Case Study

# Localizing and Designing Computer-Based Safety Training Solutions for Hispanic Construction Workers

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**Abstract:** Despite the construction industry's generally positive reaction to the use of information and communication technologies (ICTs) in many of its functions, some of the profession's key players reside in a digital divide and do not benefit from advances in technology. Hispanic construction workers, an at-risk population with high rates of workplace accidents, are affected by that divide because they rarely take advantage of available ICTs at work. One application of ICTs that can help Hispanic/Latino workers is computer-based training (CBT) for occupational safety. However, the design of CBT materials for Spanish-speaking workers needs to go beyond basic localization of existing products in English. A radical localization approach that uses participatory design sessions with construction workers and their supervisors is proposed in this paper. This case study reports that Latino workers reacted positively and retained knowledge from CBT materials, including videos with elements of humor and without graphic representations of accidents, modeled after the genre of a television situation comedy.
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**Author keywords:** Latino construction workers; Diversity; Computer-based training; Managing Hispanic workers.



## Introduction

The global construction industry, with different degrees of adoption, embraces information and communication technologies (ICTs) to automate some of its processes and reduce project costs. In many countries, the industry relies on applied technologies, such as computer-aided design (CAD) and online communications, to perform its daily operations. Construction researchers and practitioners have realized the benefits of using computers in construction practice and education (Gambatese and Hinze 2000) for years. Computers and information technology (IT) in the construction industry have been proven effective in improving projects and saving costs (Kang et al. 2008), and existing literature in research and textbooks emphasizes how the use of ICT is reshaping fundamental communication and operation activities in the industry (Harty and Whyte 2010; Dainty et al. 2006; Lingard and Rowlinson 2005).

However, in the United States, the reports of progress and innovation in the construction industry rarely address the digital divide that affects the lower levels of the industry's hierarchy. This digital divide particularly affects the 2.7 million Hispanic construction workers, of whom two million are foreign-born (Kochhar 2008). Taking into consideration that Hispanic workers are more likely to be in lower-skilled production jobs, that 42% of the foreign-born workers cannot speak English very well, and that another 42% cannot speak English at all [Center for Construction Research and Training (CPWR) 2008], it is difficult to imagine this sector of the industry as high technology users in the workplace. Hispanic construction workers already find themselves at a disadvantage in many jobsite communication situations because of culture and language differences, lack of proper training, or scarcity of culturally usable training materials. As a result of these and other factors, between 2004 and 2006, 3,609 Hispanic individuals were reported as deceased because of workplace injuries. Of those, 34% worked in the construction industry [Centers for Disease Control and Prevention (CDC) 2008]. For the 5-year period ending in 2005, the workplace death rate on construction sites was 12.4 per 100,000 full-time Hispanic workers compared to 10.5 per 100,000 full-time non-Hispanic workers (CPWR 2008). Thus, leaving Hispanic construction workers (or another minority component of the workforce in any country) out of the benefits that the industry has obtained through the use of computing and ICT can only add to the factors that disadvantage this sector of the industry.

The purpose of this article is to address the digital divide in the U.S. construction industry by determining the feasibility of using computer-based training (CBT) solutions on the topic of workplace safety aimed at Hispanic construction workers. This article argues that culturally relevant training materials delivered through CBT methods can facilitate the adoption of industry practices by Hispanic/Latino construction workers, which could reduce the disadvantages that affect these workers and make them an at-risk population in construction sites. The case reported here confirmed the notion that general translation/localization of English-language materials is a limited approach for teaching workplace safety to Hispanic construction workers. Radical localization with participatory input from Hispanic workers, emphasizing audiovisual components, collaboration, and oral evaluation, proved to be a better approach for the intended audience. This paper is based on a case involving the localization and evaluation of a construction safety online course with input from Hispanic construction workers. Originally developed for an English-speaking audience, BuildIQ's *Jobsite Safety 1* is part of a catalog of web-based training materials for construction workers. This article focuses on the localization of that course for an audience of Hispanic construction workers in the United States.

