Adaptive Lessons Featuring Virtual Reality Experiences that Simulate On-the-Job Food Safety Learning for Artisan Dairy Processors

By: Stephanie Maggio, Julie Yamamoto, Nathaniel Powers & Clinton Stevenson
Connecting with Students
Vulto Creamery Outbreak

Sept. 1, 2016
1st Listeriosis case reported

March 3, 2017
FDA find retail sample positive for L. mono

March 10, 2017
Outbreak strain identified on additional retail samples

March 11, 2017
Vulto Creamery announces recall of all products

March 13, 2017
Last reported Listeriosis case

March 17, 2017
Vulto Creamery announces partial recall

February 28, 2017
FDA initiates investigation into Vulto Creamery

March 22, 2017
FDA closes inspection into Vulto Creamery. Key observations include:
- poor employee hygiene practices,
- black and/or green mold in multiple locations within the facility, and
- equipment in disrepair

March 29, 2017
FDA finds retail sample positive for L. mono

May 3, 2017
CDC Reports the outbreak is over. 8 illnesses, 4 states, 2 deaths

March 30, 2018
NYS entered a consent decree of permanent injunction against Vulto Creamery
Connecting with Students is Imperative
For Food Safety Training

Food Safety Modernization Act (FSMA) of 2011

Environmental monitoring is now a requirement

Impact on artisan dairy community
Small Business Hurdles to an Effective Food Safety System

1. Lack of food safety understanding \(^1,^2,^3\)
   a. i.e. understanding of terminology, cleaning & sanitation procedures, risks, etc.

2. Lack of Prerequisite Programs \(^2\)

3. Lack of resource feasibility \(^2,^3\)
   a. i.e. time, money, employees

4. Lack of employee motivation \(^2\)

5. Inadequate physical condition of the facility \(^2,^3\)

6. Lack of availability of relevant training \(^4\)

\(^1\) Walker et al. 2003; \(^2\) Baş et al. 2005; \(^3\) Karaman et al. 2012, \(^4\) Taylor 2001
Top Sanitation Concerns of Food Processors

(Ferguson 2018)
Current Food Safety Training

- Majority face-to-face training
- Majority designed with no needs analysis
- Majority designed with no learning theory consideration
Social Constructivism Paradigm

Learning occurs on two levels

Socially

In the Mind

(Vygotskii 1978)
Situated Learning Theory

- Learning in the context of where the material will be applied
- Has a social component
  - “Legitimate peripheral participation”
Legitimate Peripheral Participation

Novice learner’s initial and peripheral engagement is legitimized and thus supports the development of early practices and their inherent skills.

With extended engagement with the ‘community of practice’, the learner progressively develops or acquires greater and more sophisticated participative skills.

The ‘community of practice’ boundary is a dynamic and flexible entity, allowing ease of access to socially constructed practices and engagement.
When compared to a control group, training that includes simulation has a greater effect on the following: (n = 65)

- Post-training self-efficacy ~20% greater
- Declarative knowledge ~11% greater
- Procedural knowledge ~14% greater
- Retention ~9% greater

(Sitzmann 2011)
Adaptive Learning: Data Analytics

Lesson Summary

- **Average Grade**: 66%
- **Lesson Completion**: 69% (35 out of 51 students)
- **Adaptive Feedback in Use**: 58% (64 out of 113 states)

The percentage of your custom states (e.g., adaptive feedback for a misconception) that have been triggered and seen by at least one student.

A low value (less than 80%) suggests that your states are not effectively targeting students' responses.

Online in the Last Hour: 0

Median Time Spent: 00 M 30
Adaptive Learning: Data Analytics

- One chance: Either correct or incorrect result.
- Hope that students learn from their mistakes/misconceptions
Hypothesis

Adaptive learning featuring virtual reality experiences that simulate on-the-job training is an effective teaching strategy for improving the food safety knowledge, attitudes, norms, personal agency, intentions and behaviors of NC small dairy processors.
Instructional Design Process
Needs Analysis: Purpose

1. Identify the demographics of North Carolina Artisan Dairy Processors.
2. Use the Integrated Behavior Model (IBM) to assess which components of behavior predict the Artisan’s decision to perform safe food handling behaviors.
Needs Analysis: Methods

Identified Audience \((n=49)\)

Face-to-face Interviews \((n=7)\)

Online Survey \((n=21)\)
Needs Analysis: Demographics

Key Characteristics of NC Artisan Dairy Processors (n=19)
Needs Analysis: Relative Risk

Risk Level Determination:

- 1pt for producing raw products
- 1pt for offering tours
- 1pt for farm on site
Needs Analysis: Target Audience Values

Ranked Values of NC Dairy Processors

- Producing a product that customers will enjoy: 76
- Producing a product that meets quality standards (i.e. texture, consistency, color, etc.): 65
- Meeting production goals: 63
- Producing a product that will not make customers sick: 53
- Expanding the business: 10
Needs Analysis: Behavior Predictors

Linear Regression Predicting Intentions to Perform Food Safety Behaviors

- Experiential Attitudes
- Attitudes
- Instrumental Attitudes
- Injunctive Norm
- Perceived Norms
- Descriptive Norm
- Perceived Control
- Personal Agency
- Self-Efficacy

