Efficacy in Occupational Safety and Health Training of Dairy Workers:

Predictors of Test Performance on a Dairy Safety Knowledge Test

From a Demographic Cohort

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Abstract

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Background: Efficacy-driven assessments of culturally and linguistically appropriate occupational health and safety training (OHS) for workers who speak English as a second language remain uncommon. This study analyzes predictors of performance on a dairy safety knowledge test using pre-and-post knowledge assessments. The safety training course was delivered by iPad™ to Idahoan dairy workers, managers, and owners. Objective: The objective of this study was to correlate and predict changes in safety knowledge to 1) course participant characteristics and 2) compare quantitative readability scores with qualitative judgement of a Spanish speaking panel. Methods: Predictors of pre-test (baseline) scores and change in test scores of n= 1,338 participants were compared, and multivariate iterative linear regressions were used to predict test performance, adjusting for variables such as occupation, education level, native language and years in dairy work. Test question reading ease was compared to the percentage of participants who answered the question correctly in order to correlate readability scores with test performance, using both quantitative calculated reading ease scores and reading ease judgement by a panel of native Spanish speakers. Results: Test scores for each language group improved between pre-test and post-test. Education was the most predictive variable of higher baseline scores and change in test scores amongst dairy safety course participants, regardless of language. There was no significant evidence that either reading ease score or readability of individual questions as assessed by a native Spanish speaking panel were related to performance. Conclusion: The results indicate that dairy safety worker training results showed improvement in safety knowledge and test scores. Education level appears to be a key determinant of increases in safety knowledge, and therefore safety training programs need to address the learning needs of less educated workers. Further work is necessary to define optimal readability for test questions in Spanish.

INTRODUCTION

The American dairy industry is going through increased intensity of production and is experiencing a change in the demographics of the workforce away from the traditional family farm model. As of 2015, immigrant workers accounted for 51 percent of all dairy labor (1). While many terms (such as "Latino", "Latina", "Latin American", "Hispanic" etc.) are often used interchangeably to define the population of interest, the term "Latinx" will be used henceforth, as it is used to indicate "any person of Latin American descent residing in the United States (2), and is gender inclusive. In the Midwest and Western regions of the United States, 90 percent of migrant farm workers are Hispanic [Latinx] (3).

There have been few published research articles or guidelines specific to developing or assessing occupational safety and health training for immigrant, Latinx workers in the dairy industry (4). Occupational safety and health ("OSH", interchangeable with occupational health and safety or "OHS") training is recommended to provide training to mitigate on-the-job risks experienced by agricultural workers. Specific standards, such as Z 490.1, developed by the American Society of Safety Professionals (ASSP), provide guidance on how to manage overall safety training programs, as well as criteria for developing training that incorporates adult learning principles (5).

Trade associations and industry groups such as the Idaho Dairymen's Association (IDA) have worked to provide safety training solutions for workers within their state's dairy industry. In July of 2017, the IDA created the Worker and Safety Training Program, a training course that has since provided on-farm occupational safety training modules for thousands of workers on Idahoan dairy farms (6). Additionally, the IDA has recognized the importance of providing safety training by "delivering authentic, on-farm training modules in native languages" (6), with the primary objective of the course being to “promote worker safety, increase safety awareness, and reduce risk of injury and/or fatalities” (7).

To date, there have been few rigorous efficacy-based analyses of training programs with robust sample sizes within the dairy industry. Therefore, there is a need to analyze training record datasets such as the IDA’s in order to assess the impact of demographic factors, assess changes in safety knowledge by examining changes in pre-and-post test scores within the population of interest, and most importantly, use the analysis to recognize strengths and suggest improvements of current OHS training efforts for dairy workers throughout the dairy industry.

BACKGROUND

Demographics of modern dairy workers are well understood, and the industry is changing.

Many regions of the United States rely on immigrant labor in dairy work, and the Pacific Northwest is no exception. Idaho’s Magic Valley region’s Hispanic [Latinx] population grew about four-fold over the last 25 years, on the same trajectory as the dairy industry’s labor force (8). Research groups suggest a strong and interdependent relationship between an increase in the Hispanic population and the dairy labor force within this region of Idaho (8).

A number of studies have assessed demographic characteristics of Latinx dairy workers: typical ages of Latinx dairy workers range from 20-35 years (9–12); workers are most frequently of Mexican or Guatemalan national origin (9–11) and are primarily immigrants who have little dairy experience (13) and have no experience with cattle (14); workers are predominantly Spanish speaking (9), male (15), speak little or no English (11,12,16), and have limited formal education and low levels of literacy (16).

Dairy work is dangerous, and occupational health and safety training is not standardized and readily available for dairy workers.

Compared with the national average across all industries, dairy workers experience a two-fold higher rate of occupational injuries (3.3 and 6.6 per 100 full-time workers) (16). While dairy farms are becoming larger in size and fewer in number, the occupational injury rate has not changed (17). Many dairy workers also have limited or no previous dairy experience or foundational OHS training and, as a result, fail to recognize the hazards in their work (18).

18% of occupational fatalities in 2013 occurred among Hispanic [Latinx] workers, and two-thirds of those occurred within the foreign-born subset (19). Furthermore, foreign-born workers across industries suffer more extreme injuries and carry more injury burden than non-foreign-born workers (20).

OHS training for dairy workers is not standardized across the country, and little guidance and support is provided to the dairy industry to provide and create these trainings (21). Additionally, a number of historic and legally systematic regulatory exemptions of the agricultural industry (16,22,23) have allowed for the dairy industry to avoid implementation of standardized occupational health and safety training programs. While strategies such as Local Emphasis Programs (or LEPs) have been used to address hazards or industries that pose a particular risk to workers in specific industries (24), more research is needed to examine the longer-term impact of LEPs in the dairy industry (23). The Department of Labor has questioned the long-term impact of these programs, citing limitations in the measures which the Occupational Health and Safety Administration (OSHA) uses to determine success (25).

With the lack of creation and regulation of OHS programs tailored to the dairy industry, advocacy, service organizations and university programs provide some of the only OHS training materials which address language and literacy barriers confronted by workers (18). The IDA and other groups such as the National Dairy FARM (Farmers Assuring Responsible Management) Program work with the dairy industry to provide resource manuals and guides to help train workers and mitigate safety and health risks on dairy farms (21).

Non-profit national membership organizations, such as AgriSafe, represent health professionals and educators who strive to reduce health disparities found among the agricultural community by focusing on reducing agricultural injuries, diseases, and fatalities through the effective delivery of occupational health services (26).

The Centers for Agricultural Safety and Health represent a major effort of The National Institute for Occupational Safety and Health (NIOSH) to protect the health and safety of workers in the agriculture, forestry and fishing sectors (27). NIOSH, part of the Centers for Disease Control (CDC), developed the Centers through cooperative agreement grant programs to conduct research, education, and prevention projects to address the health of farming, fishing and forestry workers (27). The Centers, such as the Pacific Northwest Agricultural Safety and Health Center (PNASH) and the Upper Midwest Agricultural Safety and Health Center (UMASH) conduct research and promote health safety practices for industries such as farming, fishing and forestry (28) and work closely with universities such as the University of Washington (UW) and the University of Minnesota, respectively. The Centers develop and distribute safety training materials, such as videos, factsheets and other media to promote positive animal practices to protect those who work around animals (27–29).

Assessments of efficacy of training interventions on illness and injury rates amongst Latinx dairy workers are rare in the literature.

In general, quality randomized trials of the efficacy of OHS training are limited (30), and the dairy industry is no exception (31). A significant lack of research exploring outcomes (generally injury rates while on the job) between Latinx dairy workers and OHS training (13,32,33) has been well-documented in the literature. One scoping review was conducted to identify published reports of occupational safety interventions in the dairy industry: of nineteen articles, none of these studies had a sufficient sample size to compare injury rates as an outcome (17). Small sample sizes (10,12) and convenience sampling (10,11,34) in occupational dairy research are common, with a possibility of the presence of significant recall bias limitations.

Barriers which limit quality occupational research in the dairy industry are often reported by research teams as: time constraints and providing training for different shifts of dairy workers (9,10), lack of designated classroom space (11), lack of long-term traceability of participants, and discontinuation of tools such as pre-and-post tests after initial efficacy assessment (10,35).

OHS delivery methods and course content for training dairy workers varies greatly.

The vast majority of OHS training and education programs involve training workers directly, whether in the workplace, union hall, or community - such training may range from brief interactions with workers on the street to highly structured, long-term training programs (36). In a study by Menger et al., a review of 65 articles focused on five strategies for how to effectively tailor health and safety training for immigrant workers in the dairy industry grouped under five main themes: 1) understanding and involving workers; 2) training content and materials; 3) training methods; 4) maximizing worker engagement; and 5) program evaluation (4).

Traditionally, classroom style methods have historically been popular (especially using tools such as PowerPoint presentations and other media) and continue to be readily used (9,10,35). Other methods of delivery of OHS training can include synchronous classroom-based lectures, asynchronous computer-based training, or learner-centered, individualized methods which can include hands-on demonstration (37). The utilization of desktop computers and the internet (i.e., electronic learning or "e-learning") has been largely replaced by mobile learning, or "m-learning": the use of mobile or wireless devices for the purpose of learning and has been used in occupational settings to provide learning experiences to individual workers as well as groups of workers (38).Smartphones, handheld and tablet PCs, laptops, and personal media players can all be recognized as m-learning tools (11).

Hands-on training methods and simulations were found to be more engaging and more effective in terms of knowledge acquisition and reduction of negative health outcomes (36). Hands-on training can encompass a number of activities or strategies, and can include activities such as small group discussions and group problem-solving, risk mapping and hazard identification of worksites, storytelling or novellas, and simulations to apply knowledge in real-life situations (36). A scoping literature review conducted by Caffaro et al. noted that training received through a videotaped theater program, followed by a practical demonstration of correction moves and postures resulted in significant improvements in worker behaviors post-intervention (31).

Course content of health and safety training of Latinx dairy workers also varies greatly, but the following areas of focus were generally identified: identification of hazards in dairy work, cattle behavior and appropriate handling practices, personal protective equipment (PPE) usage, hygiene in the milking parlor related to mastitis and zoonotic disease, safety working with ATVs and other vehicles, ergonomics, waste lagoon hazards and electrical hazards (9–12,35).

Measurements of and changes in efficacy of OHS training programs for dairy workers are generally categorized in four key areas: safety knowledge, safety attitudes and beliefs, safety behaviors, and health outcome measures.

Efficacy of training programs can generally be divided into the following areas (30,31,36,37): changes in safety knowledge (SKs), changes in safety attitudes and beliefs (SABs), changes in safety behaviors (SBs), or safety and health outcome measurements (HOs). Improvements in SBs are most significant when training utilized community-based approaches or involved family members of workers (31); SABs are most significant in underserved populations and use peer educators or community health workers to provide information and provide significant positive effects of training (31). Analysis of HOs are sparse in dairy and other sectors (31,37,39).

Significant changes in SK have been noted in a number of studies involving migrant worker populations, but only when studies 1) described the process adopted for the design of the training program and 2) used pre-assessment and post-assessments and follow-up assessments months beyond the initial test (31). In one scoping review, 6 of 16 interventions focused on training or informational campaigns where knowledge acquisition was measured (17). Other studies have indicated that use of SK was not significant, especially in cases of very young migrant workers and when training materials were only provided in a non-native language (40).

Research focused on measuring changes in SAB indicates that perceived barriers of PPE usage by workers exist, which in turn inhibits PPE usage in the field. One follow-up study by Forst et al. investigating protective eyewear indicated that even after experiencing the intervention, workers bypassed usage of PPE for several reasons: perceived lack of protection, discomfort, undesirable appearance, interference with visual acuity, slowing down the work pace, and no mandate from employers (41). Measuring changes in SABs in dairy workers was not common in the literature.

Measurements of changes in SB amongst dairy workers are present in the literature (32,42) . Changes in SB can be measured based on longitudinal assessments of SK (31,43). Additionally, culturally sensitive training interventions that focus on increasing awareness and modifying behaviors to reduce exposure to zoonotic risks are essential, and have been further explored by Menger et al. (33)

As previously mentioned, measurements of rates of illness and injury is the gold standard in OHS research, but studies of dairy workers measuring this outcome are uncommon (17,39) due to a number of previously outlined factors (44).

Pre-and-post assessments of changes in safety knowledge are common in dairy safety training, and t-tests are used to compare test scores.

Within the last decade, the National Institute of Environmental Health Sciences (NIEHS) has noted the importance of pre-and-post-testing as a pillar of continued evaluation approaches (45); utilizing pre-and-post-test assessments confirmed knowledge gain and skills retention in classroom, hands-on, and e-learning contexts when examining workers who had undergone Hazardous Waste Operations and Emergency Response training (45).

Changes in SK often use pre-and-post-test assessments as the efficacy metric, which falls under Level 2 of the Kirkpatrick Levels of Evaluation. The Kirkpatrick Levels of Evaluation include: 1) Reaction (participants rating training experiences favorably), 2) Learning (assessing knowledge with pre-and-post-tests), 3) Behavior (applied knowledge gained in their daily work activities three months after training), and 4) Results (training influencing performance or injury rates) (43).

Overwhelmingly, paired t-tests were used to assess statistical significance in changes between pre-and-post-test scores (and thus changes in SK) in OHS dairy safety training courses; Juárez-Carrillo et al., Meyerhoff et al. and Rodriguez et al. all utilized between 15 and 20 pre-and-post-test questions to assess safety knowledge gains; all changes in SK in the aforementioned studies was significantly different between pre and post-test scores. (9–11). Juárez-Carrillo et al. and Rodriguez et al. used a mixture of true and false and multiple-choice questions for their assessments (9,11) while Meyerhoff et al., chose to use only true or false questions for their assessment after multiple choice questions proved to be too complex during the curriculum development stage (10).

However, it is important to note that while pre-and-post efficacy evaluations were originally used in tandem with training interventions and were statistically significant, these assessments were discontinued in future trainings due to time constraints (10), or it was suggested that training be shortened in the future to address time constraints during training (35).

Relying on text-heavy OHS training and efficacy assessment tools (such as pre-and-post-tests) assumes that the population of interest has achieved a certain level of formal education and reading comprehension skills, which is important to consider when evaluating changes in SK within the population of interest. It is important to recognize that alternative methods, such as interviewer-administered questions, may work better with low-literacy populations such as: working in teams to answer questions, playing games to review course content, using visuals, multiple choice questions with pictures and oral checklists or hands-on demonstrations (36).

The current dairy worker population has unique cultural and linguistic characteristics: providing appropriately delivered OHS dairy training continues to be a challenge for the dairy industry.

Epidemiologists and occupational health professionals have excluded migrant workers from studies because of their mobility, lack of fluency in the dominant language, cultural differences, and their informal work arrangements (46). A study by Jenkins et al. (2009) remains one of few longitudinal studies which study workers on dairy farms and noted that low response rates in this study (24.5%) indicates that Latinx employees are probably more hesitant to participate in these studies (15).

It is also important to consider the role of safety culture as it relates to Latinx dairy workers. Farmer's high tolerance of risk, denial of susceptibility, and skepticism regarding safety measures may contribute significantly to the problems encountered in the implementation of safety and health training for agricultural workers (18). This cultural phenomenon of the agricultural industry in general is especially problematic, as a power disparity often exists between farm owners or managers and workers; often, immigrant dairy workers underreport work-related injuries out of fear of job loss, deportation, and other repercussions (22).

Additionally, many immigrant Latinx workers can only speak and read in Spanish (47), and Latinx patients (within a healthcare context study) have the lowest health literacy of all subgroups in the United States (48). OSHA mandates that if an employee does not speak or comprehend English, instruction must be provided in a language the employee can understand (21). It is often assumed that most Latinx dairy workers predominantly speak Spanish, but that is not always the case: in one study, twelve native and indigenous languages were represented in their sample, such as Mixteco Bajo, Zapoteco, and others (40). While the IDA and other associations have recognized the need for providing training in indigenous languages other than Spanish (49), these linguistic nuances were not well documented in other studies or OHS programs.

Language-appropriate evaluation of training materials are not frequently used when assessing dairy safety training course content or objectives.

Readability of documents, including OHS documents, is a key factor in their adoption and application (50), and there is wide variability in the readability of texts when examining OHS materials (50,51).

Several researchers (9,10,12,35) have made direct statements of the importance of cultural sensitivity and delivery of linguistically appropriate OHS training for Latinx dairy workers: however, reading ease and literacy levels of the population of interest were discussed foundationally in the research, but was rarely assessed (nor were methods of linguistic assessments provided). The Flesch-Kincaid reading ease formula, a formula based on and created for the English language, was only used by one of five research teams to verify reading ease of the presented materials (9) in one literature review.

The term 'readability' refers to the understandability of written text (51). More than 40 readability formulas exist, such as the Fry, Flesch, Flesch-Kincaid and Simple Measure of

Gobbledygook (SMOG), which are used to assess readability of documents in the health care sector (52).

For the English language, the Flesch Reading Ease formula is frequently used to predict the mean grade level of those who correctly answered 75% of comprehension questions about the McCall-Crabbs passage (51). The McCall-Crabbs passage (originally developed in 1925) consisted of pieces of writing about 150 words in length, each followed by 8 to 10 multiple choice questions (51).

Flesch-Kincaid Reading Ease Formula = 206.835 – 1.015 x W/P – S/W
where:
S = number of syllables of the text
W= total number of words in the text
P= total number of phrases or sentences

Figure 1 – Flesch-Kincaid Reading Ease Formula (Ley and Florio, 1996)

The Flesch-Kincaid Reading Ease formula has been adapted for the Spanish language. the Spanish language structure is different from the English structure, so it is necessary to adapt the formulas to use them in Spanish texts and the reading habits of the Spanish speaking population (53,54).

Flesch-Szigriszt Index Formula = 206.835 - 62.3 x S/W - W/P
where:
S = number of syllables of the text
W= total number of words in the text
P= total number of phrases or sentences

Figure 2- Flesch-Szigriszt Index (INFLESZ) Formula (Bea-Muñoz et al., 2016)

Certain considerations need to be taken when applying readability formulas to languages other than English. Note that a perfectly bilingual person who creates text with the same information in both languages should produce text with readability that is nearly the same in both languages - even though the Spanish language tends to use longer sentences and because of its Latin origins and generally longer words, reading ease should be of equal readability (50,53).

Both formulas also have comparable interpretations to quantify reading ease of phrases. The Flesch-Kincaid formula subsequently uses a Flesch-Kincaid Readability Scale (50) while the INFLESZ formula uses a INFLESZ Readability Scale (53,55).