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## Literature Review

A review of literature in building construction and related disciplines shows that although the industry has embraced technology to support and enhance several of its core functions, it has lagged in imagining ways to use it for training workers, particularly in topics related to occupational safety and health. Published materials on the topic of computer and ICT usage in the construction industry follow two main conversational threads: (1) the general public tends to assume that the construction industry is low-tech, but it actually is more high-tech than it appears, and (2) although adoption of technology is taking place, it is happening at different rates, depending on factors of cost, the subcontracting business model of the industry, and resistance to organizational change. Most authors see the potential for a transformation of the industry because of its use of technology. In the mid-1990s, Ahmad et al. (1995) suggested that the construction industry should not see IT only as a new concept to try, but also as an innovative agent with the potential to create or redesign business procedures. The study's authors argued that design and construction organizations would benefit by redesigning many of their functions to incorporate IT solutions. To support their argument, Ahmad et al. matched the capabilities of IT (communications, data accessibility, and shared resources) to specific computing tools that can solve existing needs in the construction industry.

Twelve years after that early analysis, the construction industry was still adopting IT solutions at an apparently slow pace. Stakeholders in the industry were not convinced of the impact of implementing technology on the success of a project. Yang et al. (2007) analyzed levels of technology utilization in design and construction-related functions in construction projects. The study concluded that technology is critical to the execution of project work functions and "may contribute significantly to project performance for stakeholder success" (Yang et al. 2007, p. 732). More recently, Harty and Whyte (2010) analyzed the use of IT in construction projects (specifically in the design stage) and rejected the imposition of technology. Instead, they proposed to incorporate technological solutions into existing ecologies of practice that in many cases already use digital artifacts.

Even in the discipline of technical communication, researchers are looking at the proliferation of IT in the construction industry as a source of opportunity for developing software documentation and conducting usability studies (Woodard 2008). On the basis of cases such as Autodesk's employment of 50–55 full-time technical writers, research projects look at the construction industry as a source for jobs related to generating online help and tutorials and coordinating usability groups for CAD products, among others. Thus, insiders and outsiders in the construction industry are looking for ways that projects can implement and benefit from computing and ICT. Training is a promising area for ICT in construction.

After this review of published work on the use of computing and ICT in the construction industry, this section will focus on (1) the implementation of CBT on workplace safety for construction workers, and (2) the unique challenges that technical communicators and instructional designers working with safety professionals face when developing training materials for Hispanic workers, regardless of their medium of distribution. This review of published studies will help frame the case study of localizing a computer-based course for Hispanic workers in the context of the industry's trends and problems.

### CBT for Hispanic Workers

Although it is not widely implemented, CBT for Hispanic workers is generally described in positive terms in academic and trade publications. The literature is not vast, but it encourages the adoption of computer training tools. On the general topic of using CBT for workplace safety issues, not exclusively in the construction industry, the research team led by Anger and Rohlman has conducted studies in the horticulture (Anger et al. 2004) and food services (Eckerman et al. 2004) sectors, among others. Their research concludes that computers can be effective in providing workplace training to Spanish-speaking workers and pointed out that U.S.-born Latinos performed better than their foreign-born peers.

A report on the implementation of a web-based training solution for an office of the Department of Environmental Services in Virginia also showed positive results (Liebeskind 2005). This report is particularly relevant to this manuscript because of the bilingual demographics of the personnel, who were 10% Spanish-speaking. The course included multilingual video and text components and posttest and pretest segments to measure knowledge retention. Additionally, with the incentive of eligibility for monetary compensation, 60% of the staff adopted the online course in its first year of implementation.

Specifically in construction projects, Irizarry (2009) conducted research with prototypes of training software based on the risk-perception patterns of Hispanic workers. The study proposed a training solution that provides a diagnosis of risk factors by using sociocultural, environmental, and individual risk-perception elements.

Despite these positive cases, there are also some less positive reports on the use of CBT and Internet-based solutions for teaching concepts of workplace safety to Hispanic workers. As of 2007, only 56% of Hispanics in the United States had online access, and only 43% of foreign-born Latinos who do not speak English used the Internet (Fox and Livingston 2007). In the construction industry, research results recommend using the Internet for disseminating material to trainers, who will then teach Hispanic workers, rather than as a primary tool for reaching Spanish-speaking workers directly (Committee on Earth Resources 2003) because Hispanic workers most at-risk (i.e., recently arrived and in need of training) do not have Internet access (for at-home training) or computer literacy (for at-work training).

However, if the construction industry continues its adoption of computing and ICT for most of its vital processes, Hispanic workers will be at even more risk if the digital divide is not reconciled. The objective of reconciling this digital divide is not only to adopt technology for the sake of adopting technology, but also to enable Hispanic construction workers to take advantage of and benefit from the enhancements to workplace communication, production speed, and improved management information systems that ICT brings to other sections of the industry.

The following section reports on the situation of the diverse population of Hispanic/Latino construction workers in the United States, whose uneven levels of English proficiency and reading skills (in any language) challenge the mere translation of text-based training materials developed for their English-speaking peers.

