Evaluating online modules contextualizing STEM in poultry science for secondary students

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STEM Science, Technology, Engineering, Mathematics
Need for STEM skill development

• **Next decade:** 1 million more STEM professionals needed

• **Requires a 33% increase** in # of STEM BS degrees completed per year

• STEM skills important in both STEM and non-STEM careers
How does the US measure up in STEM skill development?
Internationally, U.S. stands in middle of pack on science, math, reading scores

Average scores of 15-year-olds taking the 2015 Program for International Student Assessment

<table>
<thead>
<tr>
<th>Subject</th>
<th>U.S.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science</td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td></td>
</tr>
</tbody>
</table>

Note: Scale ranges from 0-1,000. Reproduced from the 2015 PISA. Source: OECD, PISA 2015.

The U.S. is an “unimpressive” 38th in math and 24th in science out of 74 countries. Behind many other advanced industrial nations.
How is US education falling short?

The main reasons young Americans don’t want to study STEM:

Too difficult   Too boring   Not useful

Pew, 2013
New models for STEM teaching
Integrated, contextualized STEM

“the approach to teaching the STEM content of two or more STEM domains, bound by STEM practices within an authentic context for the purpose of connecting these subjects to enhance student learning”

Kelley and Knowles, 2016
Refining implementation of new approaches

• Program development: studies documenting research-based programs\(^1\)

• Accessible, effective for real classroom use\(^2,3\)

\(^1\)PCAST, 2012
\(^2\)Hurk et al., 2018
\(^3\)Pekrun and Linnenbrink-Garcia, 2014
THE PRESENT RESEARCH:
Testing a new model for STEM teaching in HS
Purpose: Contextualize STEM learning in poultry science to support high schoolers in developing STEM skills and motivation.
The Laying Hen Industry: an ideal context
Low public interest/awareness of poultry

Not typically included in K-12 curriculum

Poultry industry PR
• Biosecurity reduces public access to farms
Acute deficiencies in Midwest poultry interest
Instructional Design
Multi-faceted, theory-based program

- Effectively convey poultry and STEM concepts
- Improve student interest and motivation towards STEM and poultry learning
Operationalizing Contextualized STEM

Two or more subject areas in context
Practical/Authentic
Targets critical thinking, problem-solving
Learner-centered
Use of technology

Robinson et al., 2018
Online Modules based on Laying Hen Industry

- Cage Parameters
  - Feeding Space
  - Water
  - Scratch Pad
  - Perches
  - Nest Areas
  - Stocking Density
  - Cage Size
  - Space Provided
  - Employee Inspection
  - Handling Events
  - Nest Size
  - Light Intensity
  - Hens in Group

- 30 mins each
- + in class component
# Program Overview

<table>
<thead>
<tr>
<th>Module</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to the Table Egg Industry</td>
</tr>
<tr>
<td>2</td>
<td>Laying Hen Anatomy, Physiology, and Biology</td>
</tr>
<tr>
<td>3</td>
<td>Introduction to Animal Welfare</td>
</tr>
<tr>
<td>4</td>
<td>Laying Hen Management</td>
</tr>
<tr>
<td>5</td>
<td>Industry Technologies</td>
</tr>
<tr>
<td>6</td>
<td>Egg Processing</td>
</tr>
<tr>
<td>7</td>
<td>Case Study</td>
</tr>
<tr>
<td>Section</td>
<td>Content</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Welcome</td>
</tr>
<tr>
<td>2</td>
<td>Introduction Video</td>
</tr>
<tr>
<td>3</td>
<td>Reproduction Introduction</td>
</tr>
<tr>
<td>4</td>
<td>Hen Laying Cycle</td>
</tr>
<tr>
<td>5</td>
<td>External Anatomy</td>
</tr>
<tr>
<td>6-7</td>
<td>Reproductive Tract Anatomy</td>
</tr>
<tr>
<td>8</td>
<td>Anatomy of the Egg</td>
</tr>
<tr>
<td>9-10</td>
<td>Development of the Egg</td>
</tr>
<tr>
<td>11</td>
<td>Egg Abnormalities</td>
</tr>
<tr>
<td>12</td>
<td>Factors of Stress in Poultry</td>
</tr>
<tr>
<td>13</td>
<td>Stress Video</td>
</tr>
<tr>
<td>14</td>
<td>Your Thoughts</td>
</tr>
<tr>
<td>15</td>
<td>Better Egg Production</td>
</tr>
<tr>
<td>16</td>
<td>Genetics and the Environment</td>
</tr>
<tr>
<td>17</td>
<td>Your Thoughts</td>
</tr>
<tr>
<td>18</td>
<td>Careers to Consider</td>
</tr>
<tr>
<td>19</td>
<td>Your Thoughts</td>
</tr>
<tr>
<td>20</td>
<td>Selective Breeding</td>
</tr>
<tr>
<td>21</td>
<td>A Hen for Each Environment</td>
</tr>
<tr>
<td>22</td>
<td>Improvements in Science</td>
</tr>
<tr>
<td>23</td>
<td>Test Your Knowledge</td>
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</table>
### Cage Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Feeder Space</td>
<td>Large</td>
</tr>
<tr>
<td>Waterers</td>
<td>0</td>
</tr>
<tr>
<td>Scratch Pads</td>
<td>20</td>
</tr>
<tr>
<td>Perches</td>
<td>10</td>
</tr>
<tr>
<td>Nest Areas</td>
<td>50</td>
</tr>
<tr>
<td>Stocking Density</td>
<td>High</td>
</tr>
<tr>
<td>Space Provided</td>
<td>Large</td>
</tr>
<tr>
<td>Employee inspection</td>
<td>1 per minute</td>
</tr>
<tr>
<td>Handling Events</td>
<td>Petting zoo</td>
</tr>
<tr>
<td>Light Intensity</td>
<td>Lasers</td>
</tr>
<tr>
<td>Hens in group</td>
<td>100</td>
</tr>
</tbody>
</table>