Type of writing	Reading Ease	Reading grade Level	Verbal description	Fog Index Grade estimate	% of people likely to understand
Comics	90–100	5	very easy		93
Pulp fiction	80–90	6	easy	7	91
Slick fiction	70–80	7	fairly easy	9	88
Digests	60–70	8–9	standard	10	83
Quality	50–60	10–12	fairly difficult	12	54
Academic	30–50	13–16	difficult		33
Scientific	0–30	college	very difficult graduate		4.5

Figure 3 – Interpretation of Flesch-Kincaid Reading Ease Formula (Ley and Florio, 1996)

Scores	Interpretation	Example	Spanish Example
<40	Very hard	Scientific	Pediatric clinics of North America
40–55	Somewhat difficult	High school textbooks, scientific press release, specialized press	11th grade biology textbook
55–65	Normal	8th–10th grade textbooks, general press, sports press	The House of the Spirits
65–80	Somewhat easy	4th–6th grade student, famous novels	*Harry Potter and the Order of the Phoenix*, *The DaVinci Code*, the Bible
>80	Very easy	1st–3rd grade student, comic books	*Tom Thumb*, 1st grade religion textbook

INFLESZ = Índice Flesch-Szigriszt.

Figure 4 – INFLESZ Scale for Spanish (Bea-Muñoz et al et al., 2016)

Both reading scales are to be read for scores between 0 and 100, with scores between 30-40 being deemed as "collegiate reading levels"' or "very hard", and scores between 80 and 100 being deemed as "1st to 6th grade reading levels" or "very easy" in terms of reading ease. The "maximum score" is 121, while the "minimum score" is -4 for both reading ease scales.

It is important to utilize readability and literacy tools to assess course curriculums and efficacy assessments of OHS training, regardless of industry; implementing linguistically and literacy appropriate comprehensive health and safety training for agricultural workers will improve the lives of workers and employers (18).

SPECIFIC AIMS AND OBJECTIVES

Primary Aim: To predict safety training test performance of English speaking and Spanish speaking participants (note that dairy safety course participants self-identity and self-report native language as their first language, and will henceforth be referred to as "English speakers" or "English speaking" and "Spanish speakers" or "Spanish speaking" populations as applicable) of the IDA Worker and Safety Training Program by 1) analyzing which variables predict the highest baseline (pre-test) scores within the dairy safety program participants and 2) analyzing which variables predict the greatest improvement from pre-to-post test scores (change in test score).

Secondary Aim: To determine if there is a "readability effect" present in participant performance after evaluating English (using the Flesch-Kincaid readability formula) and Spanish reading ease (using the INFLESZ readability formula) of pre-and-post dairy safety test questions, and if this "readability effect" can be associated with predicting performance of participants by question for English and Spanish speakers.

Tertiary Aim: To further investigate if there is a correlation between 1) calculated reading ease scores and 2) performance of participants by dairy safety test question and in concordance of reading ease by a panel of four native Spanish speakers.

Hypotheses:

The hypotheses for the primary aim are based on the idea that several demographic factors of training course participants may contribute to higher baseline test performance, and that higher baseline test performance will result in a smaller change in test performance. Additionally, participants who speak English as their first language tend to have achieved higher levels of education, on average, as compared to participants who speak Spanish as their first language. Therefore, I expect: 1) that higher baseline scores will be associated with more years of education and a greater number of years in the dairy industry and 2) the association of baseline test scores and years of education and years of dairy experience will be more pronounced in respondents who speak English as their first language compared to non-English speakers. Additionally, I hypothesize that group-averaged post-test scores will be significantly different, and greater than comparable baseline test scores when stratified by language.

The hypothesis for the secondary aim is based on the importance of determined reading ease of pre-and-post-test questions using appropriate linguistic reading ease formulas. As previously described, the Spanish INFLESZ Scale is adapted from the English Flesch Reading Ease formula (51,53,55). Therefore, these formulas are comparable to one another, and appropriate for each specified language of interest. I hypothesize that improved test performance (by dairy safety question) will correlate with questions which possess greater reading ease scores (higher reading ease scores on a scale of 0-100 indicates a lower reading grade level is needed to read the text). For example, a question with a reading ease score of 80 on the Flesch-Kincaid Reading Ease Formula scale would be interpreted as a question that is “easy to understand” by an English speaker and would equate to a 6^{th} grade reading level.

For the tertiary aim, I anticipate that reading ease scores and performance trends will generally correlate to the perceived reading ease reported by the panel of four native Spanish speakers.

METHODS

Study Design

In summary, the IDA conducted a dairy safety training course (see Appendix C for full details regarding course curriculum, course objectives, and details about test questions) to promote worker health and safety of workers, owners, and managers on dairy farms in Idaho. The dairy safety training course served as “the intervention”. A pre-post-test analysis was conducted on this study cohort before and after the intervention, with measurements of pre and post-test scores being utilized to assess changes in safety knowledge.

The outcome is represented by pre-test and/or baseline and post-test scores of dairy safety course participants, with various demographic predictor variables contributing to test scores. The study design is defined as an interrupted time series without comparison group, as the two comparison groups are identified as the same individual’s test pre-and-post-test scores, and the safety training course provided by the IDA as the intervention. This evaluation strategy has the advantage of limiting selection bias and confounding due to fewer between-group differences.

Additional primary and secondary datasets containing demographic information and test score information was collected by bilingual IDA trainers from the IDA Dairy Worker Training and Safety Program participants between August 14th, 2017, and February 14th, 2020.

Background on IDA Dairy Worker Training and Safety Program Curriculum Development

The full dairy curriculum was originally developed by Dr. Robert Hagevoort and in conjunction with National Dairy FARM Program funds (49). In 2010, there was a collaborative effort between multiple institutions to ensure dairy farm workers and managers had the most accurate and up-to-date information available on basic principles for farm worker health and safety. New Mexico State University's (NMSU) Dairy Extension collaborated with dairy owners and workers, as well as the U.S. Dairy Education Training Consortium (formerly the Southern Great Plains Dairy Consortium), the United States Department of Agriculture's National Institute of Food and Agriculture, the Southwest Center for Agricultural Health, Injury Prevention, and Education and the High Plains and Intermountain Center for Agricultural Health and Safety (HICAHS) in the development of this safety training course (11). The IDA adopted this dairy curriculum for Idahoan dairy workers, owners, and managers (7).

IDA Dairy Worker Training and Safety Program Structure and Delivery

Training vignettes as the intervention were deployed on a mobile platform using Apple iPad™ tablets with the intent of enhancing the efficient and effective delivery and sustainability of safety training content to dairy workers on remote dairy farms (11). The IDA has recognized the importance of providing safety training by "delivering authentic, on-farm training modules in native languages" (6), and as of 2020 has begun to translate modules to the K'iche', a Mayan language from Guatemala, to meet changing worker demographics within the dairy industry (11,49). For this study, content was offered in English and Spanish only, and bilingual training staff were present in all training sessions to provide assistance to workers, answer questions, and monitor quiz taking (11).

Each training session was approximately 1.5 hours in total duration. The number of participants varied by training, but on average, the course contained about a dozen students per training session (7). If multiple sessions were needed, the IDA could train approximately 40-60 workers per day, over several days (7). Prior to training course delivery, bilingual instructors provided a verbal introduction which included training purpose, learning objectives, as well as tablet navigation instruction.

The safety and training course schedule was (generally) as follows:

- Introduction: oral presentation by bilingual trainer (approximately 5 minutes)
- Pre-test: written or read aloud as needed (time varied by participant)
  (See Appendix C for all test questions in written form)
- Training: vignette videos (Parts 1 and 2) with audio were presented to participants on individual iPads (time varied by participant)
  (see Appendix C for curriculum details)
  - Part 1: focused on general dairy farm safety such as waste lagoons, ATV usage and other hazards
  - Part 2: focused on animal handling and cattle behavior
- Post-test: written or read aloud as needed (time varied by participant)
- Participant demographics and information collected orally by bilingual trainers

Each participant was provided a set of ear buds which minimized distractions while viewing training vignettes in a group setting (11) while engaging with their iPad™ tablet. Training vignettes were delivered using the Articulate Storyline™ offline-mode application which negated the need for internet connectivity (11). Each pre-and-post-test included fifteen questions, which was administered using the Qualtrics Mobile Survey Software® application before and after the two vignettes were viewed by participants. Test questions were a combination of multiple choice and true or false questions.

Course participants were able to ask questions of bilingual trainers at any time, both during the training vignettes and during the pre-and-post-tests. If participants indicated or stated they were illiterate before or during the course, they were able to 1) partner up with someone who could read or 2) were able to have the test questions read to them by the bilingual trainers (7). The estimation of the number of illiterate participants was not formally collected, but course administrators guessed that true illiteracy was roughly between 10-20% and noted that "many of the participants struggled to read" (7). After training, each participant received an individualized certificate of training completion with their name printed on the certificate (7).

Research Setting and Participant Characteristics of IDA Study

The research participants were dairy workers of various positions on Idaho dairy farms, and occupational health and safety training was conducted on-site at various dairy farms. Training was conducted and operated by the IDA. The target training audience included new dairy farm employees who needed general training on safety issues across the dairy farm, as well as training for specific farm jobs or positions (11,21).

The IDA advertises their training program at various industry meetings and events which they attend. Often, dairymen hear about the IDA training course through their milking cooperatives (7), which encourage participation in the training program. As cooperatives are often participating in FARM program evaluations (21), the IDA training is often suggested to satisfy requirements (7).

All workers on participating dairy farms (regardless of occupation or working position within the dairy) were invited and encouraged to attend the IDA training; it is noted that some managers may skip training because they feel that the information did not apply to them (7), but most people on-site attended training. Training was provided in numerous locations on farms including milking barns, break rooms, maintenance areas, conference rooms, cow treatment barns, and outside on a lawn or under a shade tent (11). No information was provided as to dairy geographical locations, sizes, or other pertinent information regarding the dairy farms.

At the time of this analysis (and prior to data cleaning), demographic information had been collected from 1,668 participants in the IDA dairy safety training course. The eligibility for participation and collection of information from dairy workers was based on 1) participation in the occupational safety and health training provided by the IDA and 2) an attempt to complete the pre-test assessment, the post-test assessment, or both assessments, which reduced the number of eligible participants to 1,338.

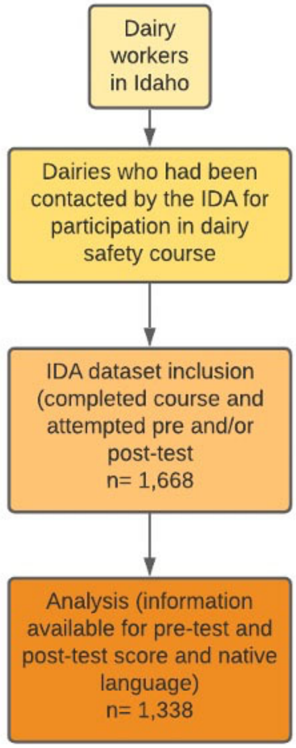


Figure 5: Participant inclusion criteria for IDA training course and analysis

<u>PrePost and Demographic Dataset: Collection and Cleaning</u>

Bilingual course trainers orally collected the following information from dairy workers enrolled in the safety training course and after training had taken place: age, gender, position in dairy work, years in dairy work, education level achieved, country of origin and native language, which were then matched to the participant's pre-and-post test score and was stored and provided to UW. The original dataset consisted of 1,668 entries.

The dataset included nine columns of information collected by the IDA bilingual trainers and provided by dairy safety course participants - all demographic information provided by dairy safety course participants to bilingual trainers was self-reported:

- Pre-test score – outcome (score of 0 to 100)
- Post-test score – outcome (score of 0 to 100)
- Age
- Gender
- Position on dairy (occupation on dairy site)
- Years in dairy work
- Education – effect modifier
- Nationality
- Native language (primary spoken language as reported by participants)

One erroneous age entry (age listed as 423 years) was still included because of the very large sample size; additionally, very young participants (some under 14 years of age) were included in the analysis because other variables such as education (elementary school) and occupation on the dairy farm ("family") corresponded and were not erroneous entries.

The data for native language was originally coded to include four groups: Bilingual, Dutch, English and Spanish. Respondents who listed their native language as "Eng/Span" or "English/Spanish" were included in the bilingual category. "Bilingual" was in reference to participants who self-identified as speaking both English and Spanish.

Descriptive statistics and graphical representations of categorical variables consisted of three coded language groups: English, Spanish and "Other". Dutch and Bilingual speakers were combined to one group ("Other") due to the propensity of Dutch speakers to also be categorized as bilingual, and to de-identify the very small number of self-identified Dutch speakers in the study. For linear regressions, Dutch and Bilingual speakers were analyzed as separate categories because of a lack of risk of participant identification within the actual regression analysis.

Education levels were also consolidated and coded. “No education”, “None”, “No” and other responses designating no formal education were consolidated and categorized as “No Education or Elementary School”. Participants reporting education levels as “professional”, or “college” were combined into one category, “College”.

Positions on dairy farms were also further coded. Positions on dairy farms constituting and reported as less than 20% of participants were amalgamated under a new label “Other” (see descriptions of positions included in the analysis in Appendix C). These positions were further categorized to “Cattle” (including calves, herdsmen, maternity and all positions who worked closely with cattle), “Farm” (general, other, outside, shop, or all positions who did not work closely with cattle), “Milker” and “Owner” for analysis of predictors of baseline and change in test scores.

The final analysis dataset included only participants that had complete pre-test and post-test scores as well as a recorded native language, bringing the final number of participants eligible to be analyzed down to n= 1,338, or 1,338 entries for the final study size.

Question Dataset: Collection and Cleaning

The Question Datasets consisted of two collections (English speakers and Spanish speakers) of unpaired datasets of individual participant responses to the thirty dairy safety course questions (fifteen pre-test questions and fifteen post-test questions), originally collected using Qualtrics Software® and by bilingual trainers. These unpaired data were provided by the IDA to UW in four datasets: English pre-test responses (n= 327), English post-test responses (n= 286), Spanish pre-test responses (n= 1,328), Spanish post-test responses (n= 1,291) (7). A function was created to quantify the proportion of participants who answered each question correctly (for Spanish and English, pre-and-post-responses).

Pre-and-post-test questions were categorized into one of three categories: Animal Handling/Behavior, Personal Safety/PPE, or Environmental/Occupational Hazard, and were also identified as either true or false or multiple choice. The number of words, syllables and phrases were also counted by online web counters (56) and verified by a native Spanish speaker, recruited by PNASH.

This information was uploaded into R, and a function was created to calculate reading ease scores by each dairy safety question and reading ease scores for all multiple choice or true or false responses for each dairy safety question; the reading ease score of both questions and answers as one unit was also summed. The Flesch-Kincaid Reading Ease Formula (Figure 1 and Figure 3) was used to assess reading ease score for all English pre-and-post-test questions, and the INFLESZ Scale was used to assess reading ease score for all Spanish pre-and-post test questions (Figure 2 and Figure 4).

Panel Dataset: Collection and Cleaning

The "Panel Dataset" consisted of responses from a panel of four native Spanish speakers about the reading ease or difficulty of test questions. The panel was recruited from the University of Washington through PNASH. Panelists received pre-and-post Spanish test questions and answers from the Question Datasets (see above) from an online Catalyst™ survey. Panel members were instructed to rate the question on a scale of 1 to 5, with a score of 1 being "very easy" and a score of 5 being "very difficult", adjudicating both question content and format for reading ease A score of a "1" correlated to a reading ease score of > 80 ("very easy"), a score of

“2” correlated to a reading ease score of 65-80 (“somewhat easy”), a score of “3” correlated to a reading ease score of 55-65 (“normal”), a score of “4” correlated to a reading ease score of 40-55 (“somewhat difficult”), and a score of “5” correlated to a reading ease score of < 40 (“very hard”) on the INFLESZ reading ease scale (Figure 4). Panelist responses were downloaded to Excel, where mean and median (see Appendix B for full panel responses) were calculated by test question.

Analysis

All data analyses were performed in R Software version 3.6.3 using the following packages: basic R, broom, data.table, devtools, dplyr, emmeans, ggplot2, ggpubr, gplots, gtools, GGally, lmtest, psych, purrr, readr, readxl, rstatix, stringi, table1, tidyr, wesanderson and zoo.

Descriptive Statistics

PrePost and Demographic Datasets

Demographic variables from course participants were averaged and summarized in a comprehensive table (see Appendix B). Mean and median values were calculated by language group for age and years in dairy. Mean and median values were calculated by occupation for baseline test scores, difference in scores, age and years in dairy. Mean and median values were also calculated for baseline test score, post-test score and change in test score, by language group.

Question Datasets

Mean, median, standard deviation and range were calculated for reading ease scores by dairy safety question; average baseline and post-test scores by topic type were calculated for English and Spanish speakers.

Panel Datasets

Reading ease scores by four native Spanish speakers were collected by dairy safety question for pre-and-post-tests: mean and median panel scores were also calculated by dairy safety test question.

<u>Primary Analysis</u>

Exploratory analysis of essential variables to be included and compared in various models; model of best fit will be utilized to predict higher baseline scores and greater difference in test scores.

Simple linear regressions were used to identify statistically significant p-values ($\alpha < 0.05$) bivariate relationships between essential categorical and numerical variables from the PrePost and Demographic Dataset. Comparison of values such as baseline and changes in test score by categorical variable (such as native language, occupation and education level) will be determined by Estimated Marginal Means (emmeans); using Estimated Marginal Means will allow for estimating the mean response and confidence intervals for each level of a factor, adjusted for the other explanatory variables in the model (CI: 0.95).

Five different exploratory multivariate regression models were built based off of findings from the pre-analysis stage and incorporated into five iterative multivariate regression models; models will be compared by significance by coefficient and the entire model ($\alpha < 0.05$), higher multiple and adjusted R^2 values, and lower AIC and BIC values, with emphasis on the lowest AIC value. The model with the best predictive p-value ($\alpha < 0.05$), will be identified as the "full model", and used to predict baseline test scores for all 1,338 participants (Full Model 1), and by Spanish (n=1,165) and English (n=157) language group (Full Model 1.1). Test scores on the IDA's dairy safety course pre-and-post-test range from 0% to 100%.

Full Model 1 to predict baseline test scores

(for dataset examining speakers of all languages, n=1,338):

- $Y_{i(\text{Baseline Test Score Combined Language})} =$

$\beta_0 + \beta_{\text{NativeLanguage}}X_{Ai} + \beta_{\text{Occupation}}X_{Bi} + \beta_{\text{EducationLevel}}X_{Ci} + \beta_{\text{YearsinDairy}}X_{Di} + \text{error}_i$

Where Y_i is baseline test score, X_A is native language (English reference category), X_B is occupation (owner as reference category), X_C is education level (elementary school or no formal schooling as reference category), and X_D is years in dairy (continuous variable). β's are the regression coefficients, and the errors are assumed to be independent and normally distributed.