### Developing Training Materials for Hispanic Workers

Technical communicators and instructional designers working with safety professionals need to be aware of the problems affecting their specific audiences, whether developing new materials or translating/localizing existing English sources. Language is the main challenge when developing training materials and technical documentation for Spanish-speaking construction workers in the United States. In 2006, 847,000 Hispanic construction workers were recently arrived foreign nationals from Latin American countries, representing 7.2% of industry employment (Kochhar 2006). Most of the 2.2 million foreign-born Hispanic workers in the construction industry do not speak English as their first language, and many



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of them do not speak English at all. As a result, existing training materials and documentation for English-speaking construction workers cannot fulfill the informational needs of this growing population. Because of this situation, and to ensure proper training regardless of language differences, the Occupational Safety and Health Administration (OSHA) released recently a memorandum emphasizing the requirements for training workers in manners they can understand and establishing that noncomplying employers may incur serious violations (OSHA 2010). Therefore, proper training needs to reflect the language used by the audience.

A second challenge is the literacy levels of recently arrived foreign-born Hispanic workers. The main problem is not that 42% of foreign-born Hispanic workers cannot read in English at all, but that "a small but significant portion of Hispanic workers are illiterate in their own language" (Brunette 2004).

In addition to English proficiency and literacy (in any language) concerns, more barriers emerge because of existing training materials' failure to reflect the multiple variations in Spanish-language patterns across Hispanic/Latino construction workers' varied ethnic and cultural backgrounds. These language barriers result from both external (existing in other countries) and internal (unique to workers in the United States) factors affecting Hispanic/Latino workers. External factors include socioeconomic and education disparities across Latin America and regional differences in Latin American Spanish. After all, "not all Spanish-speaking people have the same Spanish words for things. For example, in Nicaragua the common word for forklifts is *mulas*, but in Mexico the word is *montacargas*" (Brown 2003, p. 89). Internal factors include the use of "Spanglish" words, a combination of English and Spanish terms spoken colloquially in the United States and Latin America. Defined as "the oral encounter between Anglo and Hispano civilizations" (Stavans 2003, p. 5), Spanglish is not grammatically correct in either English or Spanish. Some identify the use of Spanglish as an important element in improving comprehension of materials developed for Hispanic construction workers.

Although several nonprofit agencies, government agencies, and companies have developed books and documentation to address the language needs of Hispanic construction workers, those materials often demand a higher level of English or Spanish competency and reading levels than the workers possess. However, research indicates that the quality of Spanish materials available varies "because most of the few materials appear to be mere translations, often inaccurate, of existing English materials" (Brunette 2005, p. 255). Existing methods for educating Hispanic construction workers available on the OSHA website are very text-heavy, even in their Spanish versions, and effectively interpreting those materials requires a high reading competence. These materials assume that Hispanic construction workers are literate in English or Spanish, although that is rarely the rule.

The following section reports on a case in which a university's research center in construction, inspired by the needs of a company specialized in developing CBT courses for construction workers, developed and evaluated different approaches for delivering safety training to Hispanic construction workers by using computers. To clear bias and limitations of the study, the company was only involved in the first stage and decided not to continue with the project. However, they gave full authorization for the study without restrictions.

## Methodology

The process of localizing an online course on workplace safety for an audience of Hispanic construction workers included several stages of localization, adaptation, and evaluation. The following variables serve as the foundation of the methodology.

- Source document: the existing online course *Jobsite Safety 1*, developed in English by BuildIQ, a company that specializes in creating and administering computer-based courses for construction workers.
- Target document: a Spanish version of the *Jobsite Safety 1* course that includes elements of the original English version but is culturally relevant and professionally effective for the target audience.
- Source audience: English-speaking construction workers and their supervisors.
- Target audience: Spanish-speaking construction workers and supervisors.

BuildIQ contacted the Virginia Tech Center for Innovation in Construction Safety and Health Research and requested help in determining the feasibility of localizing its courses for Spanish-speaking users. According to their promotional materials, BuildIQ "creates, publishes, and hosts a comprehensive curriculum of web-based training courses that focus on best practices in homebuilding" (BuildIQ 2009). Because of the changing demographics in the construction industry, BuildIQ was interested in translating its *Jobsite Safety 1* course into Spanish and making it accessible to workers and supervisors. The company was concerned about the audience's cultural and linguistic diversity, and the company wanted to consider the use of Spanglish and appropriate literacy levels. BuildIQ and Virginia Tech agreed that the localization would be seen as a process and would not be exclusively focused on a final product, and it would include the implementation of an effective "field Spanish" vocabulary and evaluating iterations of the course with Spanish-speaking construction workers. In exchange for the *Jobsite Safety 1* course localization, BuildIQ granted access to its online course catalog to students and researchers at Virginia Tech. The source document was mostly text-based; it included images only for examples and demonstrations and no multimedia components. The course included four modules: "Fall Safety Basics," "Scaffolds," "Working and Walking Surfaces," and "Stairways and Ladders."

