related to teaching, pesticide risks, and self-efficacy. The associated results are divided into subsections corresponding to the two research questions driving this study. Key findings, excerpts from interviews, and a discussion comprise each subsection.

1. *What are farmworker educators' beliefs about teaching, pesticide risk, and self-efficacy?*

Table 2. Exemplary Quotations for Coding TBI Responses

Category	Description from Luft and Roehrig (2007, p. 54)	Example Quotation from Participant
Traditional	"Focus on information, transmission, structure, or sources"	"The pesticide educator role… is a person who has the knowledge…to deal with pesticides in a safetely [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)
Instructive	"Focus on providing experiences, teacher-focus, or teacher decision"	"Based on practical experience… that's…how I decide [what to teach], based on what I think is pertinent in the field, 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/University, European American)
Transitional	"Focus on teacher/student relationships, subjective decisions, or affective response"	"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, Heath Care, European American)
Responsive	"Focus on collaboration, feedback, or knowledge development"	"… as a "teacher" [in quotes] you need 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, Latina)
Reform-based	"Focus on mediating student knowledge or interactions"	"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, Latina)

Farmworker Educators' Teaching Beliefs

The *TBI* (*Teacher Belief Interview*) revealed a range in educators' beliefs from primarily teacher-focused (traditional or instructive; n=7, 37%) to transitional (n=9, 47%) to learner-focused (responsive or reform-based; n=3, 16%). The most common types of responses coded across all *TBI* questions were *transitional* (42%) and *instructive* (28%). 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).

The responses to questions about deciding what to teach and what not to teach (Q4), deciding when to move on to a new concept (Q5), and knowing when learning is occurring (Q7) were most often coded as *instructive* (47%). Responses indicated that the typical science educator presented information in a prescriptive way; that is, she used her knowledge of what was important in deciding what to teach, moved on after she perceived that 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. (See Table 3 for a summary for teachers' responses.)

The remaining questions (Q1, Q2, Q3, Q6) were most often coded as *transitional* (54%). These questions relate to how farmworker educators describe their roles (Q1), how they maximize learning (Q2), how they know farmworkers understand (Q3), and how farmworkers learn concepts best (Q6). *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 selecting appropriate clothes to wear in the field.

Table 3. Educators' TBI Categories and Representative Quotations

TBI Category	Pseudonym	Affiliation	Representative Quotation
Traditional	Adam	SA	"[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."
Instructive	Salvador	SA	"[F]irst of all, you have to learn to communicate with them using their own language, their jargon; 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."
Instructive	Lisa	SA	"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."
Instructive	Adriana	HC	"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."
Transitional	Isabel	HC	"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."
Transitional	Ruth	CE/U	"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 part of the group."
Transitional	Lata	A	"Like I said with the more creative 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."
Transitional	Sharron	HC	"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."
Responsive	Marissa	A	"I think the first step is to find out where people are, what people know, and their interest… People have to be ready… When people can take what you've said and apply it or 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.”
Reform-based	Alicia	A	“I’m a pesticide agitator… [W]e usually end up talking about empowerment with of 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…”
Reform-based	Fabiola	HC	“[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. …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. SA = state agency; CE/U = Cooperative Extension/university; HC = health care; A = advocacy.

Interestingly, patterns of differences in *TBI* categories emerged according to work affiliation. Educators who had more teacher-centered approaches were affiliated with state agencies and universities; educators who worked as advocates and health care workers had more learner-centered approaches. State agency and university educators were most likely to be teacher-focused (n=6, 60%) and least likely to be learner-focused (n=0, 0%). In contrast, representatives from health care and advocacy groups were most likely to be transitional (n=5, 56%).

Additionally, we observed large differences between these groups in the number of pesticide lessons that they conducted. State agency and Cooperative Extension/university educators delivered few lessons each year (mean of approximately 3 per year) as compared to advocates (mean of 5 trainings per year) and health care workers (mean of approximately 241 per year).

