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The Use of Audience Response System Technology With Limited-English-Proficiency, Low-Literacy, and Vulnerable Populations

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ABSTRACT. Audience response systems (ARS) have long been used to improve the interactivity of educational activities. Most studies of ARS have addressed education of literate trainees. How well these devices work with low-literacy subjects is not well studied. Information gathering on the training audience is an important use of ARS and helpful in improving the targeting of training information. However, obtaining demographic information from vulnerable populations with reasons to be concerned about divulging information about themselves has not been tested. In addition, a culturally competent method to effectively collect demographic and evaluation data of this growing population is essential. This project investigated the use of ARS to gather information from Hispanic immigrant workers, many of whom are socially vulnerable and have limited English proficiency (LEP) and low-literacy. Workers attended focus groups and were asked to use ARS devices or clickers to respond to questions. Questions were both categorical (multiple choice) and open-ended numerical (text entry), and varied from simple queries to more sensitive points regarding immigration. Most workers answered the one-key response categorical questions with little difficulty. In contrast, some participants struggled when responding to numerical questions, especially when the response required pressing multiple clicker keys. An overwhelming majority of participants reported that the clickers were comfortable and easy to use despite the challenges presented by the more complex responses. The error rate increased as question complexity increased and the trend across three ordered categories of response complexity reached statistical significance. Results suggest that

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ARS is a viable method for gathering dichotomous or higher-order categorical information from LEP and low-literacy populations in a group setting while assuring anonymity. However, it is recommended that clickers be developed and tested with fewer, bigger, and more widely separated buttons, and less printing on the buttons for these populations. Further research is needed to determine the effectiveness of using clickers with simplified configurations in the workplace as a tool to collect data for surveys and assessments and to better engage LEP and low-literacy workers in training sessions.

KEYWORDS. Hispanic, low literacy, clicker, ARS

INTRODUCTION

Since the early use of audience response systems (ARS) by the US Air Force in the 1950s,[1] they have been used increasingly to improve learner engagement and assess knowledge acquisition. As technology has improved the ease of use, reduced the cost, and expanded the versatility of these instruments, they can and have been put to broader data collection tasks to demographically characterize the learner audience[2] and involve participants in decision-making and even in their original conception were considered useful for collecting data anonymously.[3]

ARS were designed for use by and have predominantly been used by literate audiences so that response understanding is not generally at issue. Most response devices or clickers (Figure 1) have been designed to maximize the ability to answer complex questions, including alphanumeric ones, while avoiding excessive size and key number. Most have keys marked with numbers and sometimes several letters.

The first step in evaluating training is through verification of knowledge acquisition. Evaluating individual learning in low-literacy or illiterate trainees presents a time-intensive task, as it requires adaptation of tools to be used for answering simplistically or under direct, one-on-one questioning. Collecting demographic information on a trainee population, including such factors as age, gender, duration of education, and in the case of immigrant workers, duration of residency in the United States, is important in order to tailor training and language, choose appropriate tools, and select level of complexity. When training immigrant worker populations, obtaining accurate demographic data on individuals may run counter to trainees' perceived need for anonymity.

FIGURE 1. Dongle and response device used.

Large-animal agriculture, which includes dairy, is among the most hazardous occupations in the United States.[4] Training is an essential part of keeping workers safe in this and other dangerous industries.[5,6] Dairy operations in the United States are consolidating, with reduction of small operations and an increase in large dairies and an increase in hired labor.[7] Much of this hired labor is composed of immigrant Hispanic workers. These workers are often monolingual Spanish speakers or have limited English proficiency (LEP) and by and large have limited formal and low literacy levels. It is estimated that Hispanic workers constitute over 40–60% of all hired dairy employees in Wisconsin. A 2008 study suggests that the vast majority of the immigrant dairy workers (88.5%) are from Mexico.[8] A Cooperative

Extension survey conducted with 309 immigrants workers employed in 34 Wisconsin dairies showed that this population was largely male (87%), spoke almost no English, and had limited formal education. The majority of workers (77%) were between 16 and 45 years old, and 80% spoke no English or only a few words.[9] Additionally, more than half are believed to not have legal authorization to work in the United States.[10] As a result, these workers strongly prefer anonymity, fearing that providing identifying information might place them at risk for deportation. The National Farm Medicine Center in partnership with the Migrant Clinicians Network regularly trains immigrant dairy workers. Our own experience supports the data presented above, as the workers we train are often unable to read even Spanish and are often uncomfortable providing specific demographic data about themselves and find paper questionnaires challenging.

