Evaluating online modules contextualizing STEM in poultry science for secondary students

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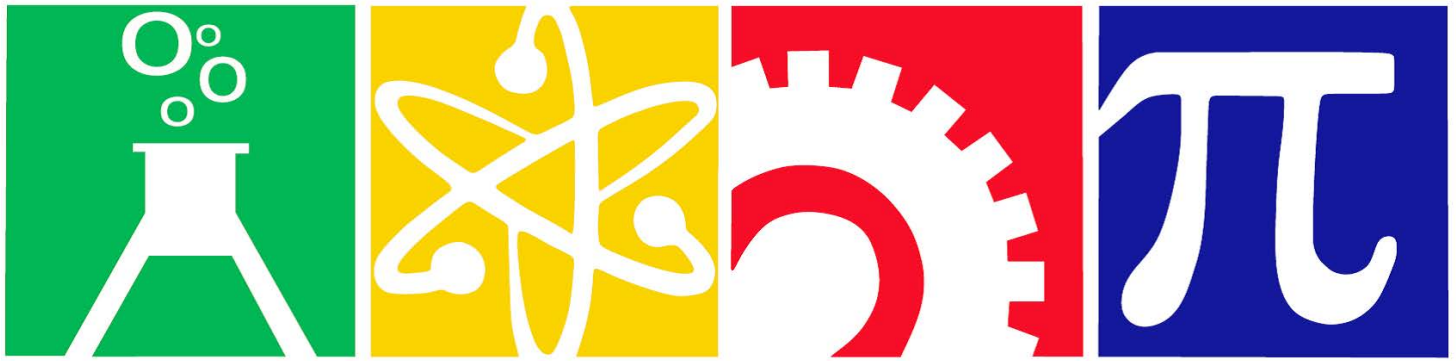
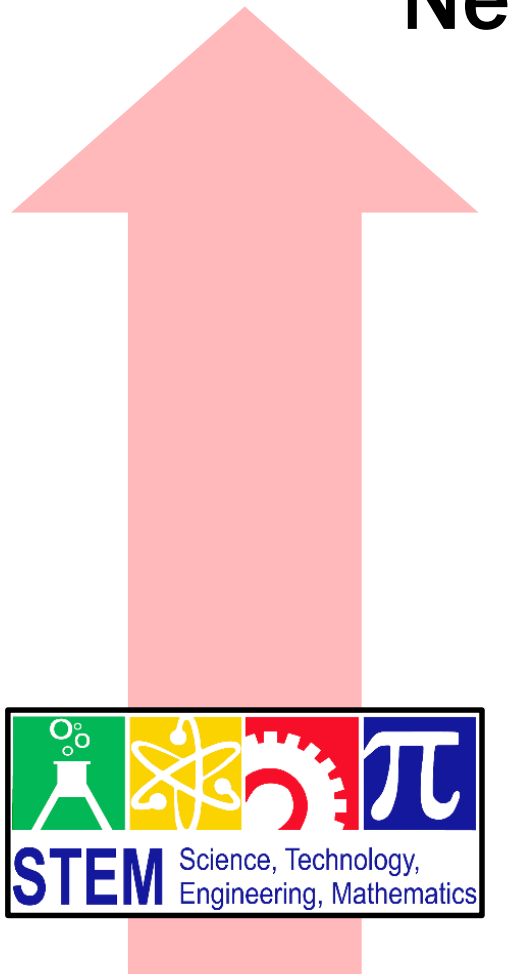