Farmworker Educators’ Beliefs about Pesticide Risk

Generally, farmworker educators’ responses on the *PRiBI* (*Pesticide Risk Beliefs Inventory*) corresponded to expert beliefs about pesticide risk (see Table 1), with facet means ranging from 4.07 to 5.53 (a score of 4 or higher on the *PRiBI* relates to agreement with an expert belief). Seven educators (6 of whom were from state agencies or Cooperative Extension/universities) had experience mixing, loading, or applying pesticides. Surprisingly, these educators had lower overall scores (mean of 84.3) (indicating less cautious/expert beliefs) on the *PRiBI* than those educators who had not had experiences working with pesticides in this capacity (mean of 93.3), primarily due to lower scores on the routes of entry and adverse health outcomes sub-scales. Although all of the farmworker educators had expert beliefs about pesticide risk, farmworker educators who had not worked directly with agricultural chemicals appeared to be more cautious in assessing risk, more closely matching expert beliefs.

Each educator was interviewed by the first author, who did not have knowledge of participants’ scores on the *PRiBI*, regarding pesticide risk beliefs. After the interview, the first author compared the interview responses to the educators’ responses on the *PRiBI* items. Interview responses corroborated educators’ generally expert understanding of pesticide risk. The combination of inventory and interview responses more fully characterized educators' beliefs as expert.

Farmworker Educators' Beliefs about 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. The highest *STEBI* score among participants was slightly lower than the average score of experienced secondary science teachers (Blanchard, Osborne, & Albert, 2011). Educators who provided increased numbers of trainings each year tended to have lower combined *STEBI* scores; that is, they were less certain they could effectively teach about pesticide risk and/or believed that what they taught would less likely result in farmworkers' learning about pesticides. For example, health care worker Scott who averaged 450 lessons each year had a *STEBI* score of 45, health care worker Isabel who conducted 180 lessons each year had a *STEBI* score of 53, and state agency educator Lisa who provided 2 lessons per year had the second highest *STEBI* score of 66. The highest *STEBI* scores were found for educators from state agencies who were European American, who were not proficient in Spanish, who provided few lessons each year, and who were teacher-centered in their teaching beliefs.

The finding that educators with the highest *STEBI* scores described teacher-centered beliefs might be interpreted to suggest that educators who perceive themselves to be highly efficacious believe that they are able to "transfer to them [farmworkers] a skill that can be applicable to their daily lives" (Salvador, state agency educator). Despite the literature on positive relationships between self-efficacy and teaching practices for formal educators (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 were most traditional and less likely to relinquish control in pesticide lessons to allow farmworkers to shape the direction and focus. Additionally, educators with the highest self-efficacy taught the fewest number of lessons and thus were arguably the least experienced of the teachers. Similar to the highly confident pre-service teachers described by Settlage et al. (2009), those farmworker educators with the least amount of experience were most likely to believe that their lessons would be successful and promote learning among the farmworkers.

Conversely, the informal educators in this study who conducted the largest number of lessons had the lowest self-efficacy. Our data suggests that it was the sustained experiences of these informal educators in the challenging field and migrant camp contexts in which the lessons were delivered that led to these educators' doubting how successful the lessons would be in terms of farmworker learning and in farmworkers' acting on what they had learned.

2. *What are the salient factors for farmworker educators in Bandura's model of reciprocal determinism?*

The personal factors in Bandura's model that we investigated included teaching beliefs, beliefs about pesticide risk, and self-efficacy (see Figure 1). As previously described, we found that two distinct categories of farmworker educators emerged in each of these belief areas (see Figure 2). Educators who were employed by health care and advocacy organizations had learner-focused beliefs about teaching, more cautious beliefs about adverse health-related risks associated with pesticide exposure, and lower self-efficacy (Group A). These educators averaged high numbers of pesticide lessons each year. They were overwhelmingly female (n=8, 89%) and proficient in Spanish (n=8, 89%), and all had educational attainment no higher than a Bachelor's degree. In contrast, the second group of farmworker educators from state agencies and Cooperative Extension/universities had teacher-centered beliefs, less cautious pesticide risk beliefs, and higher self-efficacy (Group B). They provided a limited number of pesticide lessons each year. The educators were predominantly European American (n=9, 90%) and recipients of a graduate degree (n=7, 70%).

