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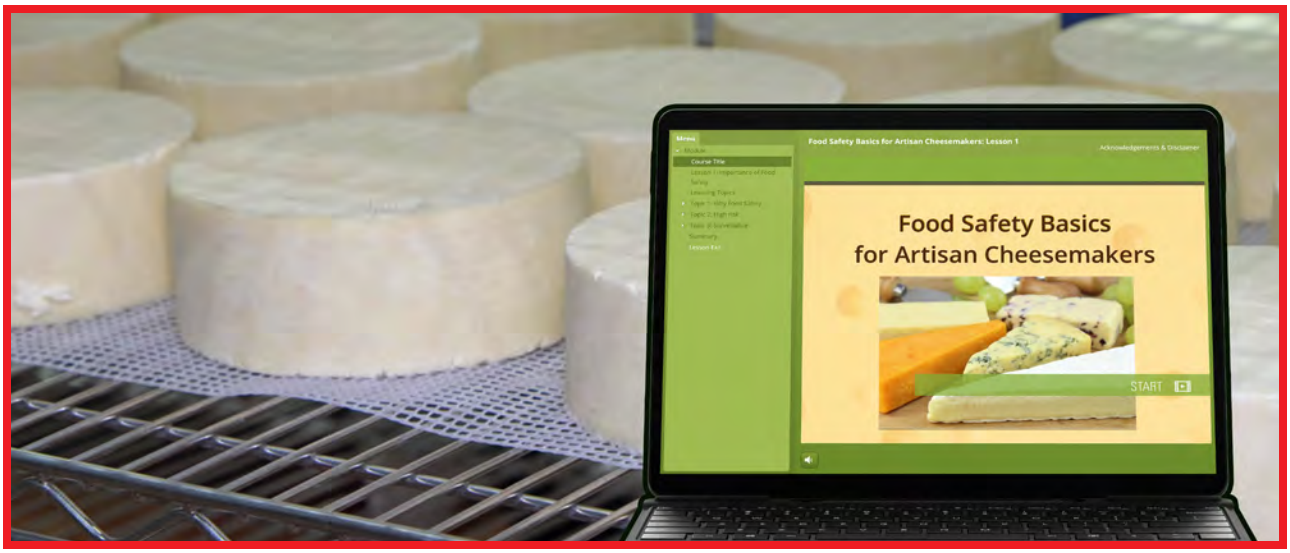

Development and Evaluation of an Online Food Safety Course for Artisan Cheesemakers in the United States

ABSTRACT

With over 90 U.S. outbreaks dating back to 1998 that were linked to cheese products, cheese processors in the United States are an important node for food safety. Awareness of food safety best practices and complying with regulations has been identified as a need by many cheese safety experts. In response, an online "Food Safety Basics for Artisan Cheesemakers" course was developed for a national audience by following the principles of instructional design. Over 800 participants registered for the course within the first year, 30% of whom (248) completed the course. Participants' reactions to the course and self-reported knowledge gain was measured as were attitudes, self-efficacies, intentions, and self-reported changes in their food safety practices. Of the 128 participants who completed an evaluation of the course, 97% (124) reported that they were satisfied with course relevance and overall quality. Sixteen participants completed a follow-up questionnaire 1 month after completing the course in which they were asked to what extent they changed their food safety practices. On average, 42% reported that they either have already changed or intend to update their food safety practices in the future based on what they learned in the course.

INTRODUCTION

Dairy products accounted for more foodborne illness hospitalizations over an 11-year period (1998 to 2008) than 16 other commodity foods *(27)*. Ninety cheese-related outbreaks were reported in the United States from 1998 to 2011, with 1,882 illnesses, 230 hospitalizations, and six deaths *(15)*.

Food safety education for artisan cheesemakers will theoretically raise awareness and result in implementation of best practices *(6, 22, 23, 36)*. Whereas some study results have suggested that education results in improvements in food safety practices *(1, 22, 23, 30)*, other results have suggested that training does not influence food safety behaviors *(5, 31)*. However, food safety risks can be reduced by implementing an effective food safety management system that consists of good manufacturing practices (GMPs), risk-based preventive controls, and

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other principles to proactively control hazards before they become problematic *(19)*.