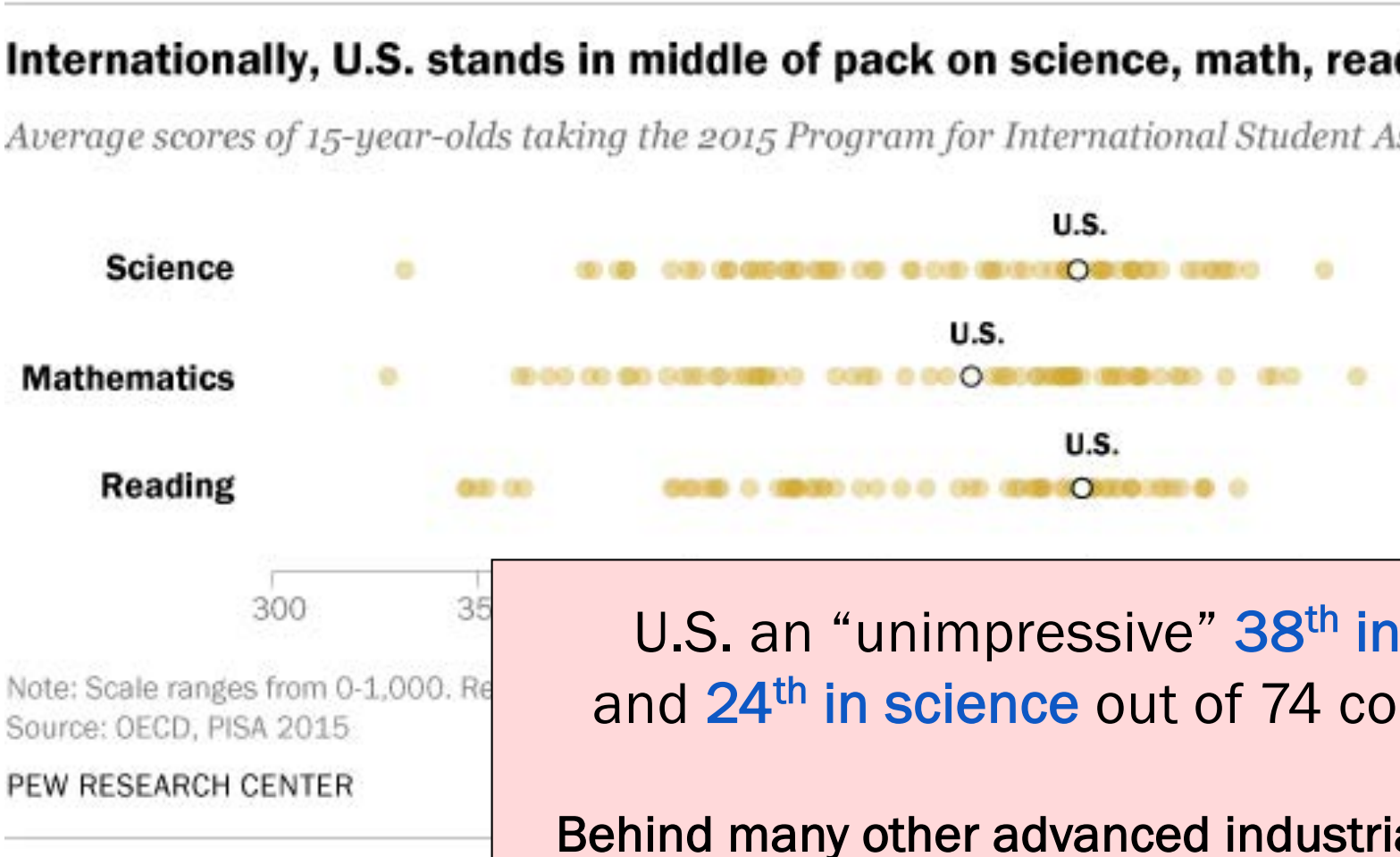
STEM Science, Technology, Engineering, Mathematics

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?



U.S. 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:

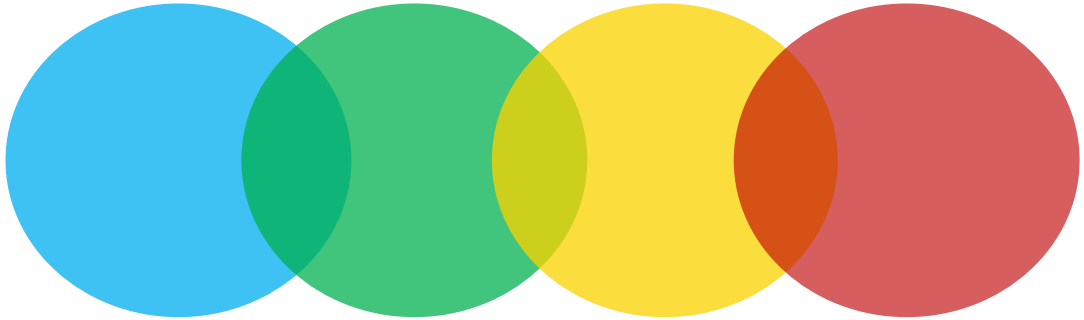
Too difficult **Too boring** **Not useful**

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]

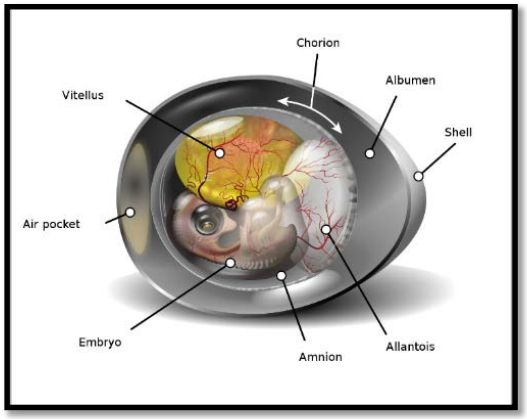
[1]PCAST, 2012
[2]Hurk et al., 2018
[3]Pekrun and Linnenbrink-Garcia, 2014