Localization has been defined as "the process of creating or adapting an information product for use in a specific target country or specific target market" (Hoft 1995, p. 11). Different degrees of localization are determined by the balance between the economic goals of a source company and the cultural understanding of the target users. These degrees include general localization (translation of the source document with minor modifications to language, currency, date, and time formats) and radical localization (incorporating cultural differences in how target users feel, think, and act beyond what is covered in general localization). This project involved a process through both degrees of localization.

- Stage 1: general localization. The target course was not developed from scratch, it was based on an existing course for English-speaking audiences. Therefore, this stage had the primary goal of determining how much of the original textual content developed by BuildIQ could be effectively communicated in Spanish. A secondary goal in this stage was to conduct participatory design sessions with the Hispanic construction workers to gather their creative input on how to redesign the computer-based course to accommodate their specific needs and limitations.
- Stage 2: radical localization. After determining how much of the source document's content and format was suitable for the target audience, the goals were to implement the participants' feedback and design a culturally relevant localized



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version of at least one module of the course that addressed the needs of Spanish-speaking, low-literacy users.

Stage 1 included an initial audience analysis conducted with Hispanic construction workers and supervisors who were contacted through the Spanish-speaking community in Blacksburg, Virginia. After the source document was translated from English to Spanish, the modules were tested with workers from a residential construction company contacted through the Virginia Tech Center for Innovation and Construction Safety and Health Research's external advisory board. After the initial evaluation, the workers were invited to provide input during a participatory design session. A second iteration of the participatory design process took place with input from workers from a nonresidential construction site on the Virginia Tech campus. In this stage, all participants were compensated at a rate of $12 per hour.

In Stage 2, the prototypes developed with input collected during Stage 1 were evaluated by workers from a residential construction company in Floyd, Virginia. All evaluator workers were compensated at a rate of $12 per hour. The following section details the planned and modified research design and participatory design methods for each stage.

### General Localization

During Stage 1 of the localization process, the first step was to translate the source document from English to Spanish. The translation team was comprised of two native Spanish-speaking instructors from the Foreign Languages and Literature department at Virginia Tech. Supervised by the author (also a native Spanish speaker), the localization team used two construction dictionaries for subject matter reference, *Means Spanish/English Construction Dictionary* (used as the primary resource for technical vocabulary) and *DeWalt Illustrated Spanish/English Construction Dictionary* (used as the secondary resource for resolving doubts and discrepancies).

In parallel with the translation process, audience analysis for the target course was conducted to document the needs of the specific users. The audience analysis consisted of a focus group session with seven Hispanic construction workers in Blacksburg, Virginia. The audience was very diverse despite the identification of all members as Hispanic or Latino construction workers. Table 1 includes the profiles of two focus group participants (and potential target audience members for the course) who were interviewed in the analysis stage.

Whereas differences in country of origin, immigration status, literacy level, experience in construction jobs, age, and time working in the United States complicated the localization process, strong common threads also kept the audience unified. The main similarities among members of this diverse audience were profession (they all described themselves as construction workers in the United States), language (they were all Spanish-speaking), information and training needs (the focus group participants did not have formal training in construction safety and were willing to learn with the appropriate materials, and most had never used a personal computer), and delivery preference (they all preferred oral instructions to written materials).

The audience analysis process also included interviews with two construction supervisors in the United States (one of them bilingual) and two in Mexico (both bilingual) to determine how a CBT course on safety in Spanish would be received in their jobsites. On the basis of the audience analysis interviews with workers and supervisors, the general localization process expanded to accommodate the target audience's need for

**Table 1.** Profiles of Two Potential Users, Illustrating the Workforce's Diversity

| | User 1 | User 2 |
|---|---|---|
| Country of origin | El Salvador | Mexico |
| Age | 32 years | 21 years |
| Time in United States | 9 years | 3 months |
| Construction experience | 9 years | 2 months |
| Highest education | 2nd grade | First year of high school |
| Computer experience | None | Has used Windows XP, Word, and Internet Explorer |
| English proficiency | None | Basic |
| Reading proficiency in Spanish | Basic | Reads newspapers and magazines |
| Artifacts/documentation used in the workplace | Oral instructions | Oral instructions and flyers from OSHA |

- A focus on their specific professional discourse (in this case, the vernacular Spanish or Spanglish used at U.S. construction sites); and
- An emphasis on oral instruction (because of a combination of low literacy levels and a tradition of oral instructions, not written documentation).