![Image of chicken cages](image)
Game

Event Log
Day 3 -
Bad news: we are in a state of emergency at the farm. Mortality is higher than ever, and production is hitting record lows. The birds seem to be pecking at each other. Can you help us solve the issue?

How does lighting relate to cannibalism?

a) Too bright of lighting can cause cannibalism

b) Too dim of lighting can cause cannibalism
Our hens produce lots of manure every day, which we have to process, store and transport in an environmentally safe and economically efficient manner. Fortunately, manure makes great fertilizer, so it’s in high demand with crop farmers.
Program Participants
## Participants

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers</td>
<td>16</td>
</tr>
<tr>
<td>Classes</td>
<td>23</td>
</tr>
<tr>
<td>Students</td>
<td>499</td>
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</tbody>
</table>
## Survey Respondents

<table>
<thead>
<tr>
<th></th>
<th>Count 1</th>
<th>Count 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers</td>
<td>16</td>
<td>13</td>
</tr>
<tr>
<td>Classes</td>
<td>23</td>
<td>15</td>
</tr>
<tr>
<td>Students</td>
<td>499</td>
<td>169</td>
</tr>
</tbody>
</table>

= 34.1%
Requirements

- Fall 2018 Semester
- Modules must be completed within the space of 8 wks

Teacher Preparation

- Facilitator Guide
- Training
Program Assessment
Study Design

IRB approved
Single group
Mixed-methods, qualitatively driven
Sequential explanatory

Pre-Survey
LEARNING EXPERIENCE
Content Assessment
Post-Survey
Teacher Focus Group
Instrumentation

- Content quizzes for first six modules, pre- and post-
- Individual Interest Questionnaire (IIQ)
- Intrinsic Motivation Inventory (IMI)
Data Analysis

Quantitative

- SAS software
- Paired t-tests, MANOVA
- Significance declared at p<0.05

Qualitative

- Thematic coding of student and teacher responses\(^1\)

\(^1\)Braun and Clarke, 2006
Results
Content Learning
The image shows a bar chart titled "Mean Content Quiz Score." The chart compares mean scores for different modules before (Pre) and after (Post) some intervention. The y-axis represents the mean score ranging from 0 to 8, and the x-axis represents the modules labeled 1 to 6. Each bar is labeled with an asterisk to indicate a significant difference in scores between the Pre and Post conditions. The chart suggests an increase in mean scores for most modules, with statistical significance marked by asterisks.
## Content Quizzes