Full Model 1.1 to predict baseline test scores, stratified by language

(for datasets examining English speakers only and Spanish speakers only):

- $Y_{i(\text{Baseline Test Score English Language})} =$

  $\beta_0 + \beta_{\text{Occupation}}X_{Ai} + \beta_{\text{EducationLevel}}X_{Bi} + \beta_{\text{YearsinDairy}}X_{Ci} + \text{error}_i$

Where Y_i is baseline test score, X_A is occupation (owner as reference category), X_B is education level (elementary school or no formal schooling as reference category), and X_C

is years in dairy (continuous variable). β's are the regression coefficients, and the errors are assumed to be independent and normally distributed.

- $Y_{i(\text{Baseline Test Score Spanish Language})} =$

  $\beta_0 + \beta_{Occupation}X_{Ai} + \beta_{EducationLevel}X_{Bi} + \beta_{YearsinDairy}X_{Ci} + error_i$

Where Y_i is baseline test score, X_A is occupation (milker as reference category), X_B is education level (elementary school or no formal schooling as reference category), and X_C is years in dairy (continuous variable). β's are the regression coefficients, and the errors are assumed to be independent and normally distributed.

The full models will then be used to predict differences in test scores (changes between baseline and post-test score); baseline test score will be included as a variable in the model to account for higher baseline test scores "closing the improvement gap" of post-test scores. The models will be evaluated for predictive value by once again examining statistical significance of p-values ($\alpha < 0.05$), and multiple and adjusted R^2 values, for all language groups (Full Model 2) and for English and Spanish speakers only (Full Model 2.1).

Full Model 2 to predict changes in test score

(for dataset examining speakers of all languages, n=1,338):

- $Y_{i(\text{Change in Test Score Combined Language})} =$

$$\beta_0 + \beta_{NativeLanguage}X_{Ai} + \beta_{Occupation}X_{Bi} + \beta_{EducationLevel}X_{Ci} + \beta_{YearsinDairy}X_{Di} + \beta_{BaselineTestScore}X_{Ei} + error_i$$

Where Y_i is difference in test score, X_A is native language (English reference category), X_B is occupation (owner as reference category), X_C is education level (elementary school or no formal schooling as reference category), X_D is years in dairy (continuous variable), and X_E is pre-test score (continuous variable). β's are the regression coefficients, and the errors are assumed to be independent and normally distributed.

Full Model 2.1 to predict changes in test score, stratified by language

(for datasets examining English speakers only and Spanish speakers only):

- $Y_{i(\text{Change in Test Score English Language})} =$

$$\beta_0 + \beta_{Occupation}X_{Ai} + \beta_{EducationLevel}X_{Bi} + \beta_{YearsinDairy}X_{Ci} + \beta_{BaselineTestScoret}X_{Di} + error_i$$

Where Y_i is difference in test score, X_A is occupation (owner as reference category), X_B is education level (elementary school or no formal schooling as reference category), X_C is years in dairy (continuous variable), X_D is baseline score (continuous variable). β's are the regression coefficients, and the errors are assumed to be independent and normally distributed.

- $Y_{i(\text{Change in Test Score Spanish Language})} =$

$\beta_0 + \beta_{Occupation}X_{Ai} + \beta_{EducationLevel}X_{Bi} + \beta_{YearsinDairy}X_{Ci} + \beta_{BaselineTestScore}X_{Di} + error_i$

Where Y_i is difference in test score, X_A is occupation (milker as reference category), X_B is education level (elementary school or no formal schooling as reference category), X_C is years in dairy (continuous variable), X_D is baseline test score (continuous variable). β's are the regression coefficients, and the errors are assumed to be independent and normally distributed.

A Wilcoxon rank sum test will be used to determine if post-test scores were significantly better than baseline test scores for English speakers and Spanish speakers, with effect size and magnitude presented and examined.

Secondary and Tertiary Analysis

Reading ease score predictor best fit model and test question performance (percentage of respondents who answered question correctly) by dairy safety question; panel average score rating predictor by reading ease score outcome and panel average score rating predictor by percentage of participants who answered question correctly.

Using bivariate linear regressions, calculated reading ease score (or readability) will be used to attempt to predict higher percentages of respondents who answered each dairy safety question correctly from the Question Datasets ($\alpha < 0.05$) in both English speaking and Spanish speaking populations. An outlier (Spanish pre-test Question 10) with a reading score of -8.059 was identified as a reading ease score outside of the prescribed range described by the INFLESZ Scale (scores can range between -4 to 121) and was excluded from secondary and tertiary regressions but was included in applicable mean and median calculations.

A simple linear regression will be performed with reading ease score being utilized to predict higher percentages of respondents who answered each dairy safety question correctly within the English-speaking group, the Spanish-speaking group, and for both languages combined (totaling three "simple models"). This same linear regression will be run again, where the three aforementioned simple models will also be adjusted for effect modifiers as pre-or-post question status (to total three "adjusted models").

The six models will be compared and assessed for best fit using coefficient values ($\alpha < 0.05$), higher multiple and adjusted R^2 values, and lower AIC and BIC values, with emphasis on the lowest AIC value. Likelihood Ratio Tests (LRT's) will be used to compare simple models to adjusted models by language group ($\alpha < 0.01$).

Simple linear regressions were performed between the average rating of difficulty of question by a panel of four native Spanish speakers (on a scale of 1 to 5), and the reading ease score of all dairy safety questions ($\alpha < 0.05$). The 1 to 5 scale, with 1 being "very easy" and 5 being "very difficult" roughly correlates to the INFLESZ Scale for the Spanish language (Figure 4). A second simple linear regression will be performed between the native Spanish speaker panel ratings and the percentage of correct responses of participants for each dairy safety question ($\alpha < 0.05$).

RESULTS

Demographic Information

Spanish speakers made up the vast majority of dairy safety course participants (n=1,165, 87.0%), with 74.4% of these participants originating from Mexico (Table 1); the majority of Spanish speakers (69.8%) had a middle school education or less. Spanish speakers had the highest mean age of any group (36.7 years) and yet spent an average of 8.26 years in dairy, the fewest of any language group (Table 1). Only 16.3% of dairy safety course participants were women. Follow-up time between pre and post-tests within this demographic cohort study was approximately one and a half hours, including the safety training course as the intervention.

Table 1 provides prevalence values from demographics from analyzed data, displayed by language groups. Table 2 provides prevalence from demographic information stratified by occupation. A comparison table was created which summarizes findings of demographics of Latinx dairy workers against the population of interest in the current study (see Appendix B). Table 3 provides pre-test, post-test and difference in test scores by language.

Table 1: Demographics of dairy workers by language group (n=1,338)

	English (N=157)	Spanish (N=1165)	Other (N=16)	Overall (N=1338)
Age				
Mean (SD)	35.2 (16.5)	36.7 (15.8)	26.4 (10.5)	36.4 (15.9)
Median [Min, Max]	32.0 [2.00, 77.0]	36.0 [14.0, 423]	26.0 [14.0, 58.0]	35.0 [2.00, 423]
Missing	2 (1.3%)	6 (0.5%)	0 (0%)	8 (0.6%)
Gender				
F	26 (16.6%)	190 (16.3%)	2 (12.5%)	218 (16.3%)
M	131 (83.4%)	975 (83.7%)	14 (87.5%)	1120 (83.7%)
EducationAttained				
Elementary School or None	8 (5.1%)	333 (28.6%)	0 (0%)	341 (25.5%)
Middle School	9 (5.7%)	480 (41.2%)	0 (0%)	489 (36.5%)
High School	79 (50.3%)	286 (24.5%)	14 (87.5%)	379 (28.3%)
College	61 (38.9%)	61 (5.2%)	2 (12.5%)	124 (9.3%)
Missing	0 (0%)	5 (0.4%)	0 (0%)	5 (0.4%)
Nationality				
El Salvador	0 (0%)	14 (1.2%)	0 (0%)	14 (1.0%)
Guatemala	0 (0%)	32 (2.7%)	0 (0%)	32 (2.4%)
Honduras	0 (0%)	4 (0.3%)	0 (0%)	4 (0.3%)
Mexico	4 (2.5%)	987 (84.7%)	5 (31.2%)	996 (74.4%)
Netherlands	0 (0%)	0 (0%)	2 (12.5%)	2 (0.1%)
Peru	0 (0%)	105 (9.0%)	0 (0%)	105 (7.8%)
Puerto Rico	0 (0%)	2 (0.2%)	0 (0%)	2 (0.1%)
US	153 (97.5%)	21 (1.8%)	9 (56.2%)	183 (13.7%)
YE				
Mean (SD)	16.3 (18.8)	8.26 (7.99)	11.7 (15.4)	9.22 (10.2)
Median [Min, Max]	8.00 [0, 77.0]	6.00 [0, 60.0]	5.50 [0, 58.0]	6.00 [0, 77.0]
Missing	6 (3.8%)	5 (0.4%)	0 (0%)	11 (0.8%)

Table 2 provides prevalence from demographic information stratified by occupation. A comparison table was created which illustrates previous findings of demographics of Latinx dairy workers against the population of interest in the current study (see Appendix B). Examining occupation, the majority of participants identified their occupation as “milker” (n=550), with “outside” including (n= 499) participants as the second largest occupation category (Table 2); milkers had the lowest average baseline score of 59.2%. The majority of milkers (95.9%) had a high school education or lower and identified as Spanish speaking. Owners (n= 22) made up the smallest occupation category and had the highest pre-test score

(88.7%). No owner had less than a high school education, and all identified as English speaking.

Table 2: Demographics of dairy workers by occupation (n=1,338)

	Owner (N=22)	Calves (N=63)	General (N=46)	Herdsman (N=23)	Maternity (N=27)	Milker (N=550)	Outside (N=499)	Shop (N=21)	Overall (N=1338)
Pre-percent									
Mean (SD)	88.7 (7.95)	61.4 (16.0)	59.5 (22.8)	75.6 (21.6)	69.0 (17.5)	59.2 (18.0)	66.2 (18.3)	71.4 (17.5)	63.6 (18.9)
Median [Min, Max]	93.0 [67.0, 100]	60.0 [27.0, 93.0]	67.0 [0, 93.0]	80.0 [0, 100]	73.0 [27.0, 93.0]	60.0 [0, 100]	67.0 [0, 100]	73.0 [33.0, 93.0]	67.0 [0, 100]
Difference in Score									
Mean (SD)	8.77 (8.26)	27.5 (14.9)	33.7 (18.8)	18.6 (15.1)	23.4 (13.2)	27.7 (16.8)	23.2 (17.0)	25.4 (16.2)	25.4 (16.9)
Median [Min, Max]	7.00 [0, 33.0]	27.0 [0, 67.0]	27.0 [0, 93.0]	13.0 [0, 60.0]	26.0 [6.00, 46.0]	27.0 [-26.0, 100]	20.0 [-26.0, 100]	20.0 [0, 67.0]	26.0 [-26.0, 100]
Age									
Mean (SD)	38.1 (12.4)	33.0 (10.4)	37.6 (11.4)	39.0 (9.22)	37.0 (12.2)	34.7 (19.7)	38.4 (12.4)	34.3 (12.3)	36.4 (15.9)
Median [Min, Max]	35.5 [22.0, 64.0]	32.0 [12.0, 62.0]	37.0 [16.0, 65.0]	39.0 [23.0, 63.0]	36.0 [20.0, 70.0]	33.0 [14.0, 423]	37.0 [14.0, 80.0]	35.0 [2.00, 59.0]	35.0 [2.00, 423]
Missing	0 (0%)	0 (0%)	1 (2.2%)	0 (0%)	0 (0%)	3 (0.5%)	3 (0.6%)	0 (0%)	8 (0.6%)
EducationAttained									
Elementary School or None	0 (0%)	9 (14.3%)	12 (26.1%)	2 (8.7%)	4 (14.8%)	147 (26.7%)	133 (26.7%)	5 (23.8%)	341 (25.5%)
Middle School	0 (0%)	26 (41.3%)	22 (47.8%)	3 (13.0%)	11 (40.7%)	239 (43.5%)	164 (32.9%)	4 (19.0%)	489 (36.5%)
High School	5 (22.7%)	23 (36.5%)	8 (17.4%)	8 (34.8%)	8 (29.6%)	141 (25.6%)	157 (31.5%)	8 (38.1%)	379 (28.3%)
College	17 (77.3%)	5 (7.9%)	4 (8.7%)	10 (43.5%)	4 (14.8%)	20 (3.6%)	43 (8.6%)	4 (19.0%)	124 (9.3%)
Missing	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	3 (0.5%)	2 (0.4%)	0 (0%)	5 (0.4%)
OrderedLanguage									
English	22 (100%)	7 (11.1%)	6 (13.0%)	11 (47.8%)	2 (7.4%)	23 (4.2%)	49 (9.8%)	5 (23.8%)	157 (11.7%)
Spanish	0 (0%)	54 (85.7%)	40 (87.0%)	12 (52.2%)	25 (92.6%)	523 (95.1%)	442 (88.6%)	15 (71.4%)	1165 (87.1%)
Other	0 (0%)	2 (3.2%)	0 (0%)	0 (0%)	0 (0%)	4 (0.7%)	8 (1.6%)	1 (4.8%)	16 (1.2%)
YE									
Mean (SD)	31.7 (15.0)	5.33 (5.50)	9.16 (7.51)	19.3 (12.8)	10.3 (9.33)	5.96 (6.67)	10.9 (10.7)	13.7 (14.2)	9.22 (10.2)
Median [Min, Max]	26.5 [10.0, 61.0]	3.00 [0, 24.0]	8.00 [0.250, 40.0]	20.0 [1.00, 63.0]	9.00 [0.500, 31.0]	4.00 [0, 60.0]	9.00 [0, 77.0]	8.00 [1.00, 48.0]	6.00 [0, 77.0]
Missing	0 (0%)	0 (0%)	1 (2.2%)	0 (0%)	0 (0%)	3 (0.5%)	2 (0.4%)	0 (0%)	11 (0.8%)

Pre-and-Post Test Scores and Improvement in Test Scores

Table 3 provides pre-test, post-test and difference in test scores by language. Change in test scores when examining all language groups indicated that Spanish speakers improved the most from pre-to-post-test score (difference in score of 26.7 points), and that English speakers improved the least (difference in scores of 16.2 points) with speakers of “Other” languages as the middling group (mean difference in scores of 18.9 points) (Table 3).

Table 3: Pre-test score (baseline), post-test score, and improvement (difference) in test scores when examining all language groups

	English (N=157)	Spanish (N=1165)	Other (N=16)	Overall (N=1338)
Pre-percent				
Mean (SD)	79.9 (13.9)	61.3 (18.5)	71.6 (15.9)	63.6 (18.9)
Median [Min, Max]	80.0 [20.0, 100]	64.0 [0, 100]	73.0 [33.0, 93.0]	67.0 [0, 100]
Post-percent				
Mean (SD)	96.1 (6.43)	88.0 (11.6)	90.4 (9.93)	89.0 (11.4)
Median [Min, Max]	100 [60.0, 100]	93.0 [13.0, 100]	93.0 [67.0, 100]	93.0 [13.0, 100]
Difference in Score				
Mean (SD)	16.2 (13.0)	26.7 (17.1)	18.9 (11.1)	25.4 (16.9)
Median [Min, Max]	13.0 [-7.00, 73.0]	27.0 [-26.0, 100]	17.0 [1.00, 34.0]	26.0 [-26.0, 100]

Dairy Safety Test Questions

Table 4 describes the prevalence of dairy safety question topic type, summary statistics, and performance of both English and Spanish speaking groups; additionally, the reading ease scores of both English and Spanish questions as well as the prevalence of category of safety question and the percentage of correct responses selected by participants was computed and compared between English and Spanish speakers.

When identified by topic, dairy safety questions (in both Spanish and English) focused on Animal Handling/Behavior (60%), Personal Safety/PPE (26%) of Environmental/Occupational Hazards (13%). In both pre-and-post dairy safety questions, Spanish speakers scored lower, on average, than their English counterparts in all categories (Table 4).

Table 4: Reading ease descriptive statistics from dairy safety questions			
Reading ease summary statistics, stratified by language and question type			
Language and Question Set	Mean	Median	**SD,** (Range)
Spanish Pre-Test Questions (n=15)	67.004	66.448	**26.797**, (-8.059* – 105.768)
Spanish Pre-Test Questions, *Outlier Removed	72.169	66.448	**18.310** (47.315 – 105.768)
Spanish Post-Test Questions (n=15)	68.843	73.235	**15.465**, (38.623 – 90.485)
Spanish Questions Overall (n=30)	67.924	71.735	**21.52**, (-8.06* – 105.77)
Spanish Questions Overall, *Outlier Removed (n=14)	70.387	71.735	**16.609** (38.624 – 105.768)
English Pre-Test Questions (n=15)	66.265	64.925	**23.272**, (19.1 – 113.1)
English Post-Test Questions (n=15)	65.570	72.615	**25.931**, (12.425 – 114.115)
English Questions Overall (n=30)	65.920	68.77	**24.21**, (12.43 – 114.12)

Prevalence of test questions by topic, mean performance by topic, and number of responses/participants by language and pre/post-test question status (Spanish Question 10 outlier included)				
Summary Statistics and Number of Responses [Language] [n]	**Animal Handling/ Behavior Question** Pre: n=9 Post: n=9 60%	**Personal Safety/ PPE Question** Pre: n=4 Post: n=4 26%	**Environmental/ Occupational Hazard Question** Pre: n=2 Pre: n=2 (13%)	**All Types of Questions**

Mean Pre-Test Performance [Spanish] [n= 1,328] [English] [n= 327]	 [57.34%] [71.90%]	 [74.00%] [81.08%]	 [47.85%] [88.00%]	 [60.52%] [76.49%]
Mean Post-Test Performance [Spanish] [n=1,291] [English] [n= 286]	 [87.64%] [93.11%]	 [83.82%] [93.66%]	 [90.77%] [93.31%]	 [87.04%] [93.29%]

Table 5 describes the mean and median reading ease scores by the panel of native Spanish speakers, as well as individual ratings by panelist by dairy safety test question. Means and medians of reading ease scores did not exceed a score of 3 (see Appendix B for individual panel member ratings by question), on a 1 to 5 scale, with 1 being “very easy” and 5 being “very difficult” to understand. Questions 2, 5 and 11 in the pre-test had the highest means and medians from panelists, with ten questions having a mean greater than 1.25; eleven of the post-test questions had a mean greater than 1.25 (Table 5).