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



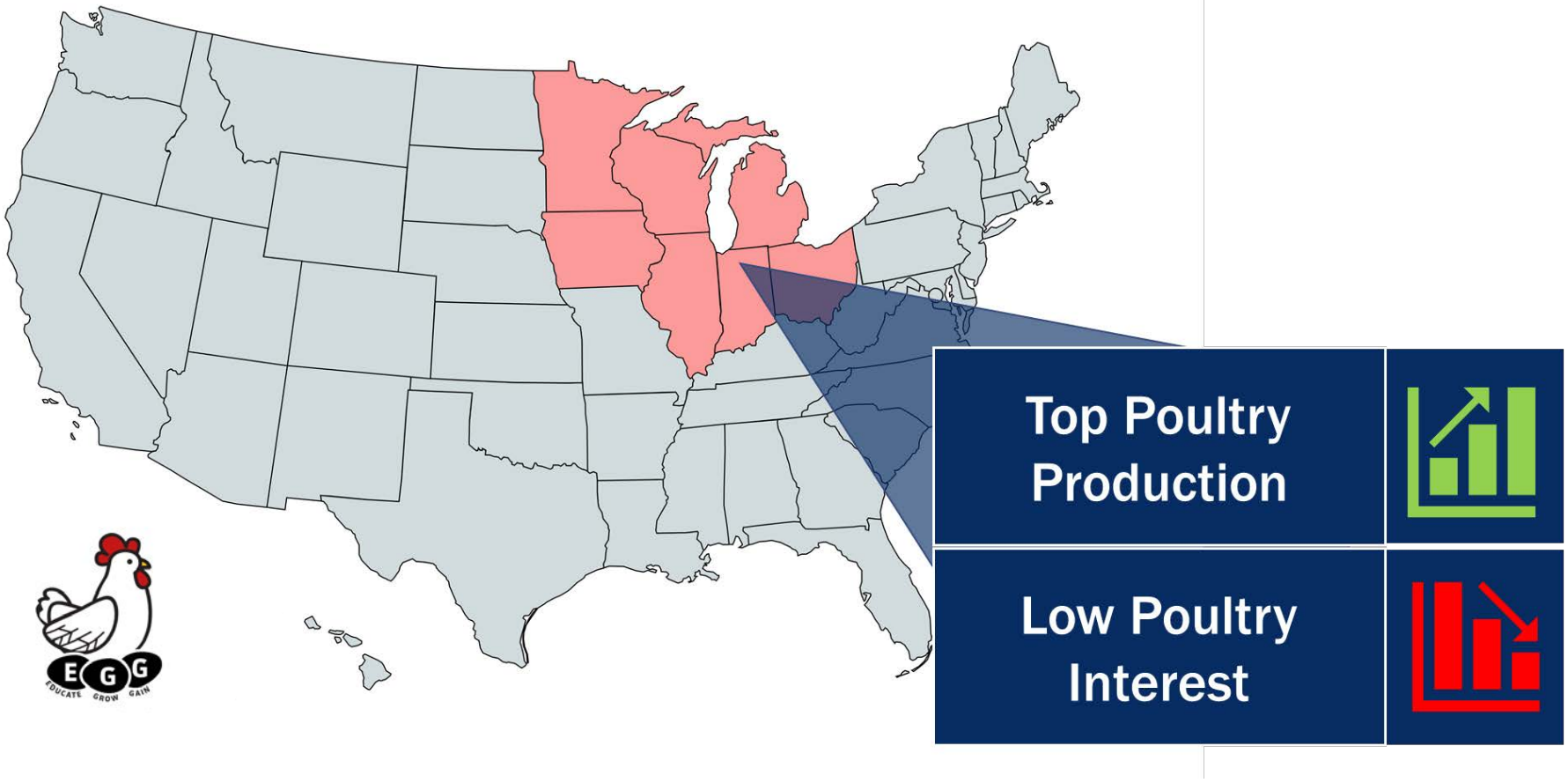
Low public interest/awareness of poultry