<table>
<thead>
<tr>
<th>Module</th>
<th>M-Pre</th>
<th>M-Post</th>
<th>t</th>
<th>df</th>
<th>P-value</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.28 ± 0.12</td>
<td>6.25 ± 0.18</td>
<td>10.41</td>
<td>168</td>
<td>&lt;0.0001</td>
<td>0.80</td>
</tr>
<tr>
<td>2</td>
<td>3.02 ± 0.11</td>
<td>4.95 ± 0.20</td>
<td>10.03</td>
<td></td>
<td>&lt;0.0001</td>
<td>0.77</td>
</tr>
<tr>
<td>3</td>
<td>5.92 ± 0.19</td>
<td>7.27 ± 0.19</td>
<td>8.16</td>
<td></td>
<td>&lt;0.0001</td>
<td>0.63</td>
</tr>
<tr>
<td>4</td>
<td>4.58 ± 0.15</td>
<td>5.69 ± 0.17</td>
<td>6.53</td>
<td></td>
<td>&lt;0.0001</td>
<td>0.50</td>
</tr>
<tr>
<td>5</td>
<td>3.89 ± 0.13</td>
<td>4.94 ± 0.17</td>
<td>5.85</td>
<td></td>
<td>&lt;0.0001</td>
<td>0.45</td>
</tr>
<tr>
<td>6</td>
<td>4.66 ± 0.16</td>
<td>6.41 ± 0.20</td>
<td>8.65</td>
<td></td>
<td>&lt;0.0001</td>
<td>0.67</td>
</tr>
</tbody>
</table>

Average score out of 10 points possible ± SEM. The table shows t-test comparisons of pre-test and post-test scores for each module. Cohen’s d effect sizes are presented for each comparison.
Qualitative data support ↑ understanding

“It taught me about the welfare and needs of poultry.”

“There wasn’t much I understood at the beginning of the module learning. I understand a lot more now.”

“As I have been doing this program my knowledge about poultry is much greater, and I am more confident when it comes to talking about poultry.”
Interest and Motivation
Paired t-test
p = 0.67
df = 168

Likert scale (1 – not true at all, 5 – very true for me)
Motivation During Modules (IMI)

- **Value/Usefulness**: Mean Student Rating
- **Interest/Enjoyment**: Mean Student Rating
- **Choice**: Mean Student Rating

*Mean Student Rating*
Likert scale (1 – strongly disagree, 7 – strongly agree)
Program Increased Participants’ Interest

“It has intrigued me and I have learned a lot more about chickens than I ever thought before.”

“I have wanted to learn more because I found the poultry modules interesting.”

“It has changed me by me being more curious in poultry.”
Poultry topics not relevant to some students

“I believe students need to have a basic animal science knowledge base to appreciate the modules.”

“I won’t ever go into [poultry]...but it was fun to learn about.”
Significant effect of teacher

- MANOVA with difference in content quiz scores, motivation during modules as DVs
- No effects of gender, community type, year in school, course type
- Significant effect of teacher
  - Content: F(66, 776) = 2.07 (p < 0.0001)
  - Motivation: F(33, 428) = 2.26 (p < 0.0001)
Program Conclusions

- Effectively convey poultry and STEM concepts
- Improve student interest and motivation toward poultry and STEM learning
Program Conclusions

- Effectively convey poultry and STEM concepts

- Improve student interest and motivation toward poultry and STEM learning
Program Conclusions

- Effectively convey poultry and STEM concepts
  - Significant improvement in content score with each module
  - Qualitative data support increases in knowledge and awareness
Program Conclusions

- Effectively convey poultry and STEM concepts ✔
- Improve student interest and motivation toward poultry and STEM learning
Program Conclusions

- Effectively convey poultry and STEM concepts
  ✔

- Improve student interest and motivation toward poultry and STEM learning
  ❓
Program Results

Improve student interest and motivation toward poultry and STEM learning

No quantitative change in individual interest

IMI results: moderate motivation during modules

Qualitative results indicate increased interest/motivation, low perceived relevance of poultry
Limitations

• Small, convenience sample
• Single semester
• Low response rate
• Pre-post design
  • Testing effects
  • Maturation
• Researcher reflexivity
Future Directions

• Enhancing relevance of poultry
• Supporting teachers in implementation

• Update program design based on suggestions:
  • More hands-on
  • More game-based
  • More discussion
Acknowledgements

- USDA SPECA Grant
- US Poultry and Egg Association
- Student and teacher participants
THANK YOU!

Questions?
References


References (cont.)


References (cont.)

- President’s Council of Advisors on Science and Technology, Engage to excel: producing one million additional college graduates with degrees in science, technology, engineering, and mathematics (Executive Office of the President of the United States, 2012).
References (cont.)