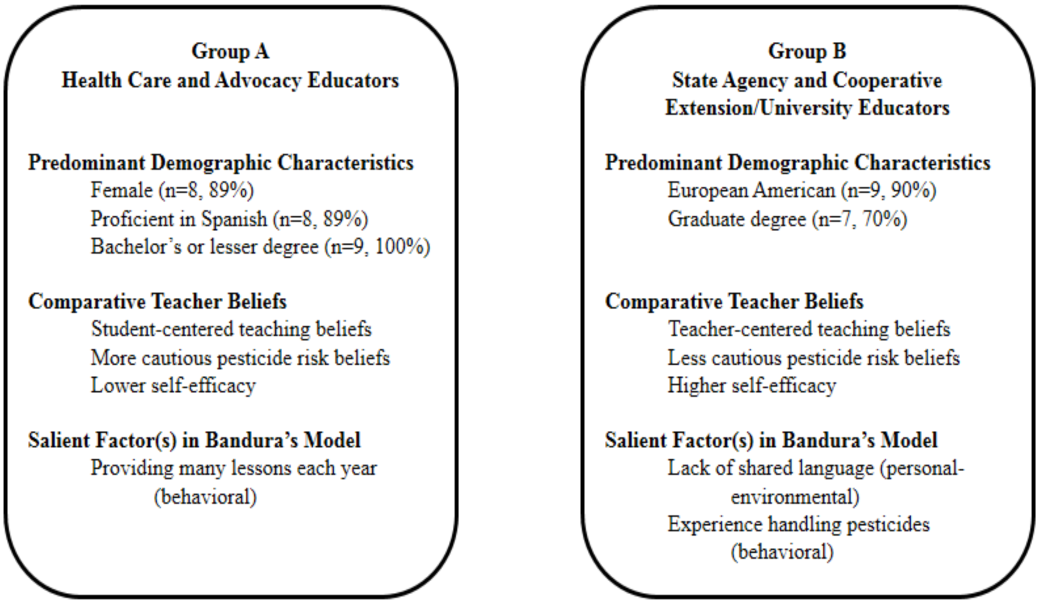

Figure 2. Comparison of predominant characteristics, teacher beliefs, and salient factors within Bandura's model of reciprocal determinism for two emerging categories of farmworker educators

The female health care educator Sharron, whose vignette opened this manuscript, exemplifies an educator in the first category (Group A). She is a European American with a Bachelor's degree who is proficient in (and comfortable with using) Spanish and who serves as an intern with a farmworker health program. On average, she provides 300 pesticide lessons to farmworkers each year. With a *PRiBI* score of 104 (maximum possible score of 114), Sharron has cautious, expert beliefs about pesticide risk.

Her responses to the *TBI* suggest a transitional or interactive approach to teaching. During an interview, Sharron stated, "My job as a teacher was to be there to find out what the questions were, what the gaps were in understanding, and then find the answer for them." Expanding on an excerpt found in Table 3, she described more typical teaching experiences than the one depicted in the vignette:

> 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 I had my laptop and my programs-will-travel kind of thing [ready-made presentations on various topics]. And I would try to set up appointments with the guys, ask them what they want to know beforehand, and then I would try to show up with that and leave them with additional resources for more information.

Although she tried to incorporate pesticide topics into every lesson, Sharron allowed farmworkers to determine the subject of the lessons, barring the kind of extenuating circumstances described in the vignette. She described how educating farmworkers was "frustrating" because farmworkers tended to be "tired [during lessons], especially after coming from the fields." Farmworker tiredness repeatedly surfaced in her interview, perhaps explaining/in combination with the vignette—her low *STEBI* score of 52. Providing many pesticide lessons seemed to breed frustration and self-doubt for this educator, with the realization that frequently farmworkers were too tired to benefit from the lessons she provided.

In contrast, consider Dana, a female Cooperative Extension educator, who represents the second group (Group B). This European American woman has a graduate degree and holds a field faculty position in a county Cooperative Extension office. She provides on average one pesticide lesson for farmworkers in a year. Dana is a state-licensed pesticide applicator with experience mixing, loading, and applying pesticides. Her *PRiBI* score of 90 indicates expert beliefs about pesticide risk, though this score is lower than found for Sharron and other health care and advocacy educators.