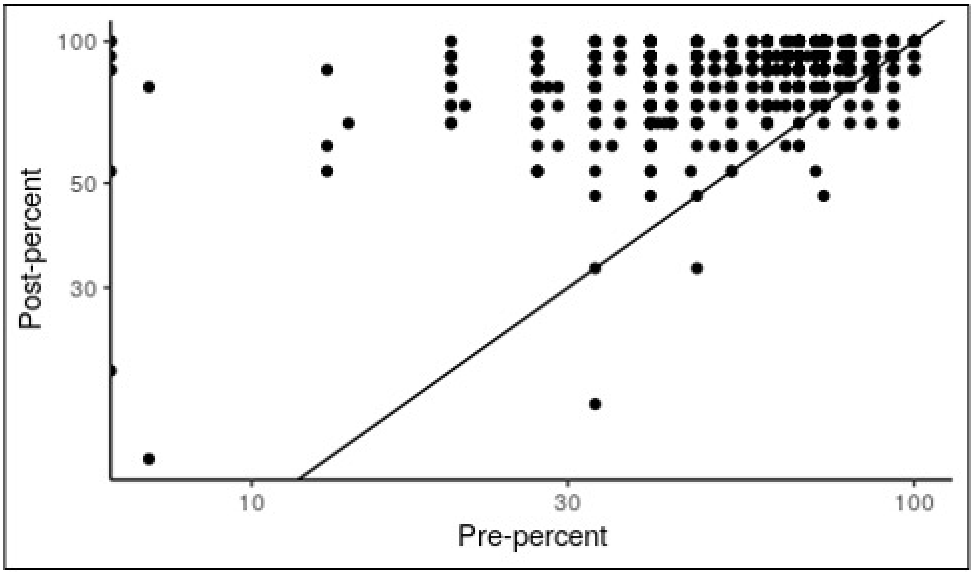
Table 5: Mean and median native Spanish speaker panel scores by dairy safety test question

Respondent Panel-Reported Literacy Score by Question (Spanish Pre-Test) *outlier included															
Question	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 5**	**Q 6**	**Q 7**	**Q 8**	**Q 9**	**Q 10**	**Q 11**	**Q 12**	**Q 13**	**Q 14**	**Q 15**
Mean Score	1	2.25	1	1	2.25	1.25	1.25	1.25	1.75	1.5	3	1	1	1.75	1.5
Median Score	1	2.5	1	1	2.5	1	1	1	1.5	1	3	1	1	1.5	1.5
Respondent Panel-Reported Literacy Score by Question (Spanish Post-Test)															
Question	**Q 1**	**Q 2**	**Q 3**	**Q 4**	**Q 5**	**Q 6**	**Q 7**	**Q 8**	**Q 9**	**Q 10**	**Q 11**	**Q 12**	**Q 13**	**Q 14**	**Q 15**
Mean Score	1.75	1.75	1.25	1.25	1	1	1.25	1.5	1.25	1.5	1.25	1	1.25	1	1.25
Median Score	1	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1

Predictors of Test Scores

In the pre-analysis phase, a number of bivariate relationships were conducted to assess key variables to include in baseline and change in test score models (see Appendix B for variables included in all five models). On a log scale, pre-test scores were initially predictive of post-test scores (p-value < 2.2e -16) (Figure 6).

Figure 6: Relationship between pre-test scores and post-test scores on a log scale



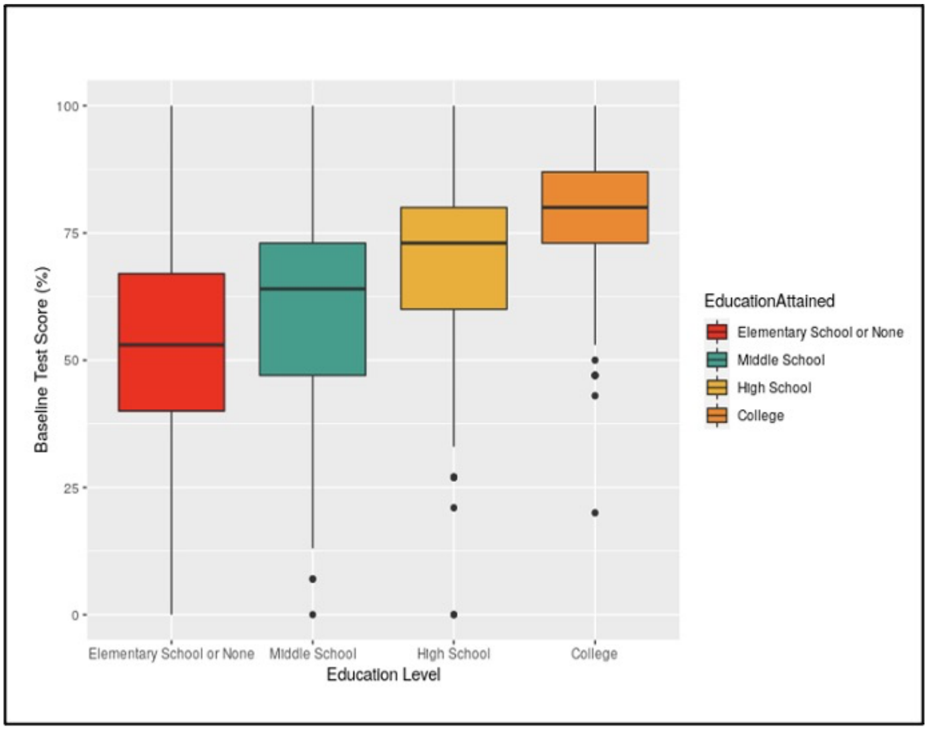
Greater number of years of formal education obtained by course participants was highly indicative of higher baseline test scores (p-value < 2.2e -16), with participants with an elementary school or no formal education scoring 17.2 points lower than those with a high school education, irrespective of language (Table 6) (Figure 7).

Table 6: Exploratory relationship between education and test scores, elementary school as reference category

	Estimates	**p-value**
Intercept	53.540	< 2e-16
EducationAttained Middle School	7.950	8.07e-11
EducationAttained High School	17.210	< 2e-16
EducationAttained College	25.210	< 2e-16

Multiple R^2: 0.177
Adjusted R^2: 0.1752
F-statistic: 95.28
p-value: < 2.2e-16

Figure 7: Relationship between education and baseline test scores



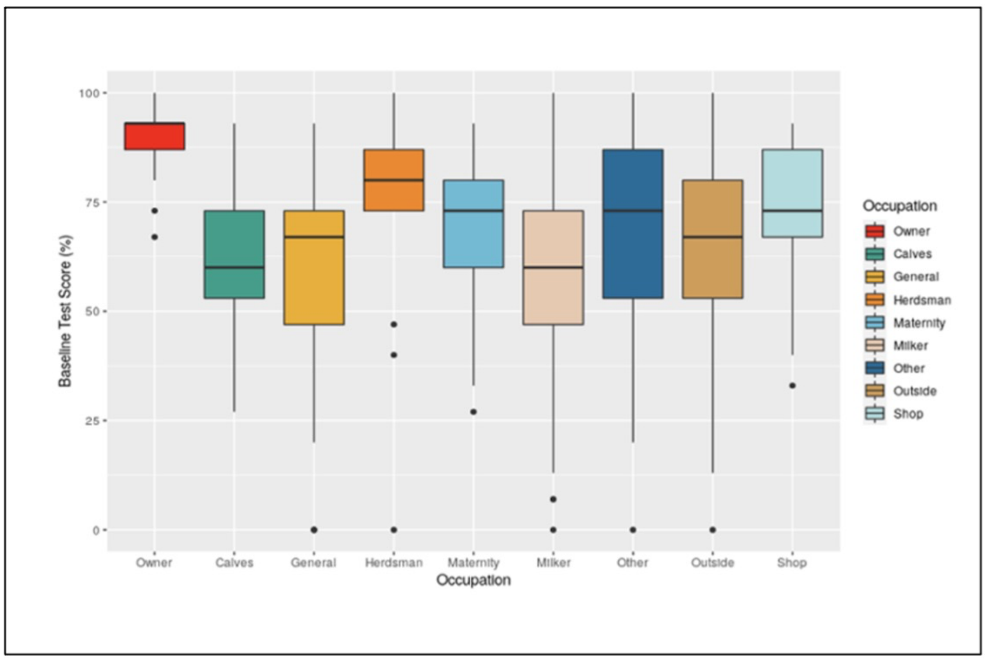
Similarly, differences in occupation resulted in significant differences between baseline test scores by occupation group. Course participants who identified as owners improved the least from pre-to-post test score (p-value = 1.789e-09) and scored higher in baseline test scores than all other occupation categories (Table 7) (Figure 8).

Table 7: Exploratory relationship between occupation and test scores, owner as reference category

	Estimates	p-value
Intercept	88.727	< 2e-16
OrderedOccupation Calves	-27.362	1.88e-09
OrderedOccupation General	-29.184	9.34e-10
OrderedOccupation Herdsman	-13.162	0.015791
OrderedOccupation Maternity	-19.690	0.000182
OrderedOccupation Milker	-29.551	1.77e-13
OrderedOccupation Other	-20.658	2.36e-06
Ordered Occupation Outside	-22.577	1.70e-08
Ordered Occupation Shop	-17.346	0.001889

Multiple R^2: 0.07525
Adjusted R^2: 0.06969
F-statistic: 13.52
p-value: < 2.2e-16

Figure 8: Relationship between occupation and baseline test scores



Analysis of Estimated Marginal Means estimated the mean differences between groups for the models of interest. Education level attained, and native language were necessary for inclusion in baseline test score predictor models, with some evidence that occupation be included because of the differences by category in mean responses for each factor, holding constant the other covariates in the model (Table 8) (see Appendix B for complete estimated marginal mean tables). Those with an elementary school or no formal education had the lowest mean baseline or pre-test score as compared to other groups (53.5 points); those with an occupation of "Milker" had the lowest mean pre-test score as compared to other occupational groups (59.2 points); by native language, Spanish speakers had the lowest marginal mean (6.13 points). The biggest contrasts by mean score for each category were between elementary school and college categories (difference in means of -25.21 points), owners and cattle workers (difference in means of 22.63 points) and English and Spanish speakers (difference in means of 18.55 points) (Table 8).

Table 8: consolidated estimated marginal means and contrast comparisons of education level, occupation and native language

Variable of Interest: Education	Estimated Marginal Mean (SE)
Elementary School or None	53.5 (0.931)
Middle School	61.5 (0.778)
High School	70.7 (0.883)
College	78.8 (1.544)

Pairs (degrees of freedom = 1329)

contrast	estimate	SE	t-ratio	p-value
Elementary School or None- Middle School	-7.95	1.21	-6.553	<0.0001
Elementary School or None- High School	-17.21	1.28	-13.409	<0.0001
Elementary School or None – College	-25.21	1.80	-13.981	<0.0001
Middle School – High School	-9.26	1.18	-7.870	<0.0001
Middle School – College	-17.26	1.73	-9.984	<0.0001
High School- College	-8.00	1.78	-4.498	<0.0001

Variable of Interest: Occupation	Estimated Marginal Mean (SE)
Owner	88.7 (3.915)
Milker	59.2 (0.783)
Cattle	66.1 (1.727)

Farm	66.1 (0.719)

Pairs (degrees of freedom = 1334)

contrast	**estimate**	**SE**	**t-ratio**	**p-value**
Owner – Milker	25.551	3.99	7.401	<0.0001
Owner – Cattle	22.639	4.28	5.290	<0.0001
Owner – Farm	22.619	3.98	5.682	<0.0001
Milker – Cattle	-6.912	1.90	-3.644	0.0016
Milker – Farm	-6.932	1.06	-6.523	<0.0001
Cattle – Farm	-0.0202	1.87	0.011	1.0000

Variable of Interest: Language	**Estimated Marginal Mean (SE)**
Bilingual	79.9 (1.433)
Dutch	69.9 (4.800)
English	83.5 (12.700
Spanish	61.3 (0.526)

Pairs (degrees of freedom = 1334)

contrast	**estimate**	**SE**	**t-ratio**	**p-value**
English- Bilingual	10.02	5.01	2.000	0.1883
English – Dutch	-3.62	12.78	-0.283	0.9921
English – Spanish	18.55	1.53	12.147	<0.0001
Bilingual – Dutch	-13.64	13.58	-1.005	0.7466
Bilingual – Spanish	8.53	4.83	1.766	0.2904
Dutch – Spanish	22.17	12.71	1.744	0.3013

Five iterative models were built with various demographic variables of interest analyzed from the pre-analysis. The “Full Model” was used to predict baseline test scores based on appropriateness of the line of best fit, high R^2 and adjusted R^2 values and superior AIC values as compared to other models (Table 9).

Table 9: AIC and BIC comparisons for five proposed models to predict baseline test scores (see Appendix A for linear regressions of models)				
Model	**Multiple R^2 Value**	**Adjusted R^2 Value**	**AIC**	**BIC**
A (Education, Language, Years in Dairy)	0.214	0.210	11265.3	11312.01
B (Education and Language)	0.2033	0.1997	11335.27	11376.83
C (Education, Language and Occupation)	0.221	0.215	11312.04	11369.19
D (Language and Occupation)	0.1239	0.1199	11505.13	11546.72
E ("Full Model") (Language, Occupation, Education Level and Years in Dairy)	***0.2258***	***0.220***	***11251.64***	11313.93

For the primary research aim, the linear regression used to predict higher baseline scores using identified variables of significant interest was most significant (the "Full Model") when years in dairy, occupation, education and native language were included in the model (p-value < 2.2e-16) (Table 10a).

Education was the primary driver of differences in baseline test performance when all languages were included within the model - participants with a middle school education scored an 8.9 points higher than those with an elementary school education or no education (p-value = 3.20e-13); participants with a high school education scored a 15.8 points higher than those with an elementary school or no education (p-value < 2e-16); and participants with a college or professional level education scored an 18.5 points higher on the dairy safety pre-test than those with an elementary school or no education (p-value < 2e-16) on baseline tests (Table 10a).

Prediction of baseline test scores only moderately significant when comparing milkers to owners (p-value = 0.05577), but Spanish speaking participants generally performed 8.5 points lower on the dairy safety pre-test then English speakers (p-value = 9.31e-07) (Table 10a). The variable of years spent in the dairy industry was only significant (p-value = 0.00179) when looking at all language groups (Table 10a), or when stratifying by Spanish language (p= 0.000220) (Table 10c). Years in dairy had no statistical significance when looking at English speakers only (Table 10b). Within the model for speakers of all languages to predict baseline test scores (Table 10a), estimates and p-values for Dutch speakers (p-value = .734), Bilingual speakers (p-value= 0.101) and those with occupations of "Farm" (p-value= 0.377) or "Cattle" (p-value= 0.166) were statistically insignificant within the model.

Table 10: Prediction of baseline test score using Model E ("Full Model") for all speakers, and stratified by the English or Spanish language

Table 10a: Prediction of baseline test scores for all speakers (n=1,138), owner and elementary school or no education as reference categories

	Estimates	p-value
Intercept	65.753	< 2e-16
Native Language Bilingual	-7.790	0.10134
Native Language Dutch	-4.086	0.73428
Native Language Spanish	-8.518	9.31e-07
FourOccupations Milker	-7.924	0.0557
FourOccupations Cattle	-5.879	0.16628
FourOccupations Farm	-3.544	0.37797
EducationAttained Middle School	8.8322	3.20e-13
EducationAttained High School	15.880	< 2e-16
EducationAttained College	18.594	< 2e-16
YE	0.158	0.00179

Multiple R^2: 0.2258
Adjusted R^2: 0.22
F-statistic: 38.39
p-value: < 2.2e-16

Table 10b: Prediction of baseline test scores for English speakers (n=157), owner and elementary school or no education as reference categories

	Estimates	p-value
Intercept	71.310	< 2e-16
FourOccupations Cattle	-4.770	0.22772
FourOccupations Farm	-6.310	0.04379
FourOccupations Milker	-12.423	0.00291
EducationAttained Middle School	5.287	0.47815
EducationAttained High School	14.958	0.01944
EducationAttained College	16.987	0.01032
YE	0.028	0.64759

Multiple R^2: 0.1852
Adjusted R^2: 0.1454
F-statistic: 4.645
p-value: 0.0001033

Table 10c: Prediction of baseline test scores for Spanish speakers (n=1,165), milker and elementary school or no education as reference categories

	Estimates	p-value
Intercept	48.443	< 2e-16
FourOccupations Cattle	0.710	0.719699
FourOccupations Farm	4.117	0.000176
EducationAttained Middle School	9.304	2.57e-13
EducationAttained High School	16.186	< 2e-16
EducationAttained College	19.860	5.42e-16
YE	0.250	0.000220

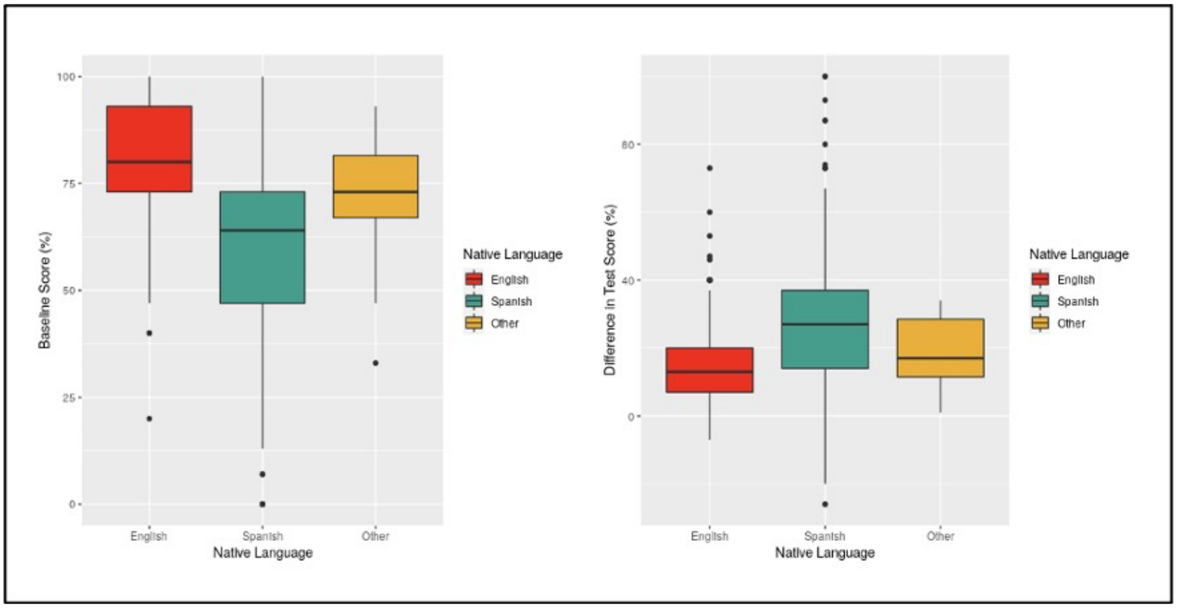
Multiple R^2: 0.1378
Adjusted R^2: 0.1333
F-statistic: 30.71
p-value: < 2.2e-16

When stratified by language group, education continued to be the biggest driver of prediction of baseline test scores. Compared to Spanish speakers with an elementary school level or no formal education, Spanish speakers with a middle school education had 9.3 point higher baseline test scores (p-value = 2.57e-13); those with a high school education scored 16.1 points higher on baseline test scores (p-value < 2e-16) as compared to those with an elementary school or no formal education; and those with a college or professional education had 19.8 point higher baseline test scores (p-value = 5.42e-16) than those with an elementary school or no formal education (Table 10c).