Once the translators created technically and grammatically correct versions of the target document in Spanish, a doctoral dissertation project in Industrial and Systems Engineering based on this project conducted successful back-translation of the "correct" translation of the course (Artis 2007). To accommodate the target audience's professional discourse needs, minor changes were made to the course by introducing terms in Spanglish and construction jargon that are not necessarily used in Latin American Spanish but are part of the lexicon of Hispanic construction workers in the United States.

The first round of evaluation was conducted with seven workers from a residential construction company in Fairfax, Virginia. The participants were individually compensated at a rate of $12 per hour. Their ages ranged from 20–30 years old, with an average of 27.28 years of age. They were all natives of El Salvador with 0–10% self-reported English proficiency, and only one of them could read and write in Spanish. One of the workers had been living in the United States for 15 years, 14 of which he was employed in construction, but the rest of his colleagues had been in this country less than eight years. The workers had not received formal training in workplace safety in a manner they could fully understand. Some reported attending safety talks in English, but most learned from their peers in informal ways. A bilingual project supervisor from the construction company who was involved in the audience analysis stage recruited workers for the evaluation.

Originally, a quasi-experimental research design was planned, with a control group taking two text-based modules (Module 2 and a randomly selected second module) and a treatment group taking one text-based module and the audio-enhanced version of Module 2. However, one of the participants (Worker 4) identified himself as completely illiterate, and two more said they preferred audio only, so the original design plan was not used. Instead, each participant took Module 2 in audio, unless they were comfortable with the text-based version. Literate participants also took a randomly selected second module.

After completing an oral pretest interview, the participants moved to laptop computers to take the course modules. While the construction workers were using the computers to evaluate the target course, their bilingual supervisor offered an expert evaluation of



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the target document for subject matter accuracy. The supervisor is a Guatemalan native who has been living in the United States for more than 20 years. He reviewed the entire course in both versions (correct Spanish and Spanglish) and then answered questions related to the material. He pointed out that the Spanglish version was too informal and looked "like a joke" and that the course had too much text for the audience.

The specific metrics of the first round of evaluation were as follows:

- Completion of at least two course modules. Illiterate or low-literacy participants only completed one module.
- Time spent per module. The session was video-recorded and timed to evaluate how long it took to complete the text and audio modules. The average time per text-based module was 12 min, and the average time for the audio module was 8 min.
- Reaction. On the basis of the evaluation model by Kirkpatrick (2006), participants were asked to complete a posttest satisfaction quiz on the course's content, assistance from the facilitators, testing environment, and usability of the interface, among other factors. When answering the question, "What would you change about the course?" most participants replied "nothing," but two noted that the content on scaffolds was very broad and needed to be sector- and trade-specific (for example, residential workers use types of scaffolds and lifts that are different from those used by their nonresidential peers, and roofers need more detail than electricians). They all said they would use or recommend the course if their supervisor adopted it, and they all also pointed out they preferred the audio-enhanced modules, which was emphasized with comments such as, "I can't read," and "We need audio."
- Learning. The second level on Kirkpatrick's evaluation model addresses knowledge retention. Learning was not a major goal in the first round of evaluation because the target course was not completely ready. However, the source course included quizzes for each module, and participants were required to complete those quizzes in the posttest segment. To accommodate the audience's low literacy levels, the quizzes were not computer-based, they were administered orally by a Spanish-speaking facilitator. Additionally, a qualitative evaluation component included an open-ended oral question in which the participants were asked to summarize what they learned from the course. In the quantitative component, the scores were very low, with the highest-scoring participant (Worker 4, who only took the audio-enhanced module) answering five of 10 questions correctly. In the open-ended oral evaluation, the workers were very talkative about their personal experiences with safety and topics mentioned in the course, but they did not summarize specific aspects of the modules.

As mentioned previously, a secondary goal of the session was to obtain input from the workers on how to redesign the course according to their cultural and professional needs and preferences. As a research methodology, participatory design originates from workplace analysis ideas used in the 1970s by Norwegian unions looking for a more democratic approach to the design of workplace tools. Its fundamental idea was "the involvement of workers, as users of technology, in the design of the tools they are using in their workplace" (Greenbaum and Kyng 1991, p. ix).