Analysis of this Cooperative Extension educator's *TBI* responses reveals teacher-centered beliefs. For example, when Dana was asked how she knew that learning was occurring among farmworkers, she responded,

> When you're asking questions throughout the training, you're delivering the information, and they're responding. When you have their attention completely. They're not staring off into space or fiddling with something. When you have their undivided attention, you know they're learning.

This reply indicates this educator's use of her observations of learners' actions to assess learning and the importance she places on attentiveness, both indicative of a teacher focus. Her composite *STEBI* score of 61 suggests higher self-efficacy than expressed by Sharron.

During her interview, however, Dana revealed that she finds difficulty engaging farmworkers in discussion during lessons/even when she has access to an interpreter—because she is monolingual. She described her uneasiness with using an interpreter to provide lessons: "I've done it [pesticide lessons] before with a translator [interpreter]. I've taught many classes with a translator, but me not understanding what the translator is saying, I'm not certain that they are delivering it correctly." Like others in the second group, Dana has teacher-focused teaching beliefs, less cautious pesticide risk beliefs, and higher self-efficacy.

Using Bandura's model of reciprocal determinism (Figure 1) to examine group differences for the two emerging categories of farmworker educators, we found several unique, salient factors that seemed to influence the teacher beliefs of the educators participating in this study. Beyond work affiliation, factors that interacted with the teacher beliefs included the quantity of pesticide lessons for educators in the health care and advocacy category and the lack of shared language and the experience of using agricultural chemicals for the Cooperative Extension/university and state agency category.

Quantity of Pesticide Lessons

Educators from advocacy and particularly health care organizations conduct a staggering number of pesticide lessons (up to 500 per year). On many days during the growing season, this means that these educators are conducting multiple sessions out in fields or in migrant camps with farmworkers. In the introductory vignette, Sharron was teaching farmworkers at the end of a long workday in the rain and while the boss was observing from his truck. Sharron repeatedly mentioned farmworker tiredness during her interview, providing an indication of the types of challenges that farmworker educators may face. Indeed, 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 from advocacy and particularly health care organizations 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 farmworker educators found in this study, Ross's (1998) synthesis of the self-efficacy literature showed a correlation between greater experience and lower general teaching efficacy but higher personal teaching efficacy beliefs. In other words, classroom teachers with more experience were more confident in their abilities to facilitate student learning but became less confident in the effectiveness of teaching in general for effecting positive change in student outcomes. Perhaps this difference in self-efficacy patterns, with classroom teachers more efficacious overall than farmworker educators, relates to classroom teachers' greater control of the learning context; indeed, studies show that many teachers who teach outdoors feel ineffective (Ferry, 1995; Simmons, 1998). These findings are consistent with Bandura's (1986) model of reciprocal determinism, which shows behavioral and environmental factors as influential in shaping beliefs.

Lack of Shared Language

Interviews with educators from state agencies and Cooperative Extension/universities (n=6, 60%) revealed that limited proficiency in Spanish, lack of comfort with speaking Spanish, and/or having to use an interpreter limited the ability to facilitate discussion among and with farmworkers. Janet, a female Cooperative Extension/university educator, voiced a belief that her Spanish language abilities, combined with gender and education level, contributed to her problematic communication with 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.

Conversely, only one advocate and no health care workers expressed concerns about language abilities. The farmworker educators employed by state agencies and Cooperative Extension/universities expressed concerns about engaging farmworkers directly or using an interpreter during lessons. The lack of a shared language and a perceived inability to engage farmworkers in discussion suggest a possible explanation for corresponding teacher-centered responses on the *TBI* among state agency and Cooperative Extension/university educators. This salient factor, shared language, represents a personal factor in that knowledge of the Spanish language is limited for farmworker educators in this group and an environmental factor in that it represents a lack of common experience between educators and learners. This lack of shared language between the second group of educators (Group B) and farmworkers likely influences not only teaching beliefs, which were captured in the TBI, but also teaching practices and the roles played by the educator and learners within the learning context. The finding that some educators describe engaging with farmworkers as difficult due to differences in language, culture, and education resonates with Lee and Fradd's (1998) concept of 'instructional congruence' that emphasizes the importance of teachers' knowledge of students' language and cultural experiences, as well as understandings of science, when working with diverse students.