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

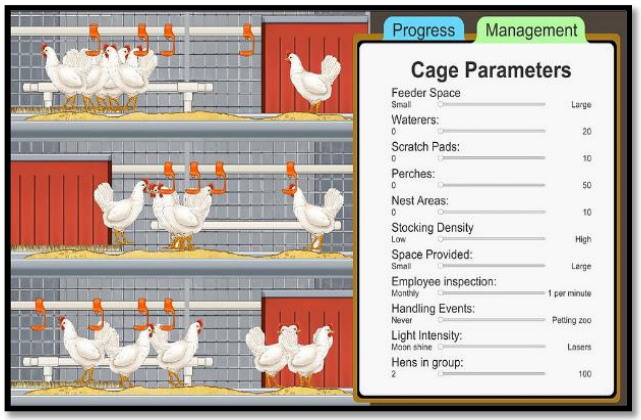
Targets critical thinking, problem-solving

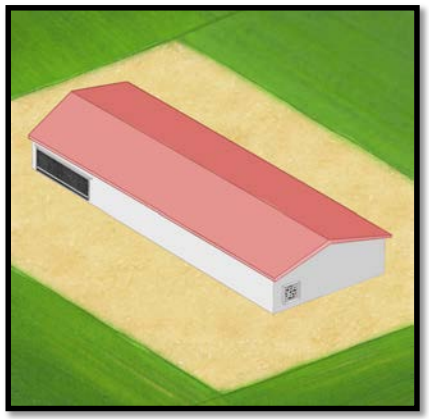
Learner-centered

Use of technology

Robinson et al., 2018

Online Modules based on Laying Hen Industry





30 mins each

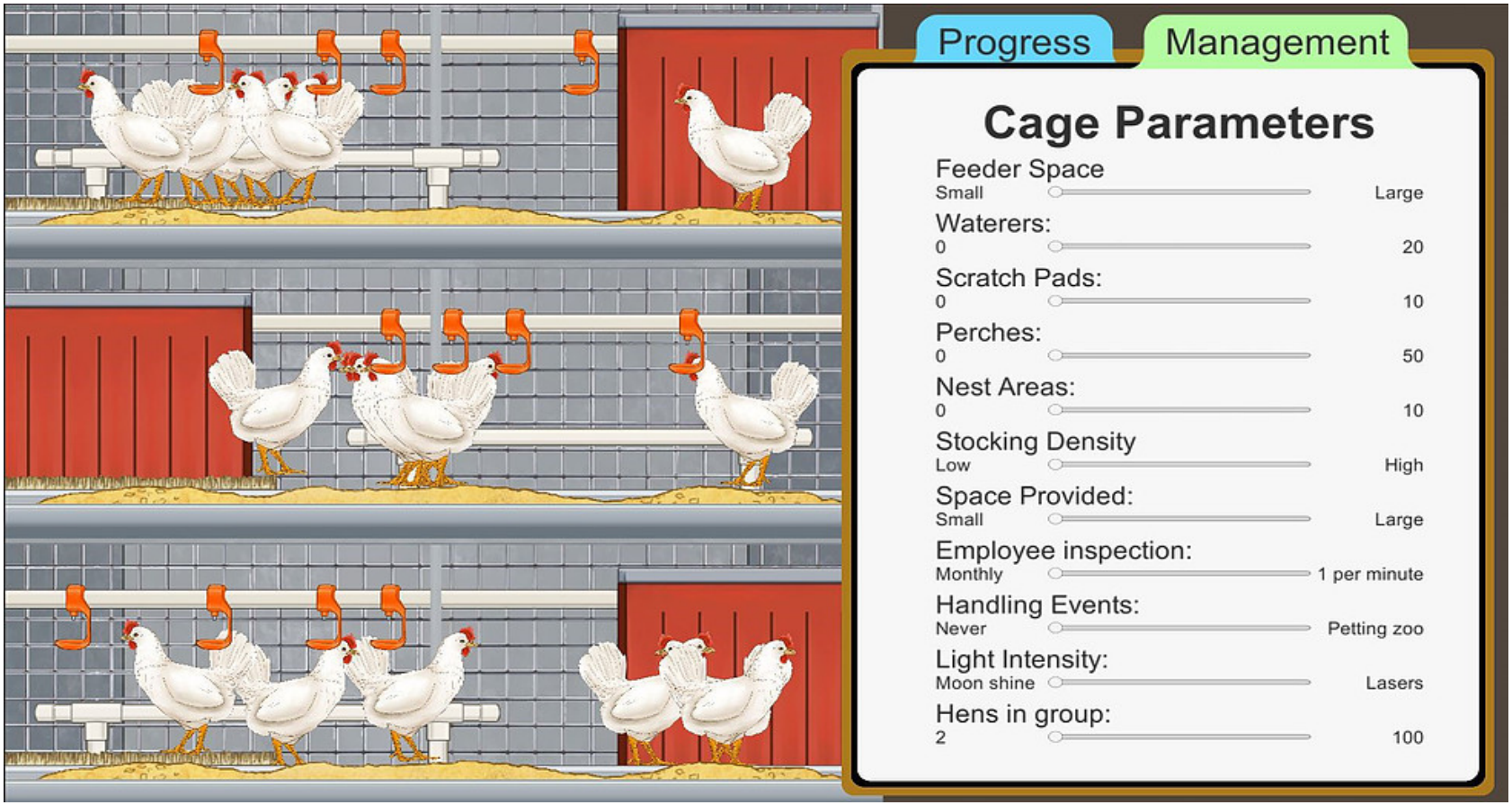