Traditionally, conducting a participatory design research project implies that the researcher will "follow an improvisational more than a strictly scientific approach, making adjustments to research strategy as more is learned" (Namioka and Rao 1996). However, to maintain methodological rigor, the participatory design component followed the basic stages identified by Spinuzzi (2005): (1) initial exploration of work, (2) discovery process, and (3) prototyping. During the initial exploration of work, the workers were interviewed in small groups to obtain an overview of the workplace's procedures and operations. They said they did not receive formal training on topics of safety and health, and they rejected the use of Spanglish in future training materials, arguing that Hispanic workers "do not talk like that when at work." In the discovery process stage, facilitators and participants envisioned the future workplace and agreed on the desired outcome of the project. Here, the facilitators noticed that most of the workers actually used words in Spanglish to describe their trades in the construction industry. When asked about their use of Spanglish, the users provided two explanations:

- There are no words in Spanish for their specific trades. Some pointed out that in their countries, "a carpenter is a carpenter," and houses do not need wood frames, so there is no translation for the profession of "framer." Likewise, because house roofs in Latin America tend to be made out of concrete, there is no professional concept of the "roofer," and it has no direct translation.
- It gives them a sense of professional reputation. Some workers mentioned that using words in Spanglish to describe their professions gives them credibility with their peers and even families. Worker 2 said that in El Salvador, "anybody can be a carpenter, but you have to be here [in the United States] to be a framer."

The next phase of the participatory design session was a group activity, in which three or four workers created paper-based

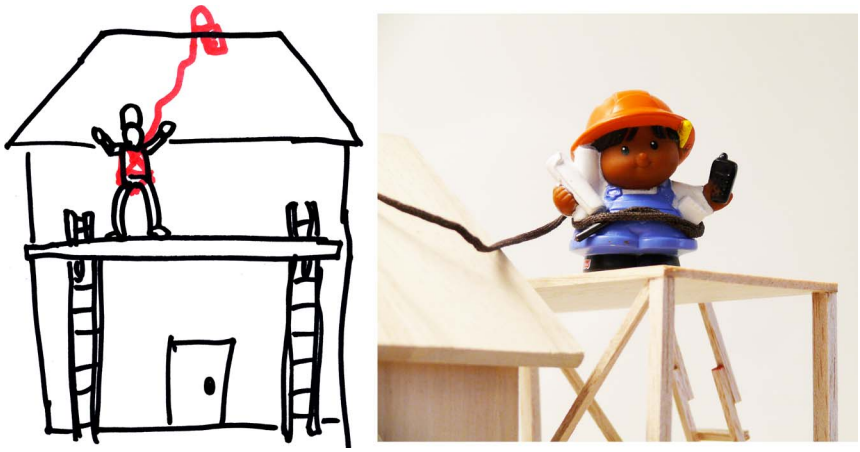

**Fig. 1.** Worker prototype (left) and stop-motion video frame (right) on scaffold safety; both illustrations show a worker on a scaffold wearing a safety harness



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mockups (Fig. 1) of what would be the interface and content of an ideal computer-based course on workplace safety for their specific needs and preferences. In participatory design projects, mockups allow the users to test and give feedback on technology not yet invented (Namioka and Rao 1996).

After analyzing the input from Stage 1, the target course in the text-only version was discarded, and the default draft became the audio-with-text version embedded in a PowerPoint file with paper prototypes of images from the mockups developed by users. In their representation, Hispanic workers saw the target course more like a television show than an interactive computer program. Thus, the prototype combined the passive design of the mockups with the interactive audio and navigation controls of the sample course. Additionally, the use of words in Spanglish was limited to name-specific trades that cannot be translated directly into Spanish. To increase the diversity of participants (all the workers in Round 1 were from El Salvador), a second round of evaluation of the revised Module 2 and an iteration of the prototyping activity took place. Four workers from a nonresidential project in Blacksburg, Virginia, were the participants in the second round of Stage 1, which took place in the Virginia Tech Center for the Study of Rhetoric in Society two months after the first session. The workers were compensated individually at a rate of $12 per hour. Three of the workers were 19 years old, and the fourth was 18. They were all natives of Mexico with 0–10% self-reported English proficiency, and they all could read and write in Spanish (one of them was a high school student before coming to the United States). All of them had been in the United States less than three years; one worker reported that he had moved to this country only three weeks before the session. They had not received formal training in workplace safety.