Outcomes and recommendations from a 2015 Artisan Cheese Food Safety Forum (Providence, RI) suggested that increasing the number of educational offerings in general, specifically through online and hands-on training, would be valuable and that stakeholders would be very likely to participate in online training programs *(9)*.

The purpose of the present study was to create an educational resource for artisanal cheese producers based on the best available science and to evaluate the effect of the online delivery of this course on the target audience's food safety knowledge, attitudes, self-efficacies, intentions, and self-reported practices.

MATERIALS AND METHODS

An online course was developed using the analysis, design, development, implement, and evaluation framework *(21)*. This framework is commonly used among instructional designers in development of online courses because it is iterative and involves reflection throughout the experience.

Needs analysis

The mixed-methods needs analysis consisted of interviews with three experts on artisanal dairy food products, interviews with five artisan cheesemakers, and an online survey of 85 individuals who were part of an artisanal dairy food safety consortium *(8, 9, 11)*. This analysis revealed that food safety education opportunities were somewhat available to most artisan cheesemakers, depending on their location and the expertise of nearby cooperative extension specialists and/or consultants. With the exception of three states, these opportunities were rarely tailored to the needs of the artisan dairy community. The resources and time required to attend a workshop, for example, were often perceived as barriers. An online course was identified as a potential solution to these problems because members of the artisanal dairy food safety consortium believed that >90% of the target audience had reliable Internet service and a computer or mobile device *(11)*. The needs analysis also revealed that the design of an online course for artisan cheesemakers should be asynchronous and self-paced and should be offered on a rolling enrollment basis *(11)*.

Course design

The subject matter was partially based on a workshop developed by instructors at the University of Connecticut (Storrs) and the Vermont Institute for Artisan Cheese (University of Vermont, Burlington) in collaboration with the Innovation Center for U.S. Dairy (Rosemont, IL). These materials were converted to this online course by North Carolina State University (Raleigh) through a collaborative process that also included the Center for Dairy Research (University of Wisconsin, Madison), Dairy Foods Extension program (Cornell University, Ithaca, NY), and an artisan advisory group that included representatives from Jasper Hill Farm (Greensboro, VT), Clock Shadow Creamery (Milwaukee, WI), The Ice Cream Club Manalapan, FL), Dairy Connection (Madison, WI), Schreiber Foods (Green Bay, WI), the American Cheese Society (Denver, CO), SYSCO Foodservices (Houston, TX), and Whole Foods (Austin, TX). The content selected for inclusion in the online course was based on an analysis *(11)* that revealed a lack of basic food safety knowledge of relevant regulations such as GMPs and various food safety practices in artisan cheesemaking facilities (e.g., environmental monitoring for pathogens).

The course content was modified and redesigned for asynchronous online delivery and to enhance retention by the specific target audience—artisan cheesemakers. The course consisted of five modules. A conversational tone was used, and a professional voice talent recorded the scripts. The design of each module was based on the Gagne et al. *(12)* model of instructional events for how adults process information. The subject matter was customized to the context of artisan cheesemaking environments (not general terms of food safety) and followed up with knowledge checks that stimulated scenario-based decision-making questions. Examples and counterexamples were used throughout, and guidance, interaction, and feedback were included in every module. These edited modules were subjected to rigorous peer review by a collaborative group of artisan dairy food safety experts who represented the academic institutions, artisan dairy foods companies, specialty food retail companies, and the nonprofit organizations.

Course development

E-learning modules were produced using Articulate Storyline e-learning software *(4)*. Each module was narrated with professional voiceover and provided a linear user experience, meaning that participants navigated through the material by clicking a "next" button at the end of each screen until they reached the end of the module. Knowledge checks (multiple-choice questions that do not count toward a course grade) were integrated throughout each lesson with videos, pictures, and links to more information. Short quizzes were placed after each module, and participants were required to obtain at least a 70% correct score before continuing to the next module.