Intention to perform behavior

Knowledge

Behavior

\[ B = -0.099 \quad (p=0.6798) \]

\[ B = 0.234 \quad (p=0.3319) \]

\[ B = 0.093 \quad (p=0.7524) \]

\[ B = -0.222 \quad (p=0.4933) \]

\[ B = -0.229 \quad (p=0.6387) \]

\[ B = 9877 \quad (p=0.0222) \]

\[ R^2 = 0.5734 \quad (p=0.0683) \]
Needs Analysis Conclusions

• 8th grade reading level
• Social aspect
• Help users identify high-risk
• Ability to “practice” new skills and build self-efficacy
Training Design

• Case study
• Adaptive learning
  – Remedial pathways
  – Personal feedback
  – Choose your own path
• Virtual situated learning
  – Observe behavior being performed
  – “Perform” behavior
Adaptive Learning - Remedial Pathways

In the Cheesy Wheel case, the first routine sample that came back positive was in Zone 1, on the cheese form used to form blocks of sharp cheddar cheese.

Use that information to locate the correct cell in the FDA table to determine which corrective actions you should take. Move the pin to the correct table cell below:

### Corrective Actions when *Listeria* species is found in an environmental sample

<table>
<thead>
<tr>
<th>PINS</th>
<th>Food Contact Surfaces (Zone 1)</th>
<th>Non-Food Contact Surfaces (Zones 2 - 4)</th>
</tr>
</thead>
</table>
| Routine Sampling Positive #1 | • Intensified cleaning and sanitizing in the area where positive occurred  
• Retest positive site and perform intensified sampling and testing during next production run (at least 3 hours into production)  
• Conduct comprehensive investigation - root cause analysis | • Clean and sanitize area where positive occurred  
• Retest positive site and perform intensified sampling and testing during next production cycle |

Follow Up Sampling Positive #2

• Intensified cleaning and sanitizing for 3 consecutive days (including disassembly of equipment)  
• Intensified sampling with 3 consecutive days  
• Hold and test product for L. monocytogenes from the second and third of 3 consecutive days

That’s still incorrect. It looks like you could use a little more information on how to use the FDA table. Click Next for more info.
Adaptive Learning - Remedial Pathways

That’s still incorrect. It looks like you could use a little more information on how to use the FDA table. Click Next for more info.
Adaptive Learning - Personal Feedback

Corrective Actions

You're ahead of the game because you've already started an EMP. All three of you probably want to jump right in to save Ginger and Walter's farm, but first, you'll need to determine which corrective actions to take. What are corrective actions? Let's look at that now.

Corrective actions eliminate the source of the issue, in this case Listeria contamination, and make sure it's totally resolved. Corrective actions can include cleaning, sanitizing, performing root cause analysis to determine the source of contamination, re-sampling, reworking or destroying any contaminated product (if necessary), and taking measures to prevent the same contamination from happening again.

Are you ready to jump in and start determining corrective actions?

- Yes, bring it on!
- I guess so but I'm not really sure how.
- Not really. This seems a bit complicated so far.

That's totally understandable. It's easy to feel overwhelmed by the new material and the seriousness of possible Listeria spp. contamination. I hope it helps to know that I'll be here to show you the way. We'll take it step-by-step until you've learned how to determine the proper corrective actions. Let's start with an example case.
Adaptive Learning - Personal Feedback

That’s totally understandable. It’s easy to feel overwhelmed by the new material and the seriousness of possible *Listeria* spp. contamination. I hope it helps to know that I’ll be here to show you the way. We’ll take it step-by-step until you’ve learned how to determine the proper corrective actions. Let’s start with an example case.
Adaptive Learning - Choose Your Path

Choose a Case Study

Now that you're comfortable identifying corrective actions, it's time to learn what to do in the worst-case scenario, a positive on a Zone 1 site.

I'm going to give you a case study to work through here in the Dairy Teaching Lab. Would you rather work on the example in the cheese room or ice cream packing area?

- [ ] Cheese Room
- [ ] Ice Cream Packaging Area

Next
Virtual Situated Learning
Virtual Situated Learning
Evaluation Will Identify

1. How \textit{effective} is the online training course using situated and adaptive learning strategies, in increasing adult learners in the workplaces’ \textit{knowledge} of training topics, specifically environmental monitoring in artisan dairy facilities?

2. Were the adult learners able to \textit{effectively apply} (behavior transfer) the training content at the dairy facility in which they work?
Experimental Design

Group A
(Control Group - Traditional Programmed Instruction)

Group B
(Intervention Group - Situated and Adaptive Learning)

Pre-eval.
• Knowledge, Attitudes, Norms, Personal Agency, Intentions

Intervention

Post-eval. 1
• Knowledge, Attitudes, Norms, Personal Agency, Intentions.
• Social & Environmental Engagement

Post-eval. 2
• Knowledge, Attitudes, Norms, Personal Agency, Self-Reported Behaviors
Significance

- Serve as a model for other industries
- Make training more affordable, flexible, and adaptive
- Keep our food system safe
- Keep small businesses in business
Lessons Learned

1. Consistency within the course is difficult to maintain when multiple groups are working on different parts of the training at the same time.
2. Regulators, industry experts, and academics can have different views on the same topic - making advice difficult to give.
Resources

Thank You!
Questions?

Stephanie Maggio (samaggio@ncsu.edu)