We chose to pilot the use of ARS in obtaining information from a low-literacy, low-English-proficiency, and socially vulnerable group of workers. As this demographic is a common recipient of the training, we often do through the National Farm Medicine Center, we wanted to test how efficiently this population could answer questions at various levels of complexity using conventional ARS "clickers." We believed that the ARS, if adaptable to our population, would provide an efficient, rapid, and nonthreatening way to capture both evaluation information as well as demographic data. This project undertook to assess the practicality of using ARS in LEP and low-literacy immigrant populations.

METHODS

As part of the formative research process guiding a larger study, investigators facilitated five focus groups with immigrant dairy workers in order to enhance the investigators' understanding of worker knowledge, attitudes, and practices related to occupational health and safety in dairies. Trained bilingual project staff moderated the focus groups in Spanish. Each focus group lasted up to an hour and a half. Focus group data were collected by written notes or by audio recorder and later transcribed. This data collection created an opportunity to test the value and ease of use of ARS by immigrant Hispanic dairy workers. There were one mixed-gender and four single-gender focus groups. A total of 35 immigrant dairy workers, 23 men and 12 women, participated in the focus groups. The focus groups took place in three locations, in two regions of Wisconsin, and community contacts assisted in participant recruitment. Four of the five focus groups, two male-only and two female-only, were conducted in a setting completely separate from the participants' workplace and without involvement of their employer. One male-only and one female-only focus group were each held in a local Mexican restaurant frequented by immigrant workers and the restaurant owner assisted with recruitment. The other two focus groups were held at a community center and recruitment was facilitated by an interpreter who works for area farmers. One mixed-gender focus group was held on a farm where all of the participants were employed and the farm owner assisted in recruitment. Each participant received a $20 gift card. All but one focus group was audio recorded. ARS was used in all five of the focus groups.

Measures

Project staff had previously developed a focus group guide directed at worker perceptions of health and safety in dairy. In addition, three sets of questions were developed to assess the viability of ARS with this population. The questions that used the ARS were read aloud while the text of the questions as projected on a screen using TurningPoint 2008 presentation and a projector. After each focus group, the moderators and investigators met with each other to debrief, review, and triangulate observations and immediate impressions of the behavior of the respondents. These were recorded and maintained for later review.

The first question set was intended as "icebreakers" designed to allow the class to become comfortable with the ARS and use of the "clickers." These questions were not analyzed for this report. During the icebreaker questions, the focus group moderators instructed the

participants on how to use the clickers. At times facilitators assisted respondents in answering questions during this period. As respondents became more familiar with the use of the clickers, facilitators provided less assistance. With each ARS question, the focus group moderator reiterated how to use the clicker. After participants had entered their responses and the moderators had closed the question response period, results were projected in graphic format. With each question and graphic response, the moderators explained the results.

The second set of questions included the test questions for this investigation and included 10 questions to obtain basic demographic information. Answer options were either dichotomous ("easy"), multiple choice ("intermediate"), or open-ended numerical ("difficult"; Table 1). Two facilitators carefully observed the respondents' use of the clickers while answering the questions. Another facilitator read and displayed the questions and possible answers. The "easy" and "intermediate" groups contained three questions each, resulting in 105 attempts per category. The open-ended numerical or "difficult" group included four separate questions answered by 35 subjects, resulting in 140 total attempts.

A third and final set of questions were three Likert scale-type questions that asked whether participants found the clickers easy and comfortable to use and whether they believed that other workers would find learning to use the clickers easy. The icebreaker question set was administered first, followed by the demographic question set. By the end of the second set of questions, with the exception of open-ended numerical questions and one multiple choice question with 10 answer options, the group members appeared comfortable with the ARS. The focus group guide was carried out thereafter, followed by the third and final set of questions on clicker use.

The amount of time required to train participants to use ARS and the time required for them to answer the ARS directed questions was logged for each focus group. The clock began with the start of the training or the question period and ended when the final participant finished answering the pertinent questions.