+ in class component

1 → 2 → 3 → 4 → 5 → 6 → 7

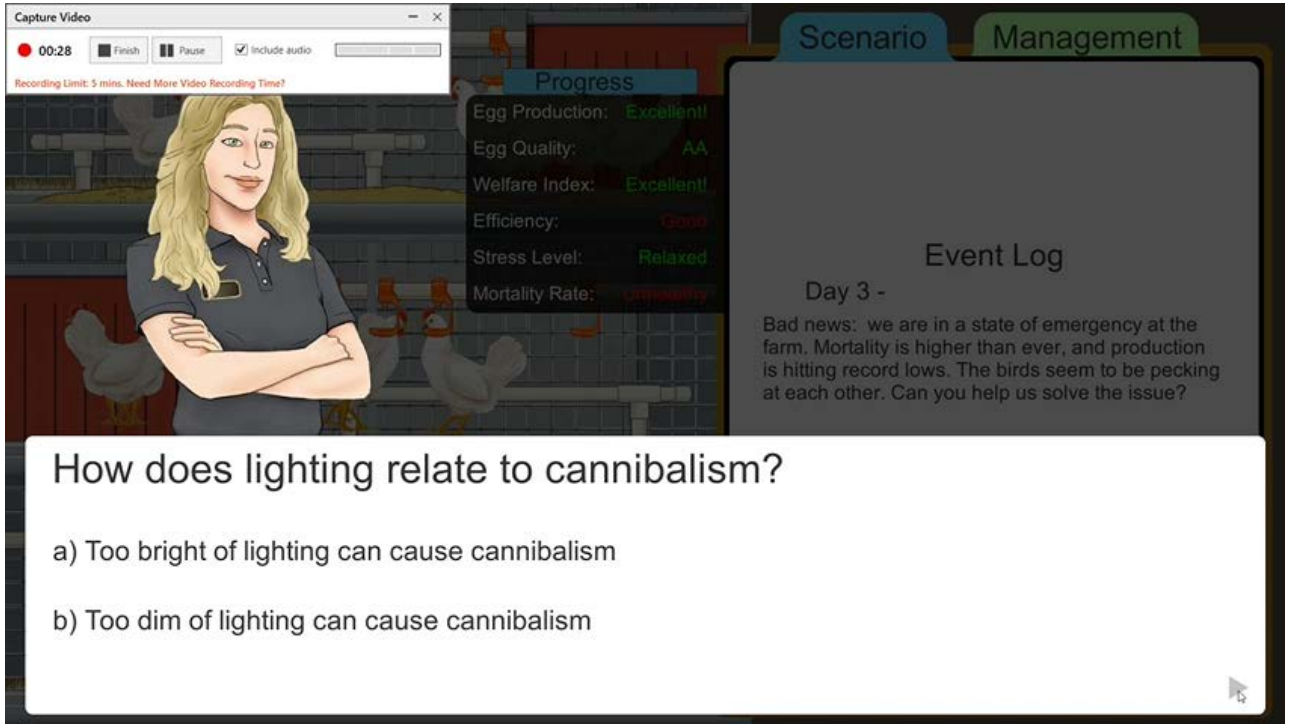
Program Overview

Module	Content
1	Introduction to the Table Egg Industry
2	Laying Hen Anatomy, Physiology, and Biology
3	Introduction to Animal Welfare
4	Laying Hen Management
5	Industry Technologies
6	Egg Processing
7	Case Study