Course implementation

The course was hosted by a learning management system (Moodle, Perth, Australia; https://moodle.com/about). Before fully implementing the course, a beta test was conducted with 25 participants who represented the target audience and were selected based on convenience sampling (the artisan advisory group identified a list of prospective volunteers based on their preexisting relationships with cheesemakers). Feedback was collected on both the course design and the evaluation instrument, and edits were made

TABLE 1. Participants' experiential attitudes toward food safety practices. Each item was paired with a seven-point scale ranging from Extremely displeasing (1) to Extremely pleasing (7); n = 41

Instrument Item	Mean	SD	Factor Loading
Learning about food safety is …	5.63	1.13	.639
Following food safety rules is …	5.71	1.29	.722
Applying Good Manufacturing Practices in my facility is …	6.12	1.12	.831
Applying Process Controls in my facility is …	5.98	1.11	.919
Implementing a program that monitors for pathogens in my cheese making facility is …	5.95	1.20	.875

accordingly. Learning analytics from the beta test indicated that completion of the course required 5 to 10 h.

The marketing campaign involved advertisements and descriptions of the course in publications of five trade organizations. A course price ($140) was set, and to maximize enrollment, a limited time discount code was advertised through these publications and by the American Cheese Society.

Course evaluation

Participants' reactions to the course and the impact of the course on their self-perceived knowledge, attitudes, self-efficacy, food safety intentions, and self-reported changes in food safety practices were assessed. Retrospective pre- and posttest questionnaires were used to measure self-perceived knowledge gain. After completion of each lesson, participants responded to a series of questions (5-point Likert scale) about their self-perceived levels of knowledge regarding the learning objectives of each lesson before and after they completed the lesson. The amount of knowledge change reported was determined by subtracting each respondent's pretest score from their posttest score.

Participants were also asked for their reactions to the course. Of the six questions, two were open ended and concerned the strength and weakness of the course. These questions were coded to identify themes. After these questions were answered, participants were asked whether they were willing to reply to more questions related to attitude, self-efficacy, and intention *(Tables 1–4)*.

The theory of planned behavior *(2)* was used to develop a model for predicting participants' intentions to improve their food safety practices after taking the course, based on their attitudes and self-efficacies. Because no published studies have included measurement of these constructs in the context of artisan cheesemakers in an online food safety learning environment, an instrument was drafted and then refined after receiving feedback from subject matter experts who regularly train artisan cheesemakers on food safety.

Experiential attitudes (a person's emotional reaction to the idea of performing a behavior, e.g., washing my hands feels good) and instrumental attitudes (a person's beliefs about the results of performing a behavior, e.g., washing my hands will result in safer cheese products) were measured with five questions (7-point Likert scale; *Tables 1 and 2*). Likert scales were also used to measure self-efficacy with six questions *(Table 3)* and intentions with five questions *(Table 4)*.

Participants' self-reported changes in food safety practices were assessed by asking participants to complete another survey 1 month after they completed the course. Willing participants answered whether they had changed any practices in their facility according to a list of 10 food safety topics; answer options were "yes," "no, and I do not intend to," and "no, but I intend to." Participants were then asked to explain their answers *(Table 5)*.

Demographic questions documented respondents' gender, age, ownership of the facility, education, number of years in the cheese business, annual production, and type of milk used in cheese production.

All surveys were face and content validated by six subject matter experts. The reliability and validity of the sections of the research instrument were determined through Cronbach's alpha and principal components analysis (PCA) factor loadings, respectively. All procedures used in this study were reviewed and approved by the Institutional Review Boards for Human Studies at North Carolina State University (protocol 12055).

Statistical analysis

The data collected were analyzed with SPSS statistical analysis software *(18)*. Descriptive statistics were used to summarize the variables of interest, and regression models were used to determine the relation between selected variables. Statistical significance was defined at the 95% confidence level ($P \leq 0.05$). The Steel-Dwass test was used to compare the means for all data sets, which were nonparametric.