Examining the effects of education when examining English speakers only model (p-value= 0.0001033) (Table 10b), indicated statistical significance in difference in baseline test scores when comparing owners to occupations listed as “Farm” (p-value=0.04379) or Milker (p-value= 0.00291), with both of these positions scoring lower on the dairy safety pre-test than those who identified as owners. English speakers with a high school education scored 14.9 points higher on baseline test scores (p-value=0.01944), and those with a college education scored 16.9 points higher (p-value= 0.01032) than those who had obtained an elementary school or no formal education.

Participants with a higher education level scored higher on the dairy safety pre-test (Figure 9). English speakers (n=157) had the highest baseline test scores with Spanish speakers (n= 1,165) having the lowest baseline test score. Speakers of “Other” languages (n=16) had higher baseline test scores than Spanish speakers but had lower baseline scores than English speakers (Figure 9). Spanish speakers improved the most between baseline and post-test scores, and English speakers improved the least between baseline and post-test score (Figure 9).

Figure 9: Boxplots of baseline test score vs. change in test score by language



Baseline test scores were the most predictive and significant variables when looking at changes in test scores. “Pre-percent” (or baseline test score) was highly significant (p-value < 2e-16) when all speakers were included in the model (Table 11a), for English speakers only (Table 11b) and for Spanish speakers only (Table 11c). Education levels once again played a role in driving predictions of significant changes in test scores for participants with a middle school (p-value= 0.031258), high school (p-value= 0.000333) and college (p-value= 0.022224) education indicating significance in the combined language model (Table 11a). Education level attained did not show significance in prediction of change in test scores in English speakers (Table 11b). For Spanish speakers, having a high school education specifically (p-value= 0.00035) was the only variable which was highly significant in predicting change in test scores (irrespective of prediction of change in test scores using baseline test scores), while achieving a middle school education (p-value= 0.045) was moderately significant in prediction of change in baseline scores;

Spanish speakers identifying as “Farm” workers (p-value = 0.04) was only moderately significant in prediction of baseline test scores.

Table 11a: Prediction of change in test scores

Table 11a: Prediction of change in test scores for all speakers (n=1,138), owner, English language and elementary school or no education as reference categories

	Estimates	p-value
Intercept	73.162	< 2e-16
Native Language Bilingual	-3.655	0.196690
Native Language Dutch	-4.373	0.541561
Native Language Spanish	-1.936	0.062291
FourOccupations Cattle	1.276	0.613798
FourOccupations Farm	1.093	0.647844
FourOccupations Milker	-0.156	0.949531
EducationAttained Middle School	1.571	0.031258
EducationAttained High School	3.001	0.000333
EducationAttained College	2.785	0.022224
YE	0.007	0.809013
Pre-percent	-0.760	< 2e -16

Multiple R²: 0.6573
Adjusted R²: 0.6545
F-statistic: 229.3
p-value: < 2.2e -16

Table 11b: Prediction of change in test scores for English speakers (n=157), owner and elementary school or no education as reference categories

	Estimates	p-value
Intercept	82.503	<2e-16
FourOccupations Cattle	1.421	0.476
FourOccupations Farm	1.165	0.463
FourOccupations Milker	0.051	0.981
EducationAttained Middle School	-2.083	0.579
EducationAttained High School	-2.340	0.472
EducationAttained College	-0.940	0.780
YE	0.025	0.423
Pre-percent	-0.826	< 2e-16

Multiple R²: 0.7653
Adjusted R²: 0.752
F-statistic: 57.87
p-value: < 2.2e-16

Table 11c: Prediction of change in test scores for Spanish speakers (n=1,165), milker and elementary school or no education as reference categories

	Estimates	**p-value**
Intercept	70.989	< 2e-16
FourOccupations Cattle	1.298	0.27585
FourOccupations Farm	1.308	0.04854
EducationAttained Middle School	1.552	0.04525
EducationAttained High School	3.237	0.00035
EducationAttained College	2.189	0.14373
YE	-0.004	0.92850
Pre-percent	-0.758	< 2e-16

Multiple R^2: 0.6347
Adjusted R^2: 0.6325
F-statistic: 285.9
p-value: < 2.2e-16

Safety Knowledge Gained

In comparing statistical differences between baseline and post-test scores for English and Spanish speakers, both groups experienced significant improvement by Wilcoxon rank sum test between pre and post test scores (Table 12). The difference between pre-test and post-test scores was significant in both English speakers and Spanish speakers (p-value < 2.2e-16), with large magnitudes, and large effect sizes of 0.698 for both language groups (Table 12) (Figure 10).

Table 12: Wilcoxon rank sum test results for comparisons of baseline and post-test performance by English or Spanish language

Table 12a: Wilcoxon rank sum test results for English speakers (n=157)

	n	Median	IQR
Baseline	157	80	20
Post-Test	157	100	7

Effect Size and Magnitude: large, 0.698
V: 9566.5
p-value: <2.2e-16

Table 12b: Wilcoxon rank sum test results for Spanish speakers (n=1,165)

	n	Median	IQR
Baseline	1165	64	26
Post-Test	1165	93	20

Effect Size and Magnitude: large, 0.698
V: 627,280
p-value: <2.2e-16

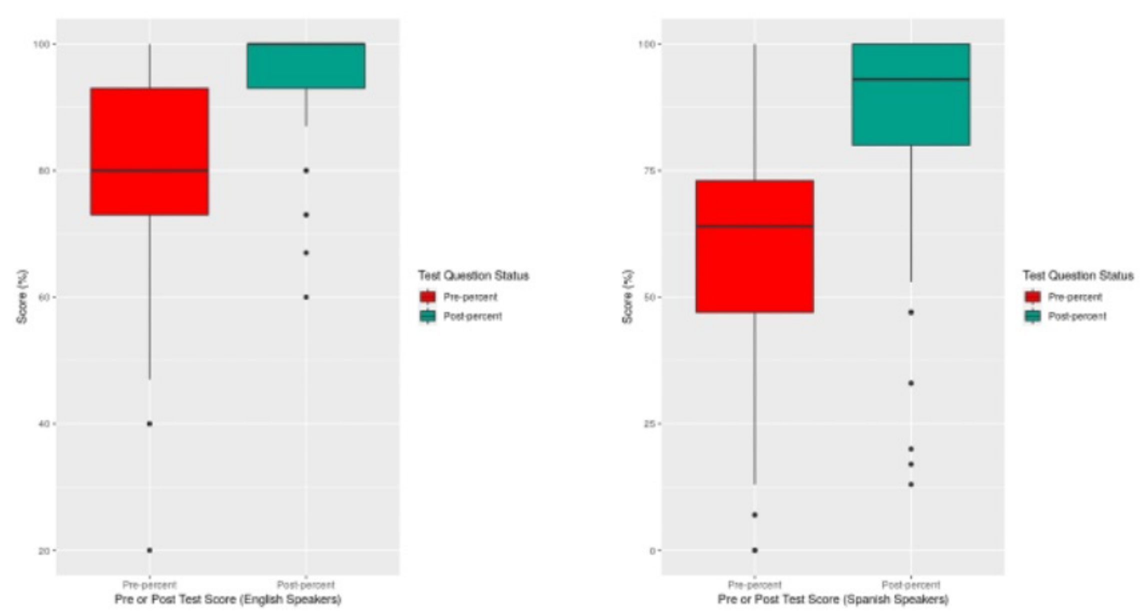


Figure 10: comparison of pre and post-test performance, stratified by language

Reading Ease Score as Predictor of Test Question Performance

For the secondary research aim, the linear regression analysis of participant performance by question by reading ease score (simple model) did not show a significant association for English speakers (p-value= 0.458) (Table 13a), Spanish speakers (p-value= 0.221) (Table 13c), or when native language groups were combined (p-value= 0.09985) (Table 13e). However, when adjusting for pre-or-post-test question status (adjusted model), stronger associations did emerge for all three models: English speakers (p-value= 0.022) (Table 13b), Spanish speakers (p-value= 0.0007549) (Table 13d), and combined language groups (p-value= 1.59e-05) (Table 13f). Adjusting for question status (either pre or post) resulted in the biggest improvement of models (Table 13), irrespective of language.

Table 13: Linear regression analysis of the association between reading ease and test performance, stratified by language and combined for language, comparing simple to adjusted models

Table 13a: Linear regression analysis of the association between reading ease between reading ease and performance by test question in the English language

	Estimates (CI)	p-value
Intercept	91.207 (72.924-109.49)	5.96e-11
Reading Ease Score Q's	-0.096 (-0.356- 0.165)	0.458

Multiple R^2: 0.020
Adjusted R^2: -0.015
F-statistic: 0.566
p-value: 0.458

Table 13b: Linear regression analysis of the association between reading ease between reading ease and performance by test question in the English language, adjusting for pre and post-test question status

	Estimates (CI)	p-value
Intercept	93.666 (72.099-115.234)	2.13e-09
Reading Ease Score Q's	-0.006 (-0.313-0.301)	0.969
Pre or Post	-4.177 (-36.412 – 28.058)	0.792
Reading Ease Score Q's*Pre or Post	-0.190 (-0.650 – 0.270)	0.403

Multiple R^2: 0.306
Adjusted R^2: 0.226
F-statistic: 3.815
p-value: 0.022

Table 13c: Linear regression analysis of the association between reading ease and performance by test question in the Spanish language

	Estimates (CI)	p-value
Intercept	97.630 (56.424-138.837)	4.42e-05
Reading Ease Score Q's	-0.348 (-0.917-0.222)	0.221

Multiple R^2: 0.05491
Adjusted R^2: 0.0199
F-statistic: 1.569
p-value: 0.2211

Table 13d: Linear regression analysis of the association between reading ease and performance by test question in the Spanish language, adjusting for pre and post-test question status

	Estimates (CI)	p-value
Intercept	71.034 (24.900 -117.170)	0.00399
Reading Ease Score	0.233 (-0.422 - 0.887)	0.47137
Pre or Post Question	43.590 (-29.471 - 98.650)	0.27670
Reading Ease Score Q's*Pre or Post	-0.888 (-1.775- (-0.001))	0.04964

Multiple R^2: 0.4842
Adjusted R^2: 0.4224
F-statistic: 7.824
p-value: 0.0007549

Table 13e: Linear regression analysis of the association between reading ease and between reading ease and performance by test question for both languages combined

	Estimates (CI)	p-value
Intercept	92.931 (73.838 – 112.023)	9.55e-14
Reading Ease Score Q's	-0.203 (-0.471 – 0.065)	0.135

Multiple R^2: 0.03871
Adjusted R^2: 0.02185
F-statistic: 2.295
p-value: 0.1353

Table 13f: Linear regression analysis of the association between reading ease and test performance for both languages combined, adjusting for pre-and-post-test question status

	Estimates (CI)	p-value
Intercept	87.178 (65.455-108.901)	7.44e-11
Reading Ease Score	0.044 (-0.264-0.353)	0.7741
Pre or Post Question	9.220 (-22.541-40.983)	0.5631
Reading Ease Score Q's*Pre or Post	-0.460 (-0.906 - (-0.014))	0.0434

Multiple R^2: 0.3627
Adjusted R^2: 0.3279
F-statistic: 10.43
p-value: 1.59e-05

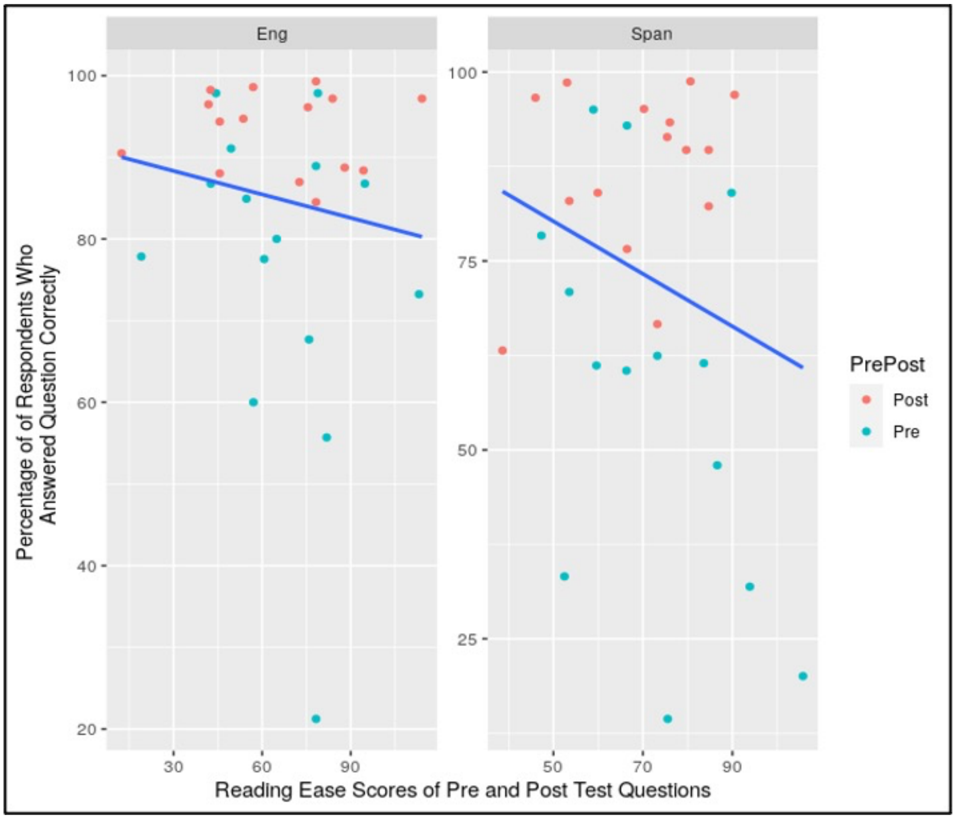
Adjusting for pre-or-post-test question status indicated the greatest improvements in multiple R^2 and adjusted R^2 models and AIC values, and presented greater statistical significance when pre-or-post-test question status was included for all adjusted models over simple models. Likelihood Ratio Tests indicated all adjusted models were superior to all simple models, with the Spanish adjusted model capturing the greatest percentage of variability of the model as it pertains to the regression line (multiple $R^2 = 0.484$) (Table 14); all AIC values were lowest for adjusted models over their simple model counterparts, regardless of language group (Table 14).

Table 14: Comparison of R^2 and AIC/BIC values examining the relationship between reading ease score and percentage of participants who answered question correctly: exploring language categories and comparing simple to adjusted models

Model	Multiple R^2 Value	Adjusted R^2 Value	AIC	BIC
English simple model	0.020	-0.015	257.649	261.852
English adjusted model	***0.306***	0.226	***251.307***	258.313
Likelihood Ratio Test model comparison (English speaker models): p = 0.0057				
Spanish simple model	0.055	0.020	270.475	274.577
Spanish adjusted model	***0.484***	0.422	***256.911***	263.747
Likelihood Ratio Test model comparison (Spanish speaker models): p = 0.0001535				
Combined language simple model	0.039	0.022	531.073	537.306
Combined language adjusted model	***0.363***	0.328	***510.822***	521.210
Likelihood Ratio Test model comparison (combined language models): p = 5.419e-06				

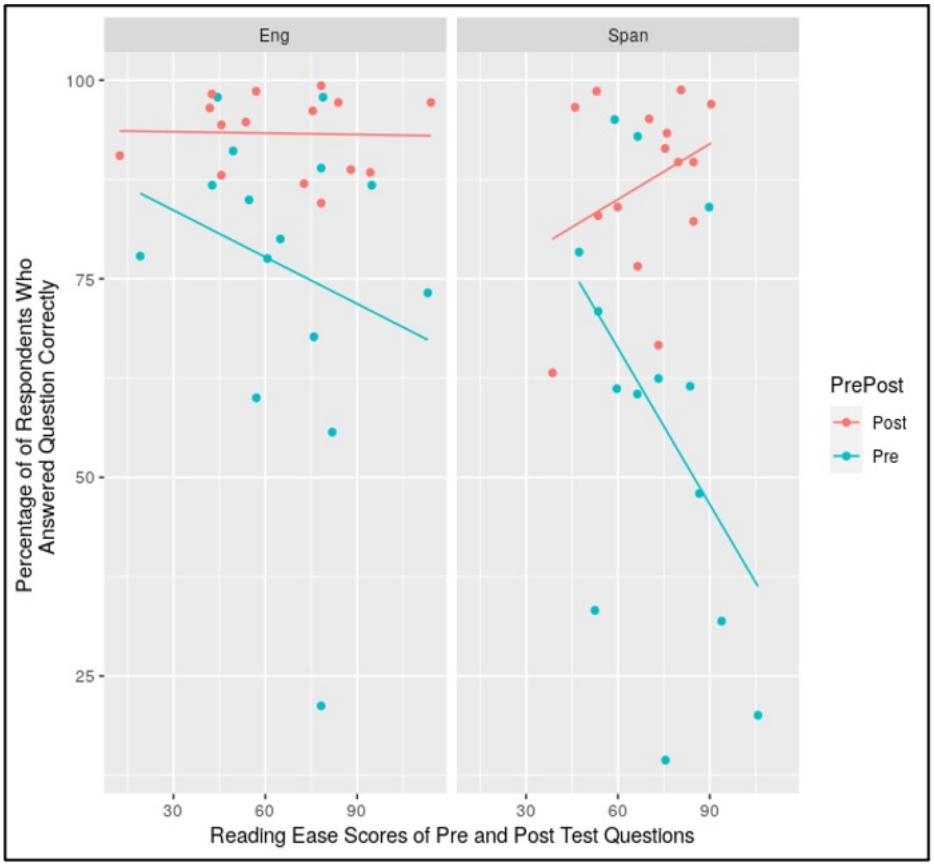
Graphically, when average reading ease scores (without adjusting for pre or post-test question status) were compared against the percentage of participants who answered test questions correctly, a relationship emerged where test questions with a *lower* reading ease score (or questions that were more difficult to read) actually had a greater percentage of participants who answered the question correctly for both English and Spanish speakers (Table 13a) (Figure 11).

Figure 11: Regression of Reading Ease of Question and Test Performance for combined pre-and-post-test questions, stratified by language (outlier Question 10 of Spanish pre-test removed)



Adjusting for pre or post-test question status resulted in more nuanced results for Spanish speakers (Table 13f) (Figure 12). Pre-test questions for both English and Spanish speakers were similar to the trends within the unadjusted graph (Figure 11). Post-test questions with a higher reading ease score (questions that were easier to read) had a greater percentage of participants who answered the dairy safety questions correctly for the Spanish post-test, while no associative relationship was presented for the English post-test (Figure 12).