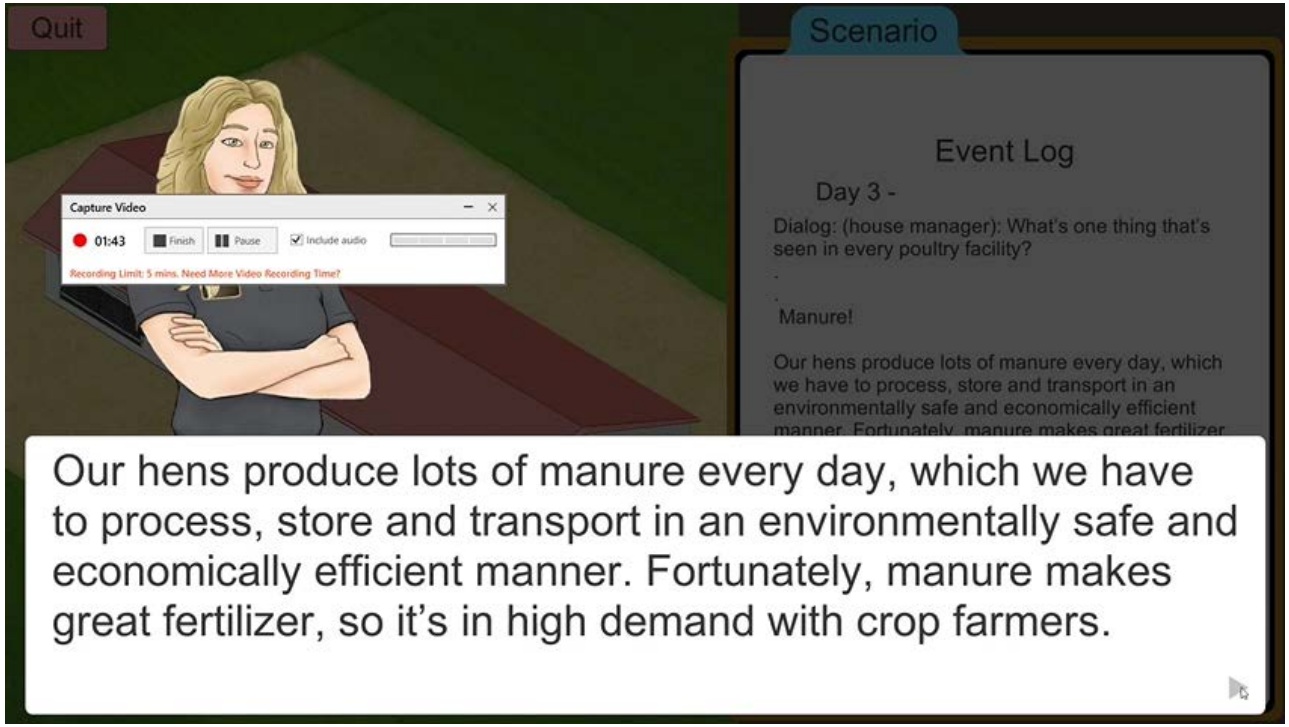
Section	Content	Features
1	Welcome	Text
2	Introduction Video	Video
3	Reproduction Introduction	Text
4	Hen Laying Cycle	Interactive chart
5	External Anatomy	Interactive diagram
6-7	Reproductive Tract Anatomy	Interactive diagram
8	Anatomy of the Egg	Interactive diagram
9-10	Development of the Egg	Interactive text slides
11	Egg Abnormalities	Interactive text slides
12	Factors of Stress in Poultry	Dialog with character
13	Stress Video	Video
14	Your Thoughts	Open-ended response
15	Better Egg Production	Pictures and character dialog
16	Genetics and the Environment	Pictures and character dialog
17	Your Thoughts	Written case study
18	Careers to Consider	Career interview video
19	Your Thoughts	Open-ended response
20	Selective Breeding	Dialog with character
21	A Hen for Each Environment	3D video
22	Improvements in Science	Interactive text slides
23	Test Your Knowledge	Drag and drop activity


Progress
Management
Cage Parameters
Feeder Space
Small
Large
Waterers:
0
20
Scratch Pads:
0
10
Perches:
0
50
Nest Areas:
0
10
Stocking Density
Low
High
Space Provided:
Small
Large
Employee inspection:
Monthly
1 per minute
Handling Events:
Never
Petting zoo
Light Intensity:
Moon shine
Lasers
Hens in group:
2
100

Game


Capture Video
00:28
Finish
Pause
Include audio
Recording Limit: 5 mins. Need More Video Recording Time?
Progress
Egg Production: Excellent!
Egg Quality: AA
Welfare Index: Excellent!
Efficiency:
Stress Level: Relaxed
Mortality Rate:
Scenario
Management
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