TABLE 2. Participants' instrumental attitudes toward food safety practices. Each item was paired with a seven-point scale ranging from Extremely unlikely (1) to Extremely likely (7); n = 41

Instrument Item	Mean	SD	Loading Factor
Learning more about food safety will help me create a safer product	6.78	0.79	.526
Food safety regulations will keep my products safer from contamination	6.22	1.08	.746
Applying Good Manufacturing Practices in my facility minimizes food safety risk	6.76	.62	.606
Applying process controls minimizes food safety risk	6.73	.71	.607
Implementing a program that monitors for pathogens in my cheese-making facility will keep my products safer from contamination	6.66	.82	.606

TABLE 3. Participants' food safety self-efficacies. Each item was paired with a seven-point scale ranging from extremely certain I could not (1) to extremely certain I could (7); n = 41

Item Questions	Mean	SD	Factor Loading
Identify if the cheese you make is high risk or not	6.29	0.75	.691
Find laws and regulations required for manufacturing cheese in my facility	6.22	0.76	.856
Identify the factors which will affect the growth of bacteria in cheese	6.32	0.72	.500
Locate the areas that are high risk for pathogens	6.29	0.90	.774
Implement GMPs (good manufacturing practices) and process controls	6.41	0.77	.769
Implement a program for monitoring for pathogens in the environment	6.37	0.73	.950

TABLE 4. Participants' intentions to change their food safety practices. Each item was paired with a five-point scale ranging from always (5) to never (1) and then responses were converted to a 7-point scale; n = 41

Item Questions	Mean	SD	Factor Loading
Follow personnel hygiene practices (frequent hand washing, no jewelry, wear hairnets and gloves while working) in your facility	6.82	.73	.763
Adopt proper cleaning and sanitation protocols to prevent cross-contamination	6.86	.43	.763
Spend time and resources to learn more about food safety in your facility	6.07	1.21	.679
Prevent foodborne illness through proper implementation of GMPs and process controls	6.78	.60	.414
Implement an environmental monitoring program in your facility	6.11	1.50	.897

Sampling

Of the 828 participants who registered for the course, only 30% (248) completed the course. Convenience sampling of these participants was used for all constructs, and 15.5% (128) of the 828 participants responded to the survey that asked for their reactions to the course. Not all of these participants consented to the other surveys in this study, which were implemented sequentially. For example, self-reported knowledge gains were recorded for 8.0% (66) of participants, and demographics were recorded for 5.7% (47)

TABLE 5. Themed responses for participants' reasons for implemented changes to their food safety practices (or not); n = 16

Practice change category	Yes/No (frequency)	Reasons of changes brought in or changes not brought in
Pest control	Yes – 6 (38%)	Sealing of cracks in floor, ceiling, walls and front door (1)
		Training the employees about pest control (3)
		Maintaining a documented log of pest control (1)
		Hired a pest control company who can monitor pests monthly (2)
		Written a pest control program (1)
	No – 10 (62%)	Already compliant (6)
		Small home producer so no changes necessary (3)
Exterior grounds	Yes – 2 (13%)	Cut down weeds next to the barn (1)
		Exterior of the building trimmed and treated to control weeds (1)
	No – 14 (87%)	Already compliant (11)
		No control over exterior of the building as it is a leased facility
		Have plans to review maintenance program to prevent cross-contamination
Construction and design of the facility	Yes – 2 (12.5%)	Fitted new air condition to aid ventilation (2)
		Cleared clutters (1)
		Changed the zones arrangement to keep raw materials away from finished products (2)
		Changed the drain brushes as suggested in the course (1)
	No – 14 (86.5%)	Already compliant (12)
		Plan to review air flow and material flow in the facility (1)
		Building a new facility and keeping the suggestions given in the training (1)
Personnel health and hygiene	Yes – 5 (33%)	Follow more rigorous hygiene (3)
		More aware of personal health and hygiene practices (2)
		Started giving employee training and issuing appropriate clothing, protective equipment and footwear (1)
	No – 10 (67%)	Already compliant employees maintain log of their personal daily health (6)
		Plan to install a foot washing station
		Plan to update employee training based on the course and document (3)
Sanitary facilities and control	Yes – 4 (27%)	Implemented food safety zone awareness and improved sanitation suggested in the course (1)
		Updated sanitary log of the facility (2)
		Trash is removed everyday (1)
	No – 12 (73%)	Already compliant (11)
		Plans to put water purification system in the facility (1)
Equipment design, installation and maintenance	Yes – 1 (7%)	
	No – 15 (93%)	Already complaint in terms of having proper design, stainless steel and food grade plastic (14)
		Can't afford to have new equipment due to very small size of the business (1)
Material management	Yes – 5 (33%)	Raw material program updated (1)
		Increased monitoring of raw material (2)
	No – 10 (67%)	