Quantitative data on question responses, response rate, response error, and nonresponse data were collected through the TurningPoint program. TurningPoint does not include nonresponse in graphic output calculations but does maintain a record of active clickers in an accessible data file, which can be used to adjust for nonresponse. We classified nonresponse, out of range, and invalid answers as incorrect answers. The autosave feature of the software was used to collect and store individual data for the first three focus groups.

In each focus group, between the second and third sets of ARS questions, facilitators conducted the focus group discussion directed at worker perceptions of health and safety.

TurningPoint 2008 was used for ARS data collection. The clicker model used was the Turning Technologies ResponseCard NXT. This model included an alphanumeric keypad and a

TABLE 1. Demographic Questions

Number	Question	Answer options	Number of answer choices	Level of difficulty
1	Gender	Dichotomous	2	Easy
2	Age in years	Open-ended	Open	Difficult
3	Country of origin	Multiple choice	3	Intermediate
4	State of origin if from Mexico	Multiple choice	10	Intermediate
5	Years of school completed	Open-ended	Open	Difficult
6	Years in the United States	Open-ended	Open	Difficult
7	Farm experience before coming to the US	Dichotomous	2	Easy
8	Large animal experience before coming to the US	Dichotomous	2	Easy
9	Years of working in US dairy	Open-ended	Open	Difficult
10	Dairy job title	Multiple choice	4	Intermediate

small liquid crystal display screen that displayed a small smiley face to indicate successful answer submission. The "dongle" or receiver model used that was attached to the computer was the Turning Technologis RF receiver. Statistical analysis was performed using SAS version 9.2 (SAS Institute, Cary, NC).

All data collection protocols were approved by the Marshfield Clinic Research Foundation Institutional Review Board.

RESULTS

Qualitative Results

Within approximately the first 10 minutes of the focus group session, the majority of participants appeared to be comfortable using the ARS clickers. However, the total time required for participants to learn to use and answer the icebreaker and demographic question sets using the ARS was approximately 25 minutes. Several respondents requested assistance in answering open-ended numerical questions such as years of education, years in the United States, or years of age. Several respondents, despite attempting to disguise their unease, showed signs of discomfort and uncertainty in using the clickers. These assessments were based on observed perplexed facial expressions and hesitancy in using the clickers of specific individuals while attempting to answer certain questions. When data were presented in graphic form after each question was answered, coordinators unanimously believed that the perplexed looks suggested that these graphs were not understood by the participants. However, whether percentage bar graphs were understandable to the participants was not a question this study was designed to answer and these data were not systematically collected and processed.

Some participants complained that the clicker buttons were too small. Observations confirmed that among these manual laborers, primarily men, many had fingers and hands large enough that made manipulating these fine controls challenging.

At one of the focus groups, a respondent's clicker malfunctioned while the demographics questions were being administered. The respondent's answers were not registered by the receiver and were treated as nonresponses during this time. The respondent notified one of the facilitators who then provided the respondent with a different clicker. The receiver logged the new clicker's responses separately, which caused the TurningPoint data to look as though one participant stopped responding and a new participant joined shortly after. This was corrected by combining the responses from the different clickers in the analysis.

Quantitative Results

During conduct of the two focus groups held at a community center, either the software autosave feature malfunctioned or due to human error, individual clicker data from the sessions were lost. However, summarized data were available for these groups preserved in the graphic TurningPoint slides, so some individual responses and all nonresponse and out-of-range answers could be back calculated out of the Microsoft Excel spreadsheet embedded in the slides. Because of the data loss, individual participants' response records could not be tracked to discern if invalid answers were consistently from the same respondent or were spread out among the group as a whole. In these groups, true response percentages could not be calculated from the graphic slides.

In all five focus groups, responses to the "easy" dichotomous questions showed no out-of-range answers and only a few nonresponses. Among the "intermediate" multiple choice questions, which included questions with as many as 10 choices, the number of nonresponses increased. The highest percentage of invalid answers was found on the "difficult" open-ended numerical questions. Table 2 shows the number and percentages of correct versus incorrect answers by difficulty of question. We found a statistically significant increasing trend in error frequency (one-sided $P = .020$) based on a Cochran-Armitage test-for-trend across the answer choice categories ranging from easy (dichotomous) to difficult open-ended numerical).