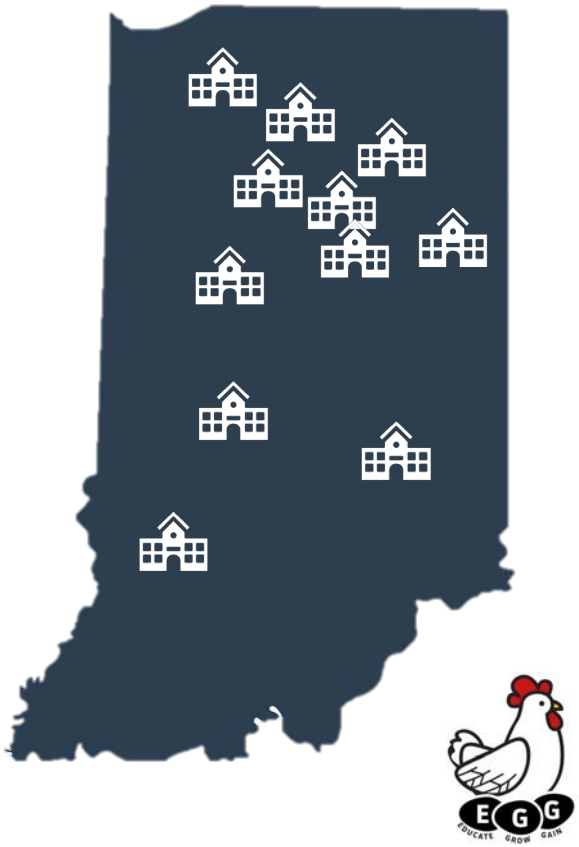
Game


Quit
Capture Video
01:43
Finish
Pause
Include audio
Recording Limit: 5 mins. Need More Video Recording Time?
Scenario
Event Log
Day 3 -
Dialog: (house manager): What's one thing that's seen in every poultry facility?
.
.
Manure!
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
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

Teachers	16
Classes	23
Students	499

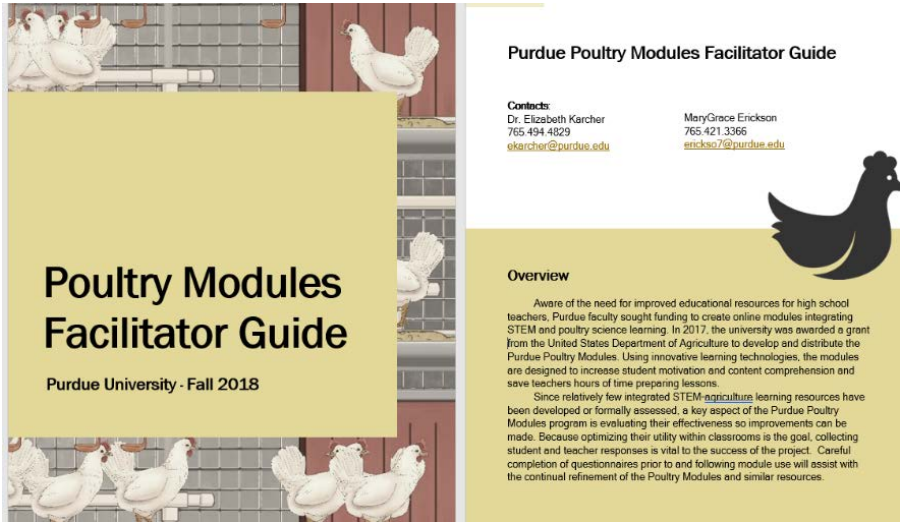


Survey Respondents

Teachers	16	13	
Classes	23	15	
Students	499	169	= 34.1%

Requirements

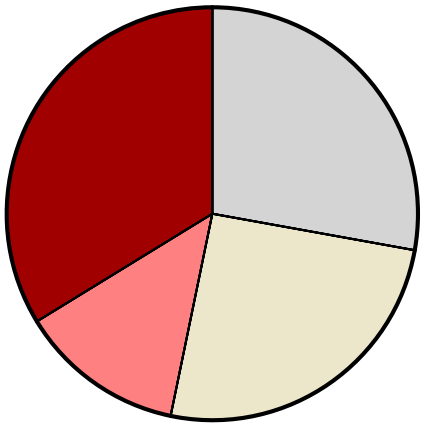
- Fall 2018 Semester
- Modules must be completed within the space of 8 wks



Teacher Preparation

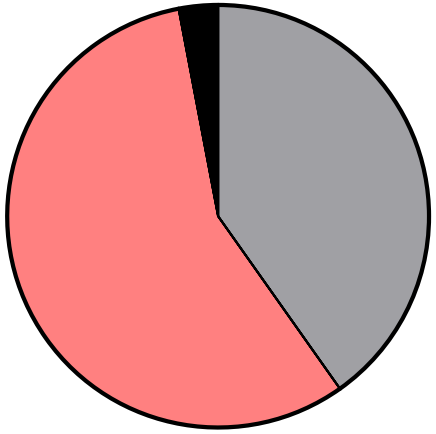
- Facilitator Guide
- Training

Classification



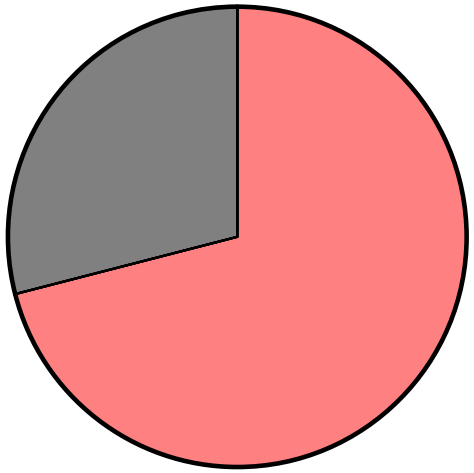
- Freshman
- Sophomore
- Junior
- Senior