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TABLE 5. Themed responses for participants' reasons for implemented changes to their food safety practices (or not); n = 16 (cont.)

Practice change category	Yes/No (frequency)	Reasons of changes brought in or changes not brought in
Cleaning and sanitizing	Yes – 5 (33%)	Increased awareness communicating the new knowledge about cleaning and sanitizing products in the facility (2)
		Seeking out suitable cleaner for drainage system (1)
	No – 10 (67%)	Already compliant (5)
		Plan to use environmental-friendly compounds
		Planning to change sanitizers
		Planning to rewrite sanitation program based on the course
In-process testing	Yes – 4 (27%)	Testing and monitoring pH (2)
		More thorough testing for *Listeria* (1)
		Tested milk samples in state lab for verification and microbial count (1)
	No – 11 (73%)	Already compliant (11)
		More training is required to establishing own labs for testing
		Plan to do index organism testing
Environmental monitoring	Yes – 0	N/A
	No – 15 (100%)	Already compliant (10)
		Plan to do in near future (2)
		ATP meter is too expensive for small cheesemakers (1)
		Plans to update current environmental monitoring program (2)

of participants. Only 5.0% (41) of participants responded to the questions that assessed their attitudes, self-efficacies, and intentions. One month after completing the course, 1.9% (16) of participants responded to a survey that assessed self-reported changes in food safety practices. The response rates for each of these constructs were different because of survey attrition and the different time intervals at which the data were collected.

RESULTS AND DISCUSSION

Participant demographic data

Of the 848 respondents who participated in the online survey, 66% were women and 34% were men in the following age ranges (years): < 25 (6%), 25 to 34 (17%), 35 to 44 (19%), 45 to 54 (28%), 55 to 64 (17%), or ≥ 65 (13%). Education level also varied: 8% had a doctoral degree, 15% had a master's degree, 49% had a bachelor's degree, 7% had an associate's degree, and 20% had a high school diploma. Regarding time in the artisan cheese business, 34% of respondents had < 1 year, 26% had 1 to 3 years, and 23% had > 5 years of experience. Regarding type of milk used for cheesemaking, 57% of the cheesemakers used pasteurized milk, 16% used raw milk, and the remaining 27% used a combination of pasteurized milk and raw milk.

Course completion rate

The course completion rate of 30% (n = 248) was relatively high in the context of online courses with voluntary participants. A meta-analysis of massive open online courses revealed course completion rates of 1 to 52%, with a median of 12% *(20)*. The researchers reported higher course completion rates in courses that were autograded, as was our course. Higher course completion rates were positively correlated with shorter and newer courses *(20)*. Therefore, future course development should focus on redesigning and advertising the course that maintains rigor but requires less time and/or appears relatively new.

Participant reactions to the course

When asked whether the course met their expectations in terms of relevance of content and overall quality, 97% (124) of participants who completed the course said "yes" and the remaining 3% said "no." When asked whether they would recommend this course to the other cheesemakers, 98% (125) responded "yes." Regarding the open-ended question about the strengths of the course, 35% (45) indicated that the course was interactive and engaging, and 29% (37) stated the additional links to various resources in the modules were helpful. Some participants experienced some technical issues

TABLE 6. Self-reported changes in food safety practices after taking online course (n = 16)