The second round's metrics were similar to those of the first session, with an emphasis on the second level of Kirkpatrick's model—learning. The participants were asked to summarize in an oral report the information received from the course. The participants spent an average 6 min taking the audio-enhanced Module 2, after completing an oral pretest interview. After taking the module, the users were interviewed and evaluated individually. All the participants said they liked the course, and two mentioned it needed more images. In the quantitative evaluation, the scores improved slightly from the first session. Worker 9 was an outlier and answered correctly seven of 11 questions. A confounding variable is that he had the highest level of education of participants in both sessions (in fact, the average education level of the whole second group was higher than the first round). The qualitative posttest component also showed minor improvement from the first session because most workers could summarize certain parts of the module. This session included a cooperative prototyping activity, in which researchers and users evaluated the process of interacting with the mockups. The goal of this activity was to find breakdowns in the interaction process to "analyze the situation and discuss whether the breakdown occurred because of the need for training, a bad or incomplete design solution, or for some other reason" (Bødker and Grønbæk 1991, p. 200). On the basis of the workers' input and preferences, the revised mockups continued to resemble a television show, specifically a situation comedy. The revised mockups had elements of humor and a serious component of safety recommendations throughout, emphasized at the end like a moral.

### Radical Localization

In contrast with general localization, the process of radical localization requires addressing the learning styles and culturally specific examples for a document's target audience (Hoft 1995). This stage included (1) cultural adaptation of the translated course, and (2) development of an effective interface for computer-based delivery of the final product. Both steps used the participatory input of the construction workers during the first stage. BuildIQ was not involved in this stage of the project. After concluding that general localization (using the source course's original format and content for an audience of Hispanic construction workers) was not effective for proper knowledge transfer, the company decided to reconsider the comprehensive approach needed.

The first decision in the radical localization process was to reduce the course's level of technicality. After the general localization sessions, the research team noticed that many recently arrived workers from Latin America had never received any training on workplace safety. Thus, instead of focusing on specific measurements and regulations (which can be learned later through additional training sessions), the project's goals were to comply with workers' rights under the Occupational Safety and Health Act of 1970 and provide fundamental life-saving recommendations in a format that Hispanic/Latino workers could understand. Table 2 gives an example of how a paragraph's level of technicality was reduced while maintaining and emphasizing a fundamental safety recommendation for the user that respected the source document's purpose. Given the Hispanic audience's preference for oral delivery, the video target contained only text for provided titles for each new lesson. The visual components of the course included (1) an instructor addressing the user directly, and (2) full-screen color images of the items and events described in the oral narration, following the literature's recommendations for using graphics in training materials for Hispanic construction workers. Furthermore, some points of the narration referred to the users in plural and

**Table 2.** Comparing Original Source and Simplified Adaptation

| Language | Original source content | Adaptation for video |
|---|---|---|
| Spanish | Si un andamio tiene una relación de altura-a-ancho de base en un rango de 4:1 *o* más, los trabajadores pueden estabilizarlo con una de estas dos opciones: instalando contrapesos para aumentar el ancho de su base, *o* atándola a la estructura con cadenas *o* cuerdas que hagan que no se voltee. Si se usan cadenas *o* cuerdas, éstas deben ser instaladas en el lado horizontal que esté más cerca al rango de 4:1 de altura. Deberá haber una cuerda *o* cadena cada 20 pies (6 metros) verticales para andamios de hasta 3 pies (1 metro) de ancho, *y* cada 26 pies (7.9 metros) verticales en el caso de andamios de más de 3 pies de ancho. | Si el andamio mide de alto cuatro veces el ancho de su base, tienes que amarrarlo *o* asegurarlo a cada 20 pies (6 metros). |
| English | If the scaffold has a height-to-base width ratio of 4:1 or more, workers can stabilize it in one of two ways: install outriggers to increase the base width, or tie it to the structure with guys or ties to keep it from tipping. If guys or ties are used, they should be installed at the horizontal member that is closest to the 4:1 height ratio. There should be a guy or tie every 20 vertical feet for scaffolds up to 3 ft wide and every 26 vertical feet for scaffolds more than 3 ft wide. | If the scaffold is four times taller than the width of its base, you need to tie it or secure it every 20 ft (6 m). |



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recommended group activities, allowing for collaboration and social interaction.