Figure 12: Regression of Reading Ease of Question and Test Performance by Pre or Post, Stratified by Language (outlier Question 10 of Spanish pre-test removed)



Reading Ease Score in Concordance with Native Spanish Speaker Panel

For the tertiary research aim, the linear regression analysis of average Spanish speaker panel ratings of dairy safety test question as a predictor of reading ease score for each pre-and-post dairy safety question, did not show a statistically meaningful relationship (p-value= 0.054) (Table 15a) (Figure 13). Additionally, the linear regression analysis evaluating an association between average Spanish speaker panel rating by the percentage of course participants who answered the question correctly was not significant (p-value = .837) (Table 15b) (Figure 14). The majority of mean and median scores of all four panelists by question were between a 1 ("very easy") and a 2.5 ("easy"); a score of "4" was only given by one panelist for Question 1 on the post-test (see Appendix B).

Table 15: Linear regression analysis of the association between perceived reading ease by the native Spanish speaker panel and a) reading ease score and b) performance of participants

Table 15a: Linear regression analysis of the association between perceived reading ease by the native Spanish speaker panel and reading ease score (see Figure 12)

	Estimates (CI)	p-value
Intercept	88.057 (69.262 – 106.852)	3.29e-10
Panel Score	-12.540 (-25.317 – 0.237)	0.0541

Multiple R^2: 0.1306
Adjusted R^2: 0.09838
F-statistic: 4.055
p-value: 0.0541

Table 15b: Linear regression analysis of the association between perceived reading ease by the native Spanish speaker panel and participant test performance (see Figure 13)

	Estimates (CI)	p-value
Intercept	70.231 (40.346-100.116)	4.92e-05
Panel Score	2.057 (-18.260 – 22.373)	0.837

Multiple R^2: 0.001595
Adjusted R^2: -0.03538
F-statistic: 0.04314
p-value: 0.837

Figure 13: Regression of Reading Ease of Question and Native Spanish Speaker Panel Rating

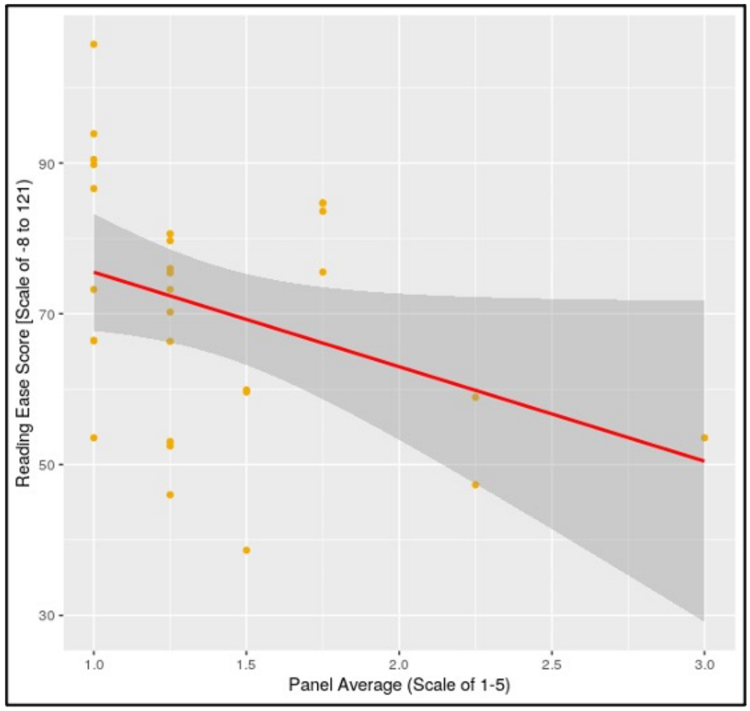
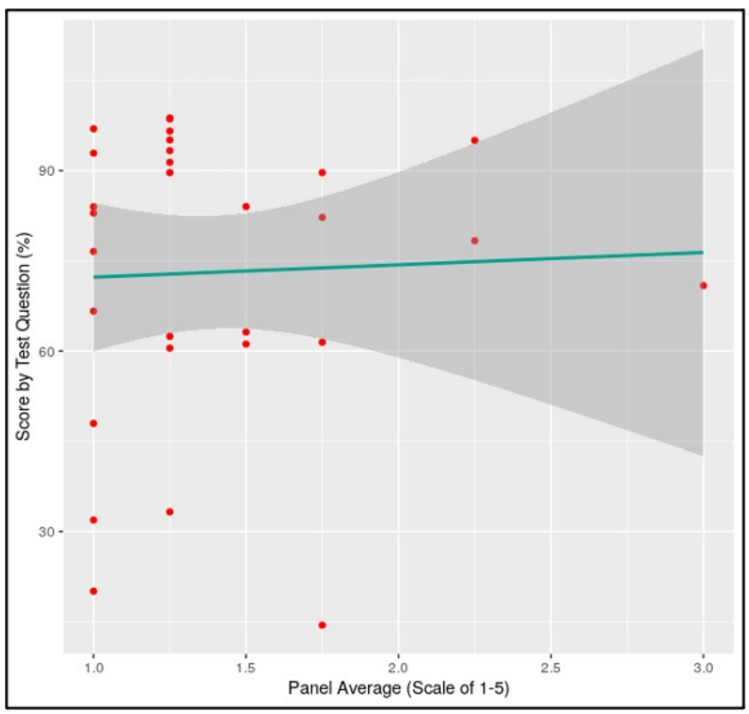


Figure 14: Regression of Test Performance and Native Spanish Speaker Panel Rating



DISCUSSION

This study of dairy worker safety training test scores identified a number of key points in the prediction of baseline and change in test scores amongst the demographic cohort of dairy workers, owners, and managers trained by the IDA's Worker Trainer and Safety Program. Additionally, these findings are in line with previous literature examining demographic information on dairy workers in the United States. Most importantly, prior research indicates that education level attained and native language of Latinx dairy workers are demographic factors of the study population which must be carefully considered when developing OHS trainings and are of the utmost importance when evaluating efficacy of OHS training.

Ultimately, education level was the biggest predictor of higher baseline test scores and was the most important and significant variable in the pre-analysis stage, with language and occupation acting as secondary drivers of higher baseline test scores; those who identified as owners and those who spoke the English language had higher baseline test scores than the majority of workers who identified as milkers and/or were Spanish speaking. Years in dairy was not a primary driver of baseline or change in test scores overall but was significant for those who spoke Spanish. Change in test scores were primarily driven by higher baseline test scores and most remarkably, education level of the participant, when investigating combined and stratified language groups. Both English and Spanish speakers statistically improved between baseline and post-test scores. Stratification of language groups presented significant findings in terms of SK gained within the limits of the IDA dairy safety test: English speakers improved less on the dairy safety test overall because baseline test scores were almost 20 points higher than Spanish speakers.

The secondary analysis showed little evidentiary support of a readability effect and using reading ease formulas to predict performance by dairy safety question – regardless of language, controlling for pre or post question status had the most bearing on model fitness as a predictor of performance, and was only significant when examining Spanish post-test dairy safety questions.

The tertiary analysis comparing native Spanish speaker panel reading ease scores to INFLESZ Scale reading ease scores was only mildly significant. Moreover, native Spanish speaker panelist reading ease scores could not be used to predict performance by dairy safety test question.

The demographic characteristics of dairy workers, owners, and managers in this study is directly in line with demographic information collected from past studies (9–12,16,17); most importantly, the majority of the dairy workers in this study identified as Spanish speaking where 70% had a middle school education or less, and worked as milkers originating from Mexico, and had fewer years of experience in the dairy industry.

In the pre-analysis stage, Estimated Marginal Mean comparisons and contrasts allowed for clarity as to which variables should be included in later prediction models, and which preliminary trends were apparent before building baseline test score prediction models.

In summary:

- Mean baseline test scores were lowest for those an elementary school education and highest in college educated participants
- Mean baseline test scores were lowest for Spanish speakers and highest for English speakers
- Mean baseline test scores were lowest for milkers and highest for owners

These distinctions are important because the results already indicate that there might be reason to treat variables such as education level, native language and occupation separately because of inherent differences in mean baseline test scores. Thus, the inclusion of education, occupation, and native language as variables of interest (in addition to years in the dairy industry) in the "Full Model".

The "Full Model" (Model E) was ultimately selected as the predictor for baseline test score model because of its high multiple R^2, adjusted R^2 and AIC values, as well as indicators from the pre-analysis that education, native language, occupation, and years in dairy demonstrated significant relationships when examining baseline test scores.

Using Model E, education was explicitly the main driver of higher baseline test scores when investigating all language groups combined, and when stratifying by the English and Spanish language – all education variables were moderately or highly statistically significant in prediction of baseline test score for all languages and was similarly important in baseline prediction models when stratified by English or Spanish language groups. It is important to consider that 89% of English speakers had a high school education or greater, while in stark contrast, 69.8% of Spanish speakers had a middle school education or less. Prior research has noted an inverse relationship between education and English as a first language and self-efficacy; while education and language were highly correlated, language was a more important predictor of self-efficacy as it relates to OHS training (57). Additionally, it has been previously noted that that the majority of Latinx dairy workers have little formal education (11,16,22,32,58–60), and that these study findings are in-step with all of the prior literature.

It is extremely important to note that within Spanish speaking dairy safety training course participants, illiteracy estimations provided by the IDA indicated that between 10-20% of participants were illiterate, or struggled to read (7), which is likely associated with fewer years of formal education in the Spanish speaking group. As this is an estimation, it is impossible to measure an illiteracy effect in either of the IDA provided datasets, and therefore cannot be measured within any of the prediction models. For future analysis, this value would be of exceptional importance so that it can be appropriately represented in future models.

Other than education, the results indicated that occupation and native language played some role in the prediction of baseline test score, and most importantly, that occupation and native language were closely related. The vast majority of dairy workers in the study were milkers (95.1% were Spanish speaking), while owners accounted only 1.6% of all dairy course participants, all of whom were English speaking – there were no Spanish speaking owners, an important distinction. From overall baseline score prediction models, lower baseline test scores were correlated with speaking Spanish and being a milker in addition to having fewer years of formal education. Conversely, higher baseline test scores were associated with being an English-speaking owner, outside worker, or "other" occupation (see Appendix C for full list of occupations as described by the IDA), and originating from the United States. Clearly, occupation may be driven primarily by native language spoken by dairy course participants.

Similarly, years in dairy as a predictor of higher baseline test scores was only significant when looking at Spanish speakers only - prior research indicates that few dairy workers have experience with cattle (14), and that the dairy workforce is made up of primarily immigrants who have little dairy experience (13), which would corroborate the concept that years spent in the industry is also related to the language which the course participant speaks, and that those who speak Spanish tend to have fewer years in dairy. Arguably, spending more time in the dairy industry as a Spanish speaker might result in higher baseline test scores because the nature of working on a dairy farm might make safety subject matter more familiar to those who have worked in the industry longer. The significance of years in dairy in certain language groups indicates that years in the dairy industry is also closely related to occupation (due to the fact that status as a milker is seen as a more entry-level position with fewer years of experience in the dairy industry, while owners would conceivably have spent the most time in the industry of any occupation).

Models for change in test scores were primarily driven by baseline test scores, which is not an odd finding. Higher R^2 values (which capture higher variability in data) for change in test score models are a direct result and highly correlated to baseline test scores – due to the high statistical significance of previous baseline test score models, this variable had the highest predictive value of change in test scores. When examining English and Spanish speakers together, baseline test score was the most significant indicator of changes in test score: lower baseline test scores enable more room for improvement. Ultimately, Spanish speakers had the lowest baseline test scores, but improved the most on the dairy safety test provided by the IDA when measuring changes in SK because their baseline test scores were lowest of any language group. Further, when investigating Spanish speakers, results in change in test scores indicated that more educated workers improved more between baseline and post-test scores, an important finding.

The impact of years of formal education also played a role in prediction of change in test scores, which was not anticipated, but extremely important. When examining English and Spanish speakers together, level of formal education attained significantly impacted changes in test score across all education levels, especially when comparing those with a middle school education to those with an elementary school or no formal education. When investigating the model for Spanish speakers, baseline test score *and* higher levels of education were highly correlated to change in test score when comparing those with an elementary school education or less to those with middle school and high school level educations. The only relationship for which statistical significance did not hold was when comparing Spanish speakers with a college education to those with an elementary school or no formal education: only 5.2% of Spanish speakers had a college education or greater, with the small sample size likely contributing to this smaller effect size within the analysis. When stratifying by English language, the model for change in test score was highly driven by baseline test score, and education level as a predictor for changes in test score was not significant at any level. This indicates that the role of years of formal education is *imperative* to consider and understand for Spanish speakers in order to predict gains in SK, while change in scores for English speakers is related to other factors.

Occupation and years spent in dairy were not great predictors of change in test scores when looking at combined language groups, or for English speakers. Occupation was only moderately statistically significant for Spanish speakers who fell into the "Farm" occupation, but due to the generalist coding of various occupations to those who worked with cattle and those who did not (when occupations are not binary) may have clouded these nuances.

It is important to note that the ultimate goal of the IDA was to verify that dairy workers who participated in the OHS training intervention were able to significantly improve their dairy safety knowledge scores (measurements of SK) between baseline and post-test scores (7) – this course goal was met, with all language groups (English, Spanish and "Other") statistically improving between baseline and post-test scores. While Spanish speakers showed more improvement between baseline and post-test scores over their English-speaking counterparts, it is evident that this is because baseline test scores were the lowest in the Spanish speaking group as compared to all other language groups. This study indicates that there is strong evidence that there are inherent differences between test performances of dairy workers are based primarily on language group, and that assessments of efficacy (changes in SK) may need to be re-evaluated to ensure that the assessments are best suited to the specific population of interest.

Across all findings for the primary aim, it is clear that education is the biggest driver of baseline and change in test scores, which makes the consideration of measurements of efficacy using changes in SK very important. Previous studies have also indicated the importance of tailoring OHS training to participant characteristics such as education and literacy levels, especially as it relates to dairy workers who speak English as a second language. As Arcury et al. reported, limited education among agricultural workers may affect safety training in several ways including 1) limited literacy, 2) limited development of learning skills, and 3) limited ability to learn complex concepts (18). Assessments of SK were not significant in studies focused on very young migrant workers where training materials were only provided in the non-native language (40); given that the majority of participants in the IDA dairy safety training course had fewer years of formal education than their counterparts in other language groups, it is incredibly important and helpful that the course material and assessments were translated into Spanish, in both written and oral form. However, very few studies, with a few exceptions (9), have previously assessed reading ease of written assessments intended for the population of interest, despite indicating the importance of cultural sensitivity and delivery of linguistically appropriate OHS training for the population of interest within the study conclusions (9,10,12,35), and despite the demographics of dairy workers, who possess low literacy rates and few years of formal education (16,23) being well-understood.

Given that years of formal education is the biggest driver of baseline and change in test scores, for improvement of the IDA training course in order to better protect dairy workers through OHS, there are several aspects of the findings which should considered in order to make improvements to the IDA's Worker Training program: 1) collect and understand information about participants as it relates to years of formal schooling and illiteracy for future trainings and recognize that changes in SK may reflect the ability of participants to take tests rather than knowledge gains; 2) acknowledge that m-learning, while convenient, may have limitations in regard to delivery of OHS training for the population of interest; 3) continue to use bilingual trainers to present OHS training and information to augment positive health and training outcomes; and 4) eliminate the use of pre-post-test assessments and efficacy measures of SK in favor of other methods such as changes in SBs, SABs and eventually strive to measure changes in HOs as the gold standard.

Recommendation 1 – Measure Rates of Illiteracy and Recognize Base Safety Knowledge Contributors from Characteristics of Course Participants

For the IDA and future of the Dairy Worker Safety and Training Program, the most important aspect to consider is the challenges experienced by the population of interest in terms of language and literacy, especially given that the majority of dairy workers in the study (62%) have a middle school education or less years of formal education, and that 10-20% are illiterate (7). For future development of the dairy safety training course, prevalence of participant illiteracy should be collected by bilingual trainers and noted by administrative staff for future research, implementation, and assessment of curriculum design to better tailor future trainings once true illiteracy rates of the population of interest are known. It is recommended that setting a baseline of illiteracy in the study population would be the first step for future studies and for further improvements to the Training Program, especially if changes in SK are to continue to be measured as indicators of course efficacy. While changes in SK are frequently use pre-and-post assessments (9–11) to assess changes in SK and are generally effective (31,45), it is imperative that materials be presented in the native language (40), and that assessments are conducted at future points with the population of interest to truly measure changes in knowledge (43). It is a benefit that the IDA presents information to dairy workers in native and preferred languages (7), but assumptions that course participants can read and write in their native language, which is not always the case (47), may present problems and limit efficacy evaluations of the safety training course.

With the format of the dairy safety test being written, as well as the traditional presentation and assessment of SK gained, it is also important to highlight that fact that participants who are English speaking and originate from the United States may have an advantage in the ability to simply take tests as opposed to their Spanish speaking counterparts, resulting in higher baseline test scores in English speakers. Higher levels of education achieved by course participants from the United States (98% of English speakers in the study were from the US) might indicate more time and advantages in a “traditional” Western schooling format, where written tests are a common assessment tool used by schools and universities. Conversely, the majority of Spanish speakers were foreign-born, and likely did not have as many years of formal education in US-based schools, which may have contributed to lower baseline test scores.

The importance of education level correlating to higher baseline tests is also further supported by the relationship demonstrated between years of experience in the dairy industry and baseline test performance in the Spanish speaking group – it was clear that number of years in the dairy industry did result in higher baseline test scores for Spanish speaking groups, while it had no effect when examining English speakers. This parallels the theory of years spent in Western schooling environments improving baseline test scores – as a milker, more time spent with cattle and on a dairy may provide higher levels of basic safety knowledge due to experience than years of formal education alone.

Recommendation 2 – Consider alternatives to m-learning to best suit population of interest

Alternatives to using electronic m-learning to provide dairy safety information might be considered – while utilizing m-learning tools is importance from a convenience standpoint (11,38), incorporation of group work and discussion, identification of hazards and perceptions of hazards by workers, and other strategies *in* addition or in place of m-learning might be an alternative solution to improve safety outcomes for dairy workers.

The IDA utilized iPads to present training vignettes in video form, which is both convenient and allows for multiple training sessions on a dairy because of the approximately 1.5-hour timeframe and a lack of space for trainings noted by trainers and course creators (7,11). While the training videos and video scripts were not analyzed for this research and cannot be commented on in terms of efficacy, it is important to highlight that these OHS training videos were provided on an individual basis with little room for interactive learning amongst peers, which may not be best suited for the population of interest.