Experience with Pesticides

Educators from state agencies and Cooperative Extension/universities were more likely (n=6, 60%) than health care and advocacy educators (n=1, 11%) to have engaged in hands-on activities with agricultural chemicals and were also more likely to express less cautious beliefs about pesticide risks overall and routes of entry and health outcomes in particular. Janet, a Cooperative Extension/university educator with a history mixing, loading, and applying pesticides, describes early experiences with pesticides:

> [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.”

Nespor’s (1987) concept of episodic storage, one of his four features of beliefs, is useful in understanding this educator’s recollections. Nespor asserts that ‘critical episodes’ shape educators’ practices. ‘Critical episodes,’ such as the one described here, in which pesticides were handled in a casual way might explain the less cautious beliefs expressed by individuals who have mixed, loaded, and applied pesticides.

Perhaps ironically, Joe, also a Cooperative Extension/university educator, asserts that these “real-world” experiences are necessary for an informal science 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 [personal protective equipment] 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 these educators who have had more experience with the content of pesticide lessons are less concerned about pesticide risks related to routes of entry and health effects.

Nespor (1987) describes the important role of ‘critical episodes’ in shaping educators' beliefs, and these findings highlight the importance of specific pesticide experiences that functioned in shaping the beliefs of these farmworker educators. In this case, 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 deemphasizes pesticide risks based on familiarity with pesticide application. Although authentic learning experiences can be valuable for students (Cronin-Jones, 2000; Hammerman, Hammerman, & Hammerman, 1985; Schmidt, 1996), 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 farmworker educators’ examining the quality of their experiences and considering the influence their pesticide experiences may have on their risk beliefs prior to their working with farmworkers.

Conclusions and Implications

The farmworker educators in this study sorted into two main groups according to beliefs about teaching, pesticide risk, and self-efficacy: educators who were affiliated with health care and advocacy organizations and educators who were affiliated with state agencies and Cooperative Extension/universities. Health care and advocacy educators (Group A) typically held beliefs that were more learner-focused and were characterized as being female and proficient in Spanish, having lower levels of educational attainment, and teaching more numerous lessons. They also tended to have lower self-efficacy and greater concern about pesticide risks. The state agency and Cooperative Extension/university educators who comprised the second group (Group B) expressed more teacher-focused beliefs, less cautious pesticide risk beliefs, and higher self-efficacy. These educators tended to self-identify as European American, have higher levels of education, teach few lessons each year, and have experience working with pesticides.

The learner-centered educators from health care organizations and advocacy groups (Group A) interact with farmworkers in multiple capacities and provide pesticide education as one facet of their roles. These educators work almost exclusively with farmworkers, and their narrow focus on farmworkers may correspond to greater comfort and familiarity with engaging farmworkers in lessons and allowing farmworkers to shape the direction and form of pesticide lessons. In working so closely with farmworkers, the educators may recognize that the conditions for farmworker education often undermine the quality of farmworkers' learning experiences. The environmental conditions under which these educators work serve as an explanation for experienced informal educators' doubts regarding the efficacy of their teaching farmworkers, consistent with Bandura's (1986) model.

In contrast, Cooperative Extension/university and state agency workers (Group B) serve a broader audience, including farm owners and operators, and divide their time between educating farmworkers and their other job responsibilities, including providing educational programming and consultation for farm owners, in the case of Cooperative Extension/university employees, and enforcing regulations, in the case of state agency personnel. They do not generally have ongoing relationships with farmworkers. These educators expressed concerns about their ability to communicate with farmworkers, as well as difficulty engaging with farmworkers due to differences in culture and education. In agreement with the recommendations of Settlage et al. (2009), we believe that these farmworker educators with limited experience engaging farmworkers and high self-efficacy would benefit from greater self-doubt about the efficacy of their instruction. Experiences that would give them more exposure to farmworkers, perhaps by accompanying another educator who works more regularly with the audience, may cause them to question the learning among farmworkers, become less content with their teaching practices, and reconsider their teaching approaches (Southerland et al., 2011; Blanchard et al., 2011).