Initial testing in a focus group meeting with three construction workers from Mexico in Blacksburg, Virginia, showed that the video was perceived as "interesting but too serious." The evaluators agreed that the use of video, audio, and images was effective, but they pointed out that it was difficult to pay attention through all three lessons (with a total running time of 8 min). A second video, more faithful to the mockups developed by Hispanic construction workers, was created with data collected from the participatory design sessions. The second video incorporated feedback and creative ideas from the workers' cultural preferences collected during the participatory design sessions. This included elements of narrative (the workers preferred listening to a story than taking a formal course), some instances of humor (the workers responded positively to sporadic jokes in Spanish; simple, direct jokes worked better than sarcasm or irony), representations of consequences of not following safety rules (without images of injuries or fatalities), signs of good working relationships with supervisors and colleagues, respect for family values, the importance of teamwork, and the genre familiarity of a television situation comedy.

The original idea was to have construction workers "act" in the second video; however, most workers contacted decided against acting and instead proposed using animation. Through an agreement with Fisher-Price Inc., the second video features Little People construction figures "enacting" a script developed in collaboration with Hispanic construction workers and based on Module 2 of BuildIQ's *Jobsite Safety 1* course. The stop-motion animated video reinforces concepts of scaffold safety, and it has a running time of 4 min. The video was evaluated for technical accuracy by the External Advisory Board of the Virginia Tech construction center, which is comprised of engineering and building construction professionals from industry and academia. Fig. 1 captures the evolution from worker-created prototype to stop-motion animated video.

To test the video as the main component of a CBT module, a blank interface with buttons was developed so the users could stop, fast-forward, rewind, and pause the content. On the basis of recommendations for creating interfaces aimed at low-literacy users (Nielsen 2005), the interface avoided textual elements even when the workers were not completely illiterate because low-literacy readers focus on individual words and slowly move their eyes line by line, therefore missing relevant objects in the interface (the video in this case). A group of nine workers from a residential site in Floyd, Virginia evaluated the video prototype. The participants were individually compensated at a rate of $12 per hour. Their ages ranged from 18–55 years old, with an average of 28 years of age. They were all natives of Mexico, they all had 0–15% self-reported English proficiency, and all but one worker could read and write in Spanish. They had all been living in the United States for less than 10 years. Some of them reported previous training on workplace safety, but not on the topic of scaffolds.

Initially, the workers laughed when the animation started, but as soon as the dialogue began, the participants paid full attention to the video, and it was only interrupted by laughter in some moments. Following the metrics from the previous stage, the evaluation focused on the levels of reaction and knowledge gain. In the form for evaluating reaction, all the workers gave a rating of "Very interesting" or "Interesting," and "Very easy" or "Easy" to the video. In the evaluation for knowledge gain, the workers scored an average of 4.75 on a scale of 1–5 points (5 was the highest for content comprehension). Because the content changed from the Stage 1, the quantitative test also changed, and it would be deceiving to compare results based exclusively on test scores. Therefore, the qualitative posttest narratives based on the guidelines and recommendations included in the video were the main evaluation component. All nine workers were able to summarize the module and clearly remembered the characters' names.

## Conclusion

Results from this case study show that implementing CBT programs aimed at Hispanic construction workers will not close the gap on the digital divide affecting the industry unless the course content addresses the audience's cultural and professional needs and preferences. A generally localized computer-based course that, in its original English version, relies mostly on text, was ineffective for Hispanic workers. Although implementing audio prompts improved knowledge transfer slightly, videos (specifically those with a plot, recommendations, and some humor) enhanced the memorability of a training module. Regardless of interactivity, using videos to train Hispanic construction workers facilitated the presentation of processes involving three-dimensional objects because the animation can demonstrate movement and spatial relationships, whereas words are abstract, whether written or oral. ICT makes these demonstrations possible. Even with computers, the use of Spanish-speaking facilitators is recommended because literacy levels vary among the Hispanic workforce, and facilitators can administer oral tests.

Even when the video was delivered individually on computers, the workers preferred watching it in a single screen as a group activity. Starting in the early prototype stages, they envisioned it more as a passive television situation comedy than as an interactive computer program. Because most Hispanic construction workers are not familiar with computers, they will not touch the controls ("I broke it!" said one of the second-round testers, when the audio did not start after he pressed a key) unless repeatedly instructed to do so. Further studies should focus on improving the levels of interactivity to take full advantage of the computer as a processing machine, instead of just as a television screen. The model of one student per computer was not effective with the audience of Hispanic construction workers in this case. Simple interfaces minimized the learning curve to operate a CBT course aimed at Hispanic construction workers, and access to computers was provided at work because the workers did not have computers at home.

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