Food Safety Practice	Yes	No	No but intend to
Pest control	37.50% (6/16)	50.00% (8/16)	12.50% (2/16)
Exterior grounds	12.50% (2/16)	75.00% (10/16)	12.50% (2/16)
Construction or design of facility	13.30% (2/15)	66.70 (10/15)	20.00% (3/15)
Personnel health and hygiene	33.00% (5/15)	47.00% (7/15)	20.00% (3/15)
Sanitary facilities and controls	26.67% (4/15)	66.67% (10/15)	6.67% (1/15)
Equipment design, installation and maintenance	6.67% (1/15)	86.67% (13/15)	6.67% (1/15)
Material management	33.30% (5/15)	33.30% (5/15)	33.30% (5/15)
Cleaning and sanitizing	33.30% (5/15)	46.67% (7/15)	20.00% (3/15)
Testing	26.67% (4/15)	40.00% (6/15)	33.33% (5/15)
Environmental monitoring	0.00% (0/15)	66.67% (10/15)	33.33% (5/15)

with certain Web browsers and said they wanted more in-depth knowledge on certain topics.

Self-reported practice changes

For the participants who completed the 1-month follow-up survey (1.9% [16] of all participants) that asked to what extent they changed their approaches to a list of 10 food safety practices, on average 22% of participants reported that they changed or updated their food safety practices and/or programs related to GMPs in their facility, 58% did not intend to change anything, and 20% intended to change soon *(Table 6)*. This result reflected the broad range of facility size and experience level of participants, e.g., some already had food safety plans in place. Overall, participants reported that they improved their food safety practices for every topic except environmental monitoring *(Table 6)*. The learning objective for the environmental monitoring lesson was to raise awareness and not necessarily for participants to immediately change their practices. For all topics, some participants reported that they intended to improve their food safety practices in the future. Many participants reported they do not intend to change any food safety practices because they are either already following GMPs or certain issues are not cost-effective or practical (e.g., "I cannot make any changes to the exterior of my facility because I lease it" and "I can't afford new equipment"). Due to lack of observational data, participant compliance with the requirements could not be confirmed. Discrepancies between observational and self-reported data regarding food safety practices have been previously reported *(5, 10)*.

Participant self-reported knowledge gains

The mean (standard deviation [SD]) retrospective self-reported pretest scores for lessons 1, 2, 3, 4, and 5 were 3.83 (0.70), 3.05 (1.18), 3.14 (1.40), 2.98 (1.36), and 2.69 (1.46), respectively, and no significant differences was found between these scores ($P < 0.05$). Mean (SD) retrospective self-reported posttest scores were 4.19 (0.63), 3.59 (1.18), 3.54 (1.47), 3.54 (0.17), and 3.24 (1.6) for lessons 1, 2, 3, 4, and 5, respectively. No significant gains in self-reported knowledge were observed for any of the 25 individual food safety topics or for any of the five lessons ($P > 0.05$; data not shown). These results were similar to those of some other food safety studies in which there were no significant knowledge gains due to an intervention *(14, 25, 26, 32)*. This finding may be attributed to learners' tendency to overestimate their self-perceived knowledge of food safety procedures because of optimistic bias or social (peer) desirability to comply when they self-report *(7, 34, 35)*. Self-perceived knowledge results also could have been affected by the relatively small sample size, as indicated by the large SDs for the mean scores.

Testimonials

Many verbatim comments and unsolicited feedback in the form of emails indicated that users gained usable information from the course on how to improve their businesses and practices. For example, one testimonial that came from someone who was an exact match for the target audience wrote, "I started making cheese as a hobby in our kitchen about 6 years ago. Since then, we have gradually built it into a good-sized business. At this point in time, we are making the transition from being a hobby to a business. Recently we managed to procure a government loan to build a new factory and construction is almost ready. Your course has been extremely useful in designing our new factory. None of us has any experience in cheesemaking or factory construction beyond what we have gleaned from various sources and so the information you provide is invaluable to us."

Instrumental and experiential attitudes, self-efficacies, and intentions

The Cronbach's alpha scores were 0.78 to 0.96, and the PCA factor loadings were > 0.31, both of which were within an acceptable range *(16)*. Factor analyses suggested one factor for each of the scales for all constructs *(Tables 1–4)*. The mean (SD) scores of the 41 participants for experiential attitude, instrumental attitude, self-efficacy, and intention were 5.99 (1.08), 6.68 (0.50), 6.43 (0.58), and 6.63 (0.52), respectively. Approximately 55% of the variance in participants' food safety intentions was explained by their instrumental attitudes, experiential attitudes, and self-efficacies. Typically, factors related to theory of planned behavior (attitudes, subjective norms, and perceived behavioral controls) explain 40 to 60% of the variation in behavioral intentions *(3, 13)*, in agreement with our results.