What we do not know is how the educators selected their employing institutions and whether the differences we found were a result of differences in the individuals or the cultures of the organizations in which they worked. For example, health care and advocacy work may attract individuals who prefer to work closely with farmworkers, or the institutional climates of health care and advocacy may facilitate these farmworker-focused interactions.

Using Bandura's (1986) model, three factors emerged as influencing these informal educators' beliefs. First, providing many or few lessons each year (behavioral factor) shaped an educator's belief (personal factor) about how effective a lesson would be for the farmworkers. Second, a shared language or lack of a shared language (personal-environmental factor) affected the degree to which these educators were able to engage farmworkers during lessons (behavioral factor). Third, experience or a lack of experience with handling pesticides (behavioral factor) influenced concerns about pesticide risk (personal factor). Bandura's model improved our understanding of group differences in teacher beliefs, and our findings support the validity of reciprocal determinism by suggesting the interdependent nature of personal, environmental, and behavioral factors of farmworker educators.

We wish to note that the conclusions presented herein should be interpreted in light of several caveats. First, because this study was qualitative in nature, generalization of the findings to other potential sample populations should be done with caution. We believe, however, that our study captured a large proportion (almost 20% of the total population) of the farmworker educators in the study state and that by providing information about our participants readers can determine how applicable our findings are to other states and other educational contexts. Second, we based our analyses on self-reported data provided by the teachers in questionnaires and interviews, which may have introduced bias.

Although this work focused on a case of informal educators who interacted with farmworkers to provide pesticide education, we believe that the findings from this study may have implications beyond this study group to include other formal and informal science educators and settings. First, Nespor's (1987) critical episodes surfaced in 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 pesticides may have implications for the examination of how authentic science experiences influence classroom and informal science teachers' beliefs about science content. Science education researchers have pushed for authentic science experiences for teachers (e.g., Anderson, 2007; Chinn & Malhotra, 2002) with the idea that this experience would help teachers improve their science teaching. These informal science experiences of farmworker educators are a cautionary note that not all authentic experiences may have a positive effect on science teaching, whether in formal or informal settings.

Second, teaching beliefs varied by institutional affiliation. This finding suggests that future research should examine differences among the institutions that provide pesticide education to farmworkers. In addition, we think that the role of the work institution/affiliation could be a factor for other informal settings and should be considered. Keeping in mind Bandura's (1986) model, the educator's institution may play a role in shaping teaching practices and, if this is found to be the case, ought to be included as an environmental factor.

Finally, the self-efficacy of the informal educators was lower and in some cases, remarkably lower than that of experienced classroom teachers (Blanchard et al., 2011). In light of the trend of decreasing efficacy with increasing numbers of lessons with farmworkers, this finding related to diminished self-efficacy seems to be related to the environmental conditions for conducting the lessons. We recommend that efforts be made to provide more supportive settings and improved conditions for educating farmworkers. Based on our observations with the study group, we wonder if informal educators who have a wide range of audiences in one type of environment or similar audiences in a range of settings also tend to have lower self-efficacy.

In summary, this case study revealed trends in the beliefs of informal science educators. We assert that these beliefs are of great consequence to the lives of farmworkers, given that educators' beliefs about teaching, pesticides, and self-efficacy guide their teaching practices with 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 farmworkers could, quite literally, be a matter of life or death. Informal science 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).

A follow-up study on farmworkers' learning through informal science educators' teaching seems an appropriate next step for this research. Assessing learning will be a challenge, however, given farmworkers' low-literacy levels and, therefore, their inability to use written assessments.

As the first study of science educators who teach pesticide risk information to farmworkers, this research provides much-needed baseline information on this group of informal science educators. Findings from this study may inform future efforts to enhance pesticide education and to reach out to science educators in other informal and occupational settings, a demonstrated need in the areas of environmental and science education.

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