After completing the test questions, workers, with one exception, appeared to be comfortable

TABLE 2. Correct and Incorrect Answers by Difficulty of Response for 35 Hispanic Dairy Workers

Difficulty of question	Correct	Incorrect (out-of-range, nonresponse, or invalid)	Total
Easy (yes/no)	101 (96.19)	4 (3.81)	105
Intermediate (multiple choice)	95 (90.48)	10 (9.52)	105
Difficult (open-ended numerical)	124 (88.75)	16 (11.43)	140
Total	320	30	350

FIGURE 2. Respondents' ease using clickers.

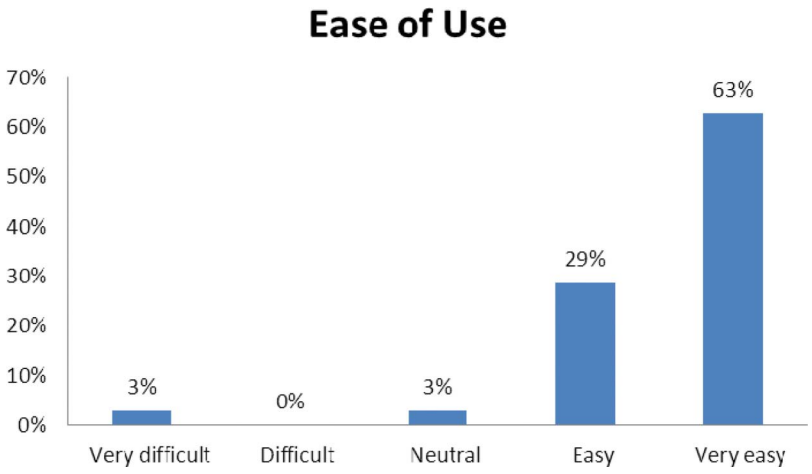
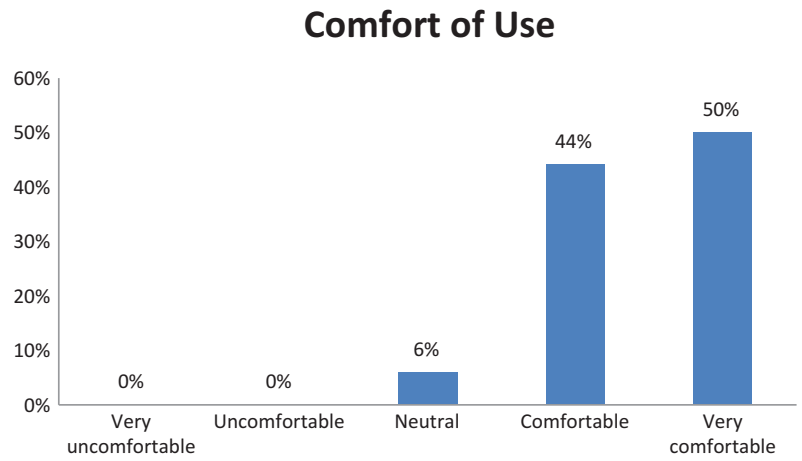


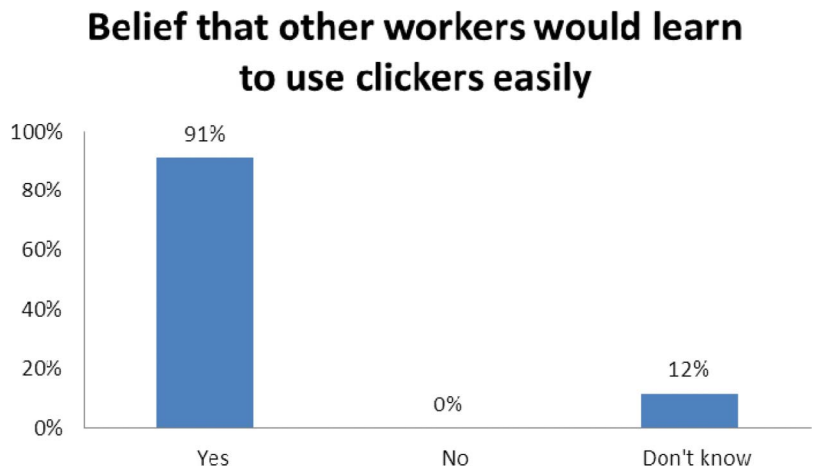
FIGURE 3. Respondents' comfort using clickers.



with clickers in answering limited multiple choice questions. They responded to questions about ease of use with a high percentage, indicating that they believed the clickers easy to use (Figure 2).