For example, introducing safety programs that use alternative teaching formats and strategies such as pictograms, group work and discussion, illustrations, and hands-on training opportunities with cattle will assist in addressing challenges for non-English laborers (61). Hands-on training methods and simulations were found to be more engaging and more effective in terms of knowledge acquisition (45) and reduction of negative outcomes (36). As presented by Román-Muñiz et al. (2016), task-based training and training by a co-worker were the only variables which had a significant protective effect of Latinx dairy workers (12). Furthermore, Román-Muñiz et al., 2016, Rodriguez et al., 2018 and Juárez-Carrillo et al., 2017 suggested that hands-on training be incorporated into future training sessions because of its importance and proven efficacy (9,11,12).

While presentations and discussion in small groups will take longer to present and implement than the presentation of the training course using m-learning, it would allow for more appropriate format and application of course content to the demographic and linguistic group which represents the vast majority of those who take the training course; alternatives to m-learning content presentation would incorporate group-based trainings and activities which may be more impactful than learning on an individual basis, and provide greater changes in SK (the primary course goal). (7)

Recommendation 3 – Continue Use of Bilingual Trainers

Continuing to utilize bilingual trainers to help facilitate and operate the IDA dairy safety course is exceedingly important – these trainers can offer support with comprehension and stimulate deeper thinking about course questions in addition to continuing to provide technical and other support during the training course. A greater number of trainers or assistants should be utilized within the IDA Worker Training course to adapt to a greater need for oral presentations, either of training material or SK efficacy assessments (should the current course format be continued in future OHS trainings).

It is important to recognize that alternative human-centric methods, such as interviewer-administered questions and working in teams to answer questions, may work better with low-literacy populations when measuring changes in SK. Playing games to review course content, using visuals, multiple choice questions with pictures and oral checklists or hands-on demonstrations (36) are also more interactive between course participants, and may improve changes in SK, and could also be further facilitated by bilingual trainers utilized in the IDA's training course. Evaluating efficacy utilizing improvements in SBs and SABs (which are most significant when using community-based approaches for SBs and peer educators for SABs) (31) might be more beneficial given the structure of the IDA dairy safety course: the bilingual trainers already closely interact with dairy workers in the course and answer questions in the current course structure, both during the pre-and-post-test assessments and the intervention. Additionally, senior workers on the farm could also aid in the training of course participants as another training alternative or augmentation. Therefore, bilingual trainers are an asset to the dairy safety course, no matter the format of the training because of the benefits illustrated by using human-centric presentations of safety information.

Recommendation 4 – Eliminate Pre-and-Post-Test Assessments of SK in Favor of Other Methods

Utilization of pre-and-post assessments to signify SK gains is not new and is often used to assess efficacy of OHS training (45), but may have limitations for populations which cannot have changes in SK reassessed over longer periods of time (from months to years). For example, significant SK gains have been noted in studies where the process adopted for the design of the training program has been described, and when pre-assessment and post-assessment tests are used *months* beyond the initial assessment (31,43) in order to measure behavioral changes (SBs) due to applied knowledge gained in work activities (43), and not necessarily by SK measurements alone over one time interval.

Pre-and-post tests can be used over the span of hours, before and after an intervention as seen in the case of the OHS course implemented and delivered by the IDA (7). Doing so achieves a Level 2 within the Kirkpatrick Model when evaluating changes in SK (43). However, to achieve Level 3 (behavior changes due to applied knowledge gained in daily work activities), the use of additional "refresher" training needs to be completed months after. It has been well described that longitudinal efficacy assessments of dairy workers in an occupational space are rare (15) chiefly due to time constraints surrounding training (9,10,62) and a lack of formal classroom space (10,35), which can ultimately lead to discontinuation of pre-and-post assessments of SK and efficacy (10,35).

Considering this, utilization of written pre-post-tests specifically to evaluate SK may be ill-suited for participants who: are illiterate, have low levels of formal education, may be unfamiliar with traditional Western style learning and classrooms. Furthermore, changes in SK over time are better measures of efficacy, as compared to measurements taken at two timepoints bookending the training intervention, as demonstrated by the Kirkpatrick Model (43).

Furthermore, removing the format of a written pre-and-post assessment as indicators of success (by measuring changes in SK) and replacing with alternative assessments of OHS program efficacy (and measuring baseline SBs, SABs or HOs) may be more beneficial given the population of interest. Based on previous research, group-based or community-based approaches as it applies to workers demonstrates significant changes in SBs (31); SABs are most significant in underserved populations when using peer educators or community health workers (36). In contrast, SK may not be as effective for very young migrant workers (40), of which the majority of course participants fit this description.

Despite the challenges associated with measuring rates of injury and illness in migrant populations, it is important for researchers within this occupational health space to create studies that investigate changes in HOs when utilizing OHS interventions, despite the challenges with small sample sizes (10,12,17), and the lack of research which quantifies changes in illness or injury rates before and after OHS training (17,31,37,39).

While the IDA training course did show statistically significant gains in terms of SK gained by way of changes in test scores between baseline and post-test scores, given the demographic makeup of the population of interest, and given the alternative ways in which efficacy can be measured, it is worth considering alternative methods of presentation, delivery and evaluation of the Worker Training and Safety program.

For the secondary analysis, the linear regression analysis of prediction of percentage of participants who answered dairy safety questions correctly using reading ease score was largely insignificant but did show better fitting models for those who spoke Spanish and when adjusting for pre-or-post-test questions. There was some indication that the model for a readability effect might have some predictive value for those who speak Spanish (as R^2 values captured roughly 50% of the variability), but that baseline test scores are directly correlated to post-test scores (and thus contribute to differences in test scores) and adjusting for pre-or-post-test question lead to the best model fit. Ultimately, the relationship between the two variables for the secondary research aim was not significant enough in either language group to indicate that using the Flesch Kincaid or INFLESZ reading ease formula or scale may not be nuanced enough to predict performance amongst the population of interest, due to a number of factors largely related to limitations of reading ease formulas in real-world settings and within the constraints of the dairy safety test questions.

Explanations as to a lack of a readability effect could include the difference in effect size comparing English speakers and Spanish speakers: there were almost ten times the number of Spanish speakers to English speakers, which magnified the effect size, depending on language group. A "coaching" effect might be present in models for Spanish speakers only (that is, that questions that were more difficult actually had a higher percentage of respondents who answered the question correctly due to support in answering more difficult questions from bilingual trainers). Additionally, a familiarity effect could be present in that some topics (such as Animal Handling/Behavior) might be more intuitive to answer than questions pertaining to Environmental Hazards or other topics because of the difference in terms of prevalence of the topic (Animal Handling/Behavior made up the majority of test questions), and that the majority of workers work with cattle rather than in a farm support position. Additionally, more years spent in the dairy industry within the Spanish speaking group may have contributed to differences in performance by test question topic.

Additionally, as the literature has made clear, readability of written materials (especially in languages other than English) is important, but many readability tools are limited in their scope due to adaptations between languages (53), assumptions that the population of interest can indeed read and comprehend information at their prescribed reading level (51,63), the assertion that most research focusing around Spanish readability is from the healthcare field (52,53,55) and not the dairy industry, and most importantly, that the Flesch-Kincaid reading formula (as the foundation of the Spanish INFLESZ formula and scale) is intended for passages of 100 words at minimum (51). The format of the questions provided from the IDA are not greater than 100 words, and usually only contain one to two sentences; additionally, one-word responses of "True" and "False" or responses made up of less than five words are not suitable to be assessed with the Flesch-Kincaid or INFLESZ formula. Thus, the responses to dairy safety questions were given less weight than the reading ease scores of the dairy safety questions themselves. Additionally, the exclusion of Question 10 as an outlier from the Spanish pre-test resulted in a weaker correlation between reading ease score and performance by dairy safety test question due to a smaller sample size (n=29 instead of n=30).

The use of the reading ease 1 to 5 scale provided to native Spanish speaker panelists was limited in that the INFLESZ reading scale could only be loosely applied; the cut-points of reading ease difficulty provided in the panelist survey matched the cut-points on the INFLESZ reading ease scale, and were intended to correlate the two values, but did not apply well. Only one panelist rated any IDA dairy safety question as higher than a "4", showing low concordance with the INFLESZ reading ease scale. Ultimately, the perceived reading ease of the pre-and-post dairy safety questions, on average, indicated that the mean and median all of the test questions regardless of pre-or-post-test question status were rated as a 1 (correlating to reading ease score of >80 or "very easy") or a 2.5 (correlating to a reading ease score of 65-80 or "easy") on a 1-5 scale, and did not show a significant statistical difference or trend. This significantly lessens the ability to verify concordance between reading ease scores dictated by traditional reading ease formulas with the native Spanish speaker panel.

Panel rating scores as prediction of reading ease scores was only mildly significant, but the implications of utilization of native Spanish speakers to adjudicate written materials in Spanish is important. Recommendations for the IDA as it relates to findings utilizing panels of native Spanish speakers and assessing reading scores or comprehensibility using language tools would be in the same vein: to utilize culturally appropriate focus groups from the population of interest to develop additional teaching vignettes or videos, and to consider testing safety knowledge questions (or other written content) utilizing native Spanish speakers to ensure written content is suitable. While panel ratings of reading ease difficulty by native Spanish speakers was not able to be correlated to reading ease score or to predict safety course participant performance by question, continuing to utilize focus groups to aid in safety course curriculum development and content and appropriate revisions (10,11) and consideration of cultural nuances as it relates to course content (10,35) are imperative to providing adequate safety course training within the dairy industry (16) and to protect worker safety (18). While the utilization of native Spanish speakers and/or Latinx dairy workers to develop OHS training for dairy workers (9,62) *is extremely important*, the inclusion of Latinx dairy workers, from understanding day-to-day tasks and perceptions of work and incorporating dairy worker comments and feedback in development of OHS training materials should not be understated in the development of OHS course curriculums and presentation methods.

To the researcher's knowledge, there is no research which has used panel rated reading ease scores compared to formal readability scores. However, due to the limitations of the use of reading ease formulas mentioned above, it is difficult to then draw conclusions as to the correlation of reading ease scores to panel scores or reading ease and participant performance by dairy safety question. Nevertheless, utilizing the native Spanish speaker panel was important in this analysis to provide additional linguistic and cultural verification of OHS training materials in practice, rather than just relying on readability scores with distinctive limitations in real-world settings.

LIMITATIONS

The biggest limitation in the primary analysis was the inability to link data from the PrePost and Demographic Dataset to the Question Datasets, as the Question Data was unpaired and deidentified from the Demographic Dataset. If these two datasets had been able to be linked, there would have been a more robust sample size to support the hypothesis surrounding a potential “readability effect”, and further, more nuanced, analysis could have been conducted because performance by dairy safety question would have been able to be linked to self-reported education level of the participants, potentially resulting in a stronger correlation value. Because the participants were unpaired it was impossible to match English pre-test responses and participants (n= 327), for example, to English post-test responses and participants (n= 286), and thus participant improvement in the dairy safety course could not be effectively measured. If the two datasets had been linked, there would have been the potential to compare participant performance by language group or by topic. For example, linking these datasets might have been able to illustrate trends such as English speakers performing better on multiple choice questions than their Spanish counterparts, or Spanish speakers performing best on questions related to cattle handling and safety.

Additionally, an important limitation of the study is the inability to quantify and incorporate 1) the participants within the study who were illiterate and 2) to not know the magnitude of illiterate individuals within the population of interest. As previously mentioned, course administrators guessed that illiteracy was roughly between 10-20% and note that many of the participants struggled to read (7), but further information was not provided for the population of interest, nor were these individuals identified in the data. It has been well described that the population of interest has fewer years of formal education (16,22,32,58–60,62) and low levels of literacy (16), and this study population is well-aligned to previous findings. Therefore, being able to quantify rates of illiteracy among Latinx dairy workers in research such as this is crucial, for both further evolutions of the IDA dairy safety course, and for other studies, as it has been demonstrated that education level is the primary driver of changes in SK. As illiteracy was unable to be properly and formally quantified, illiteracy as a variable was unable to be incorporated into prediction models for baseline test scores and changes in test scores. Understanding true levels of literacy in the population of interest might provide incentive to alter efficacy evaluation in regard to the IDA training course: evaluating changes in SK might not be as valuable to indicate improvement in the population of interest as measuring changes in SBs or SABs, as previously mentioned.

Another present limitation would be the way in which occupation was coded. The consolidation of the original nine occupational categories to four primary occupations (Cattle, Farm, Milker and Owner) may cloud distinctions of occupations and jobs roles and responsibilities, and its effects may have been lessened when incorporated into baseline and change in test score core models. The "Cattle" and "Farm" occupational labels were roughly made up of those who worked primarily with cattle and those who worked primarily without cattle, respectively, but these categorizations were not strictly binary – it is entirely possible that occupations on the farm could overlap.

The biggest limitations of the secondary and tertiary analyses were in some ways inhibited by the use of the Flesch Reading Ease formula and the INFLESZ formula to quantify reading ease of pre-and-post test questions, in addition to the small sample sizes (n=60). The biggest limitation presented by use of the Flesch Reading ease scale (and well recognized by Flesch) lies in the assumption that adult reading abilities are at the level of the highest grade completed in school (51). Additionally, the Flesch Reading Ease formula requires several samples of 100 words (51), of which the test questions in this study were never over 50 words. These limitations similarly apply to the INFLESZ formula, which was originally adapted from the Flesch Reading Ease formula.

Additionally, the reading ease formulas are often not applicable in real world settings. The outlier in the Spanish Question Dataset, "Question 10" ("Las vacas tienen buena audición (oído). No es necesario gritar, chiflar, o golpearlas para tener su atención.") had a very low reading ease score (a -8 on the INFLESZ scale, which would correlate to "scientific" level reading, and is not really intelligible on the scale, but is possible). However, the "-8 reading ease score" is due to the limitations of the INFLESZ formula, as neither it nor the Flesch-Kincaid score are suitable for very short passages and responses with one-word answers, such as "True" or "False". Therefore, this question was excluded from secondary and tertiary analyses, making the sample size even smaller. While not within the scope of this project, the reading ease scores could have been generated for the script used in the safety training vignettes to get a better understanding of presentation of the actual training materials, as these scripts, and thus passages, were longer, and better suited to using reading ease formulas.

Similarly, comparing reading ease against a panel where reading ease was designated on a scale of 1-5 is, at best, only roughly able to correlate to the unrelated INFLESZ scale (0-100), and does not leave room for nuance in terms of comparing mean and median panelist scores. It is also important to note that these four panel members have achieved a higher education level than the average Latinx dairy worker (as they were sourced from an agricultural research center), and that the other demographics of these four panelists (such as country of origin and years in dairy work) were unknown, and could not be applied within the analysis.

The biggest strength of the primary analysis is the robust sample size (n= 1,338) of the PrePost and Demographic Data. Past research that small sample sizes of Latinx dairy workers are the norm rather than the exception (10,12) – it is invaluable to the analysis that the IDA was able to collect such extensive and complete data from the population of interest and should be viewed as an achievement for the industry.

It is also worth noting the importance of quantifying and measuring outcomes of interest (in this case, SK gains or improvements in SK) to inform efficacy of the training course provided by the IDA. In addition, future OHS trainings from the association could investigate longitudinal changes in SK over the periods of weeks or months, changes in SBs and SABs of dairy workers, and of course, measurements of HOs before and after interventions in future trainings and studies when possible.

The generalizability of the study is also good in that methods and analysis used to analyze and predict test scores by language group in this study could be applied to dairy workers in other areas of the country.

DIRECTION FOR FUTURE WORK

The importance of culturally and linguistically appropriate training for Latinx dairy workers needs to continue to be a priority for occupational health and safety researchers within the dairy industry. Incorporation of worker perspective and having cultural representation in the development of training will in turn better protect workers (16). Additionally, it has been shown that improved transfer of knowledge (improvements in SK) was greater amongst workers who received culturally and linguistically appropriate training (18,31,40,45). Latinx focus groups made up of dairy workers can aid in creation of course structure (workers can provide information about workflows and timing on site) and course content (perceptions and base knowledge will provide insight about what topics are important to cover in training); input from Latinx dairy workers when writing and developing safety and training course curriculum is invaluable to ensure that the presented information is well-received and understood, especially in dairy work.

In regard to data collection, a recommendation for future research utilizing IDA Worker and Safety Training Program would be to match responses by dairy question (Question Datasets) to pre and post-test performance information collected in the Demographic Dataset. It is also important to collect information on performance by topic or question type once the two aforementioned datasets are linked in order to better understand performance on tests as it relates to topic type. In general, linking the Question Datasets with the Demographic Datasets would allow for more robust analysis of efficacy of the curriculum in future research endeavors.

Continuing to verify efficacy of the IDA Worker and Safety Training Program curriculum and other OHS training programs is crucial to meeting ultimate course goals – to provide training which prevents and lessens the rates of illness and injury in dairy workers. The IDA should be applauded for its contributions and its goals of protecting dairy workers. In a perfect world, all dairy farms in this country should be able to provide injury and illness rates of their working population and should provide this information before any OHS training takes place so that changes in SKs, SABs, or any other efficacy metric can be measured and validated as a direct result of OHS interventions and trainings. While the challenges of measuring outcomes in a largely migrant population have been well described (15,32), dairy groups and researchers need to continue to collect robust efficacy-based quantifiable data whenever possible in order to better protect dairy workers across the country. It is also important to consider that some efficacy metrics such as measuring SBs and SABs may be more effective than measuring changes in SKs given the population of interest's low levels of formal education and literacy.

Due to societal pressures such as systemic racism, fear of deportation, fear of job loss, a lack of health insurance, and others (22), Latinx dairy workers are an extremely at-risk population: until sweeping societal changes, solutions and calls for racial equity are demanded by society, many of these challenges will continue to persist and limit the effectiveness of further evaluations of OHS training to Latinx dairy workers. Particularly, the issue of “illegal immigrants” and the stigma associated with this status needs to be addressed through societal and legislative inclusion and recognition of Latinx dairy workers as nationals requiring the same access to healthcare, safety training, and other government benefits. Despite these challenges, it is imperative that researchers should continue to engage with Latinx dairy workers and include them in research which is geared towards lessening illness and injury on the job. Future studies need to be designed which could lessen or eliminate the aforementioned challenges in OHS efficacy research in order to increase enrollment of Latinx dairy workers.

CONCLUSION

Although there was a lack of strong evidence for the presence of a “readability effect” between reading ease score and performance of participants by test question, and no linkages between readability effect and concordance with reading difficulty ratings from a native Spanish speaker panel or as a predictor of participant test performance, analysis of demographic information from dairy safety course participants was fruitful.