Instrumental attitude (defined as the belief that performing best practices in food safety will result in safer food) was a significant predictor of intentions ($P < 0.01$; $\beta = 0.619$), experiential attitude (defined as an individual's reaction to the idea of performing best food safety practices) was a marginally significant predictor ($P = 0.127$; $\beta = 0.202$) but self-efficacy was not significant ($P = 0.933$). Hinsz and Nickell *(17)* and Phillip and Anita *(29)* also reported that attitudes predicted food safety intentions of workers in their studies at a poultry processing facility and food handlers in hospitality settings, respectively. However, undergraduate students' attitudes did not predict their food safety intentions in two other studies *(24, 33)*, which may perhaps be explained by an apparent social desirability bias *(28)*.

Although the predictive effect of attitudes on food safety intentions appear to be audience dependent, the food safety intentions of employees of food companies may be enhanced through cultivating their attitudes. For example, group leaders (e.g., trainers, manager, and consultants) could refine their explanations of the effects of certain food safety practices on the integrity of finished products and eventually on the consumers.

Self-efficacy was not a significant predictor of intentions in the present study ($P = 0.933$). Perceived behavioral control, which is conceptually similar to the self-efficacy construct measured in the present study but often assessed differently, was a significant predictor of food safety intentions in Phillip and Anita's *(29)* study. However, Hinsz and Nickell *(17)* reported the opposite. Mullan and Wong *(24)* reported that perceived behavioral control was a significant predictor of college students' food safety intentions, but in contrast Stevenson et al. *(33)* reported that perceived behavioral control was a significant predictor of college students' intentions only after a food safety educational intervention and not before. These results corroborate an observation from a meta-analysis of behavioral studies that perceived behavioral control irregularly predicts intentions *(3)*. Whereas perceived behavioral control added an average of 6% to the prediction of intentions control, it more commonly directly influenced behaviors *(3)*.

An experimental regression model that also included age, years of experiences, and gender of the participants revealed that none of these factors were significant predictors of intentions (data not shown).

CONCLUSIONS

A collaborative and systematic approach to designing an online food safety course for artisan cheesemakers resulted in participants being very satisfied with their learning experiences. Whereas participants' total self-reported retrospective knowledge gains were not statistically significant, if the methodology had instead assessed knowledge before and after the course there might have been a significant increase in actual knowledge. The course did generate many positive testimonials and verbatim comments, indicating that it was a valuable resource for artisan cheesemakers, and 22% of participants reported that they changed or updated their food safety practices and/or programs related to GMPs in their facility as a result of the course. Participants' instrumental attitudes but not their self-efficacies were significant predictors of their intentions to improve their food safety practices. Therefore, the impacts of food safety training and outreach efforts directed at the artisan cheesemaking community may be improved by specifically supporting participants' instrumental attitudes (defined as their beliefs about the results of performing food safety practices). The collaborative and instructional design-focused approach to delivering food safety education to a target audience in this study may serve as a model for similar initiatives.

LIMITATIONS

An estimated 1,000 artisans are making cheese in the United States. Therefore, the sample sizes in this study, depending on the instrument being evaluated, were relatively small: 128 participants provided their reactions to the course; 66 provided information on retrospective self-reported knowledge gains; 47 provided demographic information; 41 provided answers to questions about attitudes, intentions, and self-efficacy; and 16 responded to the 1-month follow-up, self-reported food safety practices survey. Because participation in the course was voluntary, the findings in this study may be skewed toward participants who are more eager to improve their food safety programs and/or to provide results that please the researchers (acquiescence bias). Another potential source of bias was course development and program evaluation conducted by persons in the same program. The study results were based on self-reported data collected through an online survey and could have been validated by addition of observational data.

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