Most respondents also found the clickers comfortable to use in answering the questions (Figure 3) and stated that they believed that other workers would easily learn to use the clickers (Figure 4).

FIGURE 4. Respondents' belief whether other workers would learn to use clickers easily.



DISCUSSION

This small pilot study examined whether LEP and low-literacy individuals with low levels of formal education could effectively give responses to basic demographic questions using an ARS. We simultaneously assessed the participants' perception of ease of use of the clicker devices. The demographic questions asked ranged from simple dichotomous to open-ended numerical questions. Direct observations and quantitative data suggest that as answer choices increased in complexity, incorrect answers increased. By way of illustration, simple dichotomous and multiple choice responses showed no out-of-range or invalid answers across all focus groups. As answer choices became increasingly complex, nonresponse and uninterpretable results increased.

Participants responded that they were comfortable using clickers in answering questions, which included questions pertaining to the duration of residency in the United States and their educational achievements as well as age. These are questions that when asked in a one-on-one nonanonymous situation would likely cause some discomfort in workers seeking anonymity due to immigration status.

The clicker devices used in this study are routinely used in educational activities of staff, clinicians, and students in the Marshfield Clinic. They contain 12 keys with letters and a single number separated by a slash printed on each key. The devices also contain a small LCD (liquid crystal display) screen. We speculate that a simplified device with bigger and more widely separated buttons, a limited number of buttons (possibly 3–5), and less printing on the buttons would improve understanding and decrease error rate. Use of colored buttons could also improve ease of use for anumeric individuals.

The TurningPoint software allows one to present summarized anonymous results in various graphic formats. Investigators presented the data in bar charts to acknowledge that responses were received, to immediately communicate the results to participants without providing individual data and to address the ethical concerns of returning data to participants.[11] The usefulness of presenting percentage bar charts or response grids to a population with these characteristics must be questioned. McCaffery et al. found that pictographs were most effective when conveying risk information to low literate populations in Australia. But bar graphs were found to be effective when presenting medium and large numerators.[12] We did not test whether these graphs were understood, but observations made suggest that they may not have been. Further study should be devoted to identifying

the most understandable modes of visual presentation of data if such presentation is planned or needed.

Our data clearly demonstrate that our study population found the ARS easy and comfortable to use and participants universally recommended their use and predicted ease of use by other workers.

The primary caveat we derive from this study is that open-ended numerical responses present particular challenges for some within this population group. Complex multiple choice questions also appear to present difficulties for the same group. However, for simple multiple choice questions and dichotomous responses, this technology presents an excellent opportunity to collect information that might be considered sensitive by certain vulnerable populations Simplified response tools designed specifically for low-literacy populations should be tested and might make these tools even more efficient.

FUTURE RESEARCH

Our results suggest great potential of ARS devices with Hispanic immigrant workers or comparable populations in foucs group settings. Our findings also suggest a need to further explore the use of these devices with both low-literacy and vulnerable populations. Use of ARS with low-literacy populations in training settings to improve learner engagement and interactivity as well as to assess change in knowledge merits further study. Other question types like the Likert scale should be tested with the population to expand the definitions of easy, intermediate and difficult type questions. It is suggested that further research is done to determine the effect of the number of answer options in multiple choice questions on incorrect response rates. The time required to obtain demographic information by use of ARS should be compared to obtaining identical information by way of face-to-face interviews with similar sized groups to establish whether the use of ARS devices is more time-efficient. Moreover, we recommend the development and testing of simplified clickers by increasing the size of and distance between the buttons and limiting the number of characters on the clicker keys for these populations to improve ease of use. Anecdotally, many dairy workers, whether they are foreign-born, of low literacy, or both, have repeatedly reported to us their common use of cell phones and/or smart phones. The habit of pressing a button marked with a number is ubiquitous. Therefore, a key pad with numbers only should present little challenge. Finally, we did not explore the usefulness of presenting graphically presented data back to our audience after data collection. Hence, we cannot say how useful or beneficial this is. Given the opportunity for presenting graphic results to low-literacy audiences that ARS present, investigation into the value and understandability of graphic presentation of data should be explored.

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