The study found that education level attained by dairy safety course participants was the greatest predictor of higher baseline test scores and difference in test scores. Language also was a strong indicator of baseline test performance and change in test scores, with occupation as a moderate predictor variable, which was largely influenced by native language. Both English speakers and Spanish speakers improved significantly between pre-to-post test scores; Spanish speakers showed the greatest improvement between pre and post test scores using the IDA's Dairy Worker Training and Safety Program as the training intervention.

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TABLES AND FIGURES

APPENDIX A: Additional Estimates and Confidence Intervals of Linear Regressions

Estimated marginal means for education, occupation and native language

Estimated marginal means and pairs of education status

Estimated Marginal Mean (degrees of freedom = 1329)

EducationAttained	emmean	SE	df lower.CL	upper.CL
Elementary School or None	53.5	0.931	51.7	55.4
Middle School	61.5	0.778	60.0	63.0
High School	70.7	0.883	69.0	72.5
College	78.8	1.544	75.7	81.8

Confidence level used: 0.95

Pairs (degrees of freedom = 1329)

contrast	estimate	SE	t-ratio	p-value
Elementary School or None- Middle School	-7.95	1.21	-6.553	<0.0001
Elementary School or None- High School	-17.21	1.28	-13.409	<0.0001
Elementary School or None – College	-25.21	1.80	-13.981	<0.0001
Middle School – High School	-9.26	1.18	-7.870	<0.0001
Middle School – College	-17.26	1.73	-9.984	<0.0001
High School- College	-8.00	1.78	-4.498	<0.0001

Estimated marginal means and pairs of occupation status

Estimated Marginal Mean (degrees of freedom = 1334)

Four Occupations	emmean	SE	df lower.CL	upper.CL
Owner	88.7	3.915	81.0	96.4
Milker	59.2	0.783	57.6	60.7
Cattle	66.1	1.727	62.7	69.5
Farm	66.1	0.719	64.7	67.5

Confidence level used: 0.95

Pairs (degrees of freedom = 1334)

contrast	estimate	SE	t-ratio	p-value
Owner – Milker	25.551	3.99	7.401	<0.0001
Owner – Cattle	22.639	4.28	5.290	<0.0001
Owner – Farm	22.619	3.98	5.682	<0.0001
Milker – Cattle	-6.912	1.90	-3.644	0.0016
Milker – Farm	-6.932	1.06	-6.523	<0.0001
Cattle – Farm	-0.0202	1.87	0.011	1.0000

Estimated marginal means and pairs of native language

Estimated Marginal Mean (degrees of freedom = 1334)

Native Language	**emmean**	**SE**	**df lower.CL**	**upper.CL**
English	79.9	1.433	77.1	82.7
Bilingual	69.9	4.800	60.4	79.3
Dutch	83.5	12.700	58.6	108.4
Spanish	61.3	0.526	60.3	62.4

Confidence level used: 0.95

Pairs (degrees of freedom = 1334)

contrast	**estimate**	**SE**	**t-ratio**	**p-value**
English- Bilingual	10.02	5.01	2.000	0.1883
English – Dutch	-3.62	12.78	-0.283	0.9921
English – Spanish	18.55	1.53	12.147	<0.0001
Bilingual – Dutch	-13.64	13.58	-1.005	0.7466
Bilingual – Spanish	8.53	4.83	1.766	0.2904
Dutch – Spanish	22.17	12.71	1.744	0.3013

Exploratory models of baseline test scores (Model E is the "full model" used in the analysis)

Model A: prediction of baseline test score including education, native language and years in dairy variables

	Estimates	**p-value**
Intercept	60.466	< 2e-16
EducationAttained Middle School	8.728	7.41e-13
EducationAttained High School	16.076	< 2e-16
EducationAttained College	19.231	< 2e-16
Native Language Bilingual	-8.243	0.0839
Native Language Dutch	5.438	0.6522
Native Language Spanish	-9.433	2.52e-08
YE	0.215	1.03e-05

Multiple R^2: 0.2143
Adjusted R^2: 0.2101
F-statistic: 51.39
p-value: < 2.2e-16

Model B: prediction of baseline test score including education and native language

	Estimates	p-value
Intercept	60.0026	< 2e-16
EducationAttained Middle School	8.003	3.12e-11
EducationAttained High School	15.176	< 2e-16
EducationAttained College	20.027	< 2e-16
Native Language Bilingual	-9.322	0.0516
Native Language Dutch	-0.529	0.9651
Native Language Spanish	-10.714	5.70e-11

Multiple R^2: 0.2033
Adjusted R^2: 0.1997
F-statistic: 56.41
p-value: < 2.2e-16

Model C: prediction of baseline test score including education, native language and occupation

	Estimates	p-value
Intercept	70.687	< 2e-16
EducationAttained Middle School	8.383	2.65e-12
EducationAttained High School	15.305	< 2e-16
EducationAttained College	18.074	< 2e-16
Native Language Bilingual	-8.182	0.086
Native Language Dutch	-0.021	0.999
Native Language Spanish	-8.922	1.27e-07
FourOccupations Milker	-11.010	0.00597
FourOccupations Cattle	-8.608	0.03931
FourOccupations Farm	-6.040	0.12674

Multiple R^2: 0.2206
Adjusted R^2: 0.2153
F-statistic: 41.61
p-value: < 2.2e-16

Model D: prediction of baseline test score including native language and occupation

	Estimates	p-value
Intercept	88.727	< 2e-16
Native Language Bilingual	-7.974	0.1102
Native Language Dutch	4.079	0.747296
Native Language Spanish	-15.675	1< 2e-16
FourOccupations Milker	-14.587	0.000483
FourOccupations Cattle	-9.874	0.023483
FourOccupations Farm	-9.306	0.023356

Multiple R^2: 0.1239
Adjusted R^2: 0.1199
F-statistic: 31.36
p-value: < 2.2e-16

Model E (full model): prediction of baseline test score including education, native language, occupation and years in dairy

	Estimates	p-value
Intercept	65.753	< 2e-16
Native Language Bilingual	-7.790	0.10134
Native Language Dutch	-4.086	0.73428
Native Language Spanish	-8.518	9.31e-07
FourOccupations Milker	-7.924	0.0557
FourOccupations Cattle	-5.879	0.16628
FourOccupations Farm	-3.544	0.37797
EducationAttained Middle School	8.8322	3.20e-13
EducationAttained High School	15.880	< 2e-16
EducationAttained College	18.594	< 2e-16
YE	0.158	0.00179

Multiple R^2: 0.2258
Adjusted R^2: 0.22
F-statistic: 38.39
p-value: < 2.2e-16

APPENDIX B: Additional Findings

Averages of demographic findings of study population	
Characteristic	**Study Population (n=1,338)**
Age	24.1 years of age
Education attained	25.4% (n=341) elementary school or no education 36.5% (n=489) middle school 28.3% (n=379) high school 9.2% (n=124) higher education
Experience with dairy	7.25 years
Gender	83.7% male 16.3% female
National origin	74.4% Mexican origin 3.7% "Central American origin" 7.8% "South American origin" 13.7% US origin
Native language spoken	< 2.0% (16/1,338) Bilingual and Dutch 11.7% (157/1,338) English 87.0% (1,165/1,338) Spanish

Full list of bivariate relationships examined in pre-analysis

	Pre-test	Post-test	Age	Occupation	Years in Dairy	Education	Nationality	Difference in Score	Language
Pre-test		X	X	X	X	X	X		X
Post-test									
Age	X			X	X	X	X	X	
Occupation	X		X		X	X	X	X	X
Years in Dairy	X		X	X		X	X	X	X
Education			X	X	X		X		X
Nationality	X		X	X		X		X	
Difference in Score			X	X	X	X	X		X
Language	X			X	X	X		X	

Native Spanish Speaker Panel Ratings (1-5, with 1 being “very easy” and 5 being “very difficult” to understand)

Respondent Panel-Reported Literacy Score by Question (Spanish Pre-Test)

Question	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**	**Q13**	**Q14**	**Q15**
Panelist 1	1	3	1	1	3	2	1	2	1	1	5	1	1	3	2
Panelist 2	1	2	1	1	2	1	2	1	2	1	2	1	1	2	1
Panelist 3	1	3	1	1	3	1	1	1	3	3	4	1	1	1	2
Panelist 4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mean Score	**1**	**2.25**	**1**	**1**	**2.25**	**1.25**	**1.25**	**1.25**	**1.75**	**1.5**	**3**	**1**	**1**	**1.75**	**1.5**
Median Score	**1**	**2.5**	**1**	**1**	**2.5**	**1**	**1**	**1**	**1.5**	**1**	**3**	**1**	**1**	**1.5**	**1.5**

Respondent Panel-Reported Literacy Score by Question (Spanish Post-Test)

Question	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**	**Q13**	**Q14**	**Q15**
Panelist 1	4	2	1	1	1	1	1	1	2	1	1	1	1	1	2
Panelist 2	1	3	2	2	1	1	2	1	1	3	2	1	1	1	1
Panelist 3	1	1	1	1	1	1	1	3	1	1	1	1	2	1	1
Panelist 4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Mean Score	**1.75**	**1.75**	**1.25**	**1.25**	**1**	**1**	**1.25**	**1.5**	**1.25**	**1.5**	**1.25**	**1**	**1.25**	**1**	**1.25**
Median Score	**1**	**1.5**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

APPENDIX C: Idaho Dairymen's Association Supplementary Dairy Worker Safety and Training Program Information

Dairy Safety Questions Pre-Test Questions, English and Spanish		
Question	**English**	**Spanish**
Question 1	"Cattle feel calmer when:"	"Las vacas están más tranquilas cuando:"
Question 2	"When treating animals for wounds or injections, handlers should make sure to:"	"Al administrar inyecciones o curar heridas, los trabajadores deben de:"
Question 3	"When entering a pen with a bull, an animal handler should:"	"Al entrar al corral de un toro, el trabajador debe de:"
Question 4	"Milkers should always watch out for kicking."	"Los ordeñadores pueden ser pateados por las vacas."
Question 5	"Workers should follow all directions on labels when using chemicals."	"Los trabajadores deben de seguir todas las direcciones en las etiquetas de los productos químicos."
Question 6	"When working with heavy machinery, one should:"	"Cuando el trabajador trabaja con maquinaria pesada debe de:"
Question 7	"Waste lagoons are dangerous because:"	"Las lagunas de desechos pueden ser muy peligrosas porque:"
Question 8	"Good animal handling practices will lead to:"	"Buenas prácticas del manejo del ganado pueden:"
Question 9	"Walking besides a cow, in the same direction, will show her down."	"Si caminas a lado de la vaca en la misma direccion, ella acelerará su paso."
Question 10	"Cows have good hearing. You shouldn't have to yell, whistle or bang on things to get a cow's attention."	"Las vacas tienen buena audición (oído). No es necesario gritar, chiflar, o golpearlas para tener su atención."
Question 11	"Good animal handling helps build negative associations with cows."	"El buen manejo del ganado crea asociaciones negativas con ellas."
Question 12	"The best way to move a cow is to:"	"La mejor manera de mover una vaca es:"

Question 13	"Handlers should use the ___ to move cows without stressing them."	"Los trabajadores deben de usar la_____________ para mover las vacas sin estresarlas."
Question 14	"Needle stick injuries are minor and can NOT be serious."	"Las lesiones por piquetes de agujas son menores y no pueden ser graves."
Question 15	"Preventing needle stick injuries is important. What should you do as an employee?"	"Piquetes con agujas pueden ser muy peligrosos. ¿Qué debe hacer como empleado para prevenir lesiones por piquetes de agujas?"
Dairy Safety Questions Post-Test Questions, English and Spanish		
Question 1	"When moving cattle, handlers should:"	"Al mover vacas en el corral, los trabajadores deben de:"
Question 2	"The flight zone is the animal's personal space or comfort zone."	"La "zona de fuga" es el espacio personal del animal."
Question 3	"Milkers should avoid being loud in the milking barn."	"Los ordeñadores deben de evitar ser ruidosos en la sala de ordeño?"
Question 4	"Which protective gear should be worn in the milking parlour?"	"¿Qué equipo de protección debe ser usado en la sala de ordeño?"
Question 5	"After working with chemicals workers should…"	"Después de trabajar con químicos peligrosos los trabajadores deben de…"
Question 6	"Workers should be especially careful to:"	"Los trabajadores deben de tener mucho cuidado y…"
Question 7	"When working around silage piles, be aware of the danger of falling debris."	"Cuando trabaje alrededor de las pilas de ensilaje (silo), debe tener cuidado con desechos que pueden caer encima de usted mismo o sus compañeros."
Question 8	"To safety move cattle, you should:"	Para mover el ganado efectivamente, los trabajadores deben de…
Question 9	"How can you move a group of cows?"	"¿Qué técnica puede usar un trabajador para mover un grupo de vacas?"
Question 10	"You can tell you have a cow's attention by:"	"Un trabajador puede confirmar que una vaca le está prestando atención…"

Question 11	“Cattle can see almost 360 degrees around them but have a small blind spot:”	“Las vacas pueden ver casi 360 grados alrededor de ellas, pero tienen un punto ciego…”
Question 12	“For the cow, the milking parlour should be a stress-free and familiar place.”	“La sala de ordeño debe ser un lugar libre de estrés para las vacas.”
Question 13	“With much practice, good animal handling techniques will become very effective and reduce stress and injuries.”	“Aplicándolas cada día, las buenas prácticas del manejo del ganado pueden prevenir estrés y lesiones.”
Question 14	“The best way to prevent needle stick injuries is to:”	“La mejor manera de prevenir piquetes con agujas es…”
Question 15	“Needle stick injuries can be very serious, from allergic reactions to hospitalizations. What is one way to prevent this type of injury?”	“Los piquetes con agujas pueden ser muy peligrosos. ¿De qué forma puede un trabajador prevenir este tipo de lesión?”

Responsibilities associated with position in dairy work as described by the Idaho Dairymen’s Association (7)	
Title	**Responsibilities associated with title**
Calves	Feeds and cares for young calves
General	Completes a variety of tasks on the dairy (milking, feeding, caring for calves, shop work, operates equipment)
Herdsman	Oversees cows’ health, reproduction, & milk production
Maternity	Works with cows that are calving and newborn calves
Milker	Participates in the milking process in the milking parlor
Other	Included various positions constituting less than 20% of participants: Agropur, Books/Owner, Breeder, Calf Manager, Family, Farm, Feeder, Hospital, IDA, Irrigation, Manager, Mechanic, Nutritionist, Office, Pusher, Truck, Veterinarian
Outside	Completes tasks outside the milking barn (feeding, operating equipment, herds cows to the barn for milking, hoof trimming, etc.)
Owner	Owns and manages the dairy operation
Shop	Works on projects involving mechanics & welding (typically in a large shop)

Idaho Dairy Worker Training and Safety Program Curriculum

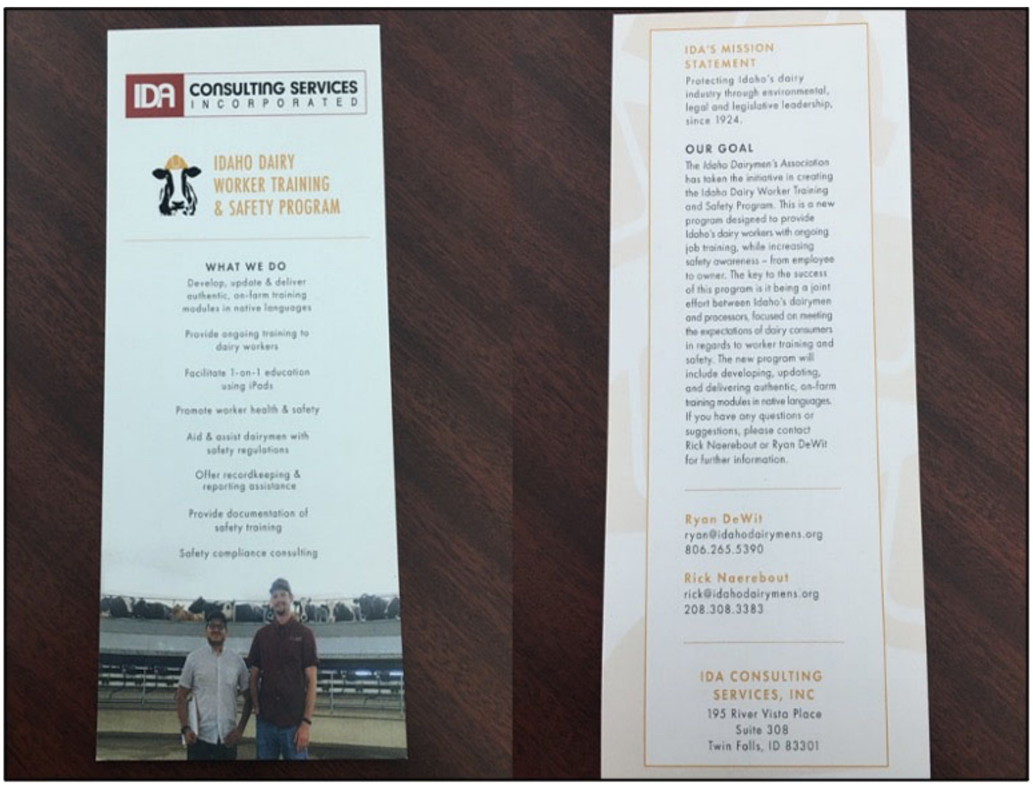
Part I: General Dairy Farm Safety

- ATV safety
- Cattle flight zone
- Chemical safety
- Eye and ear protection
- Milking barn safety
- Moving cattle safely
- Proper cattle immobilization
- PTO safety
- Safety around bulls
- Electrical safety
- Ergonomics
- Livestock-handling and treatment chutes
- Safety around heavy equipment
- Safety around the silage pile
- Safety in the machine room
- Understanding how cattle see
- Waste lagoon safety
- Working with self-locking stanchions

Part II: Animal Handling Techniques

- **Using Predictable Animal Behavior to Increase Milk Production**
  - Stockmanship (animal handling)
  - Reducing animal stress
  - Positive impacts on cows and handlers
- **How a Cow Uses Her Senses**
  - Sight, hearing, smell as senses
  - Setting the tone for interaction
  - Forming good habits
- **Working with the Pressure Zone**
- Establishing clear directions for cattle
- "Flight Zone" & "Pressure Zone"
- Adjusting pressure & behavior
- **Moving Cows More Effectively**
  - Using the herd-effect
  - Using the blindspot
  - Moving in parallel directions
  - Zig-zag pattern to move herds
- **Making the Milking Parlor a Happy Place**
  - Avoiding loud noises and stress
- **Preventing Needlestick Injuries on Dairy Farms**
  - Seriousness of needlestick injuries
  - Properly administering injections
  - Properly disposing of used needles

IDA Consulting Services Brochure (Front Side: Description of Program, Back Side: Mission and Goals)



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