Gender



- Female
- Male
- NB/NS

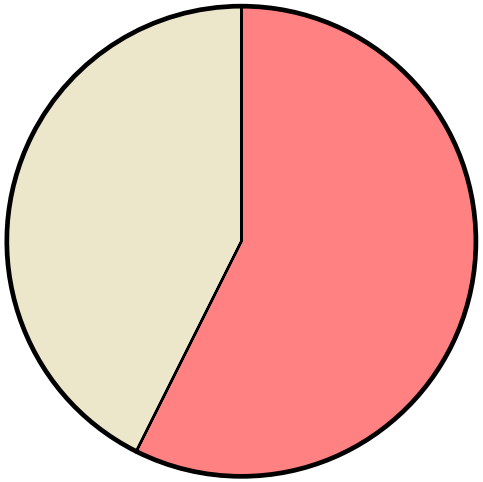
Course Type



Agriculture

Biology

Community



Rural

Urban

Program Assessment

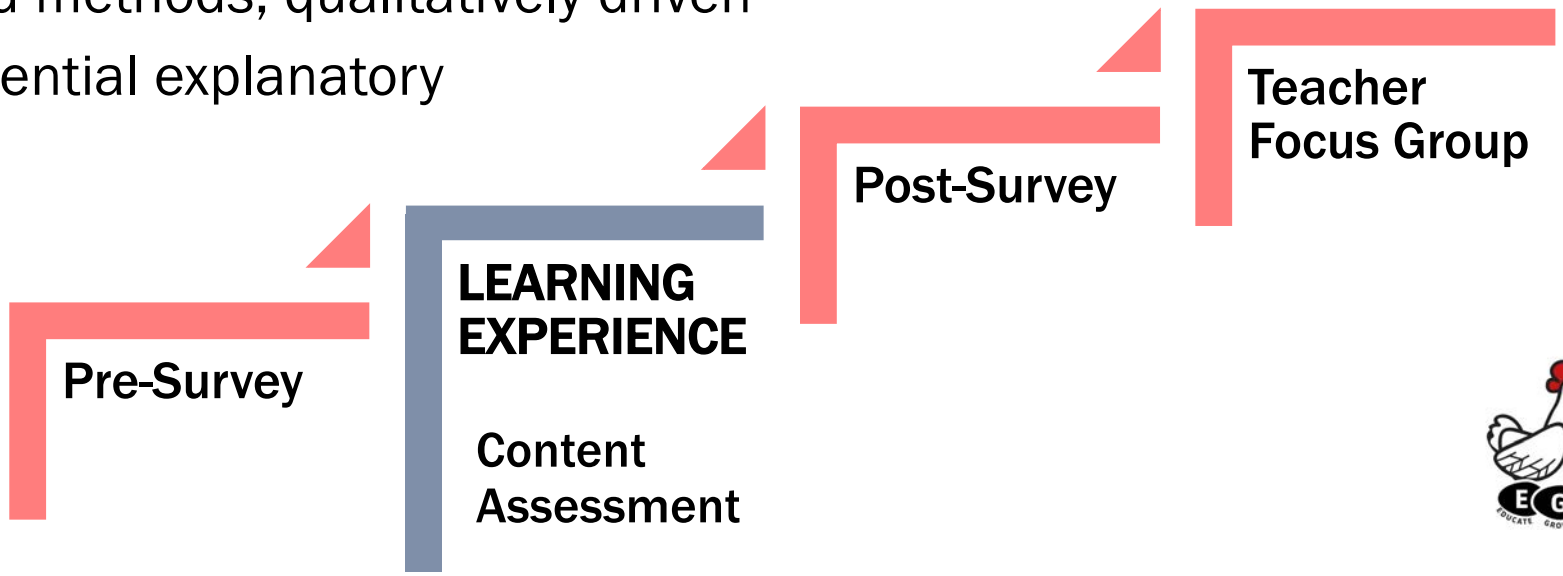
Study Design

IRB approved

Single group

Mixed-methods, qualitatively driven

Sequential explanatory



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 $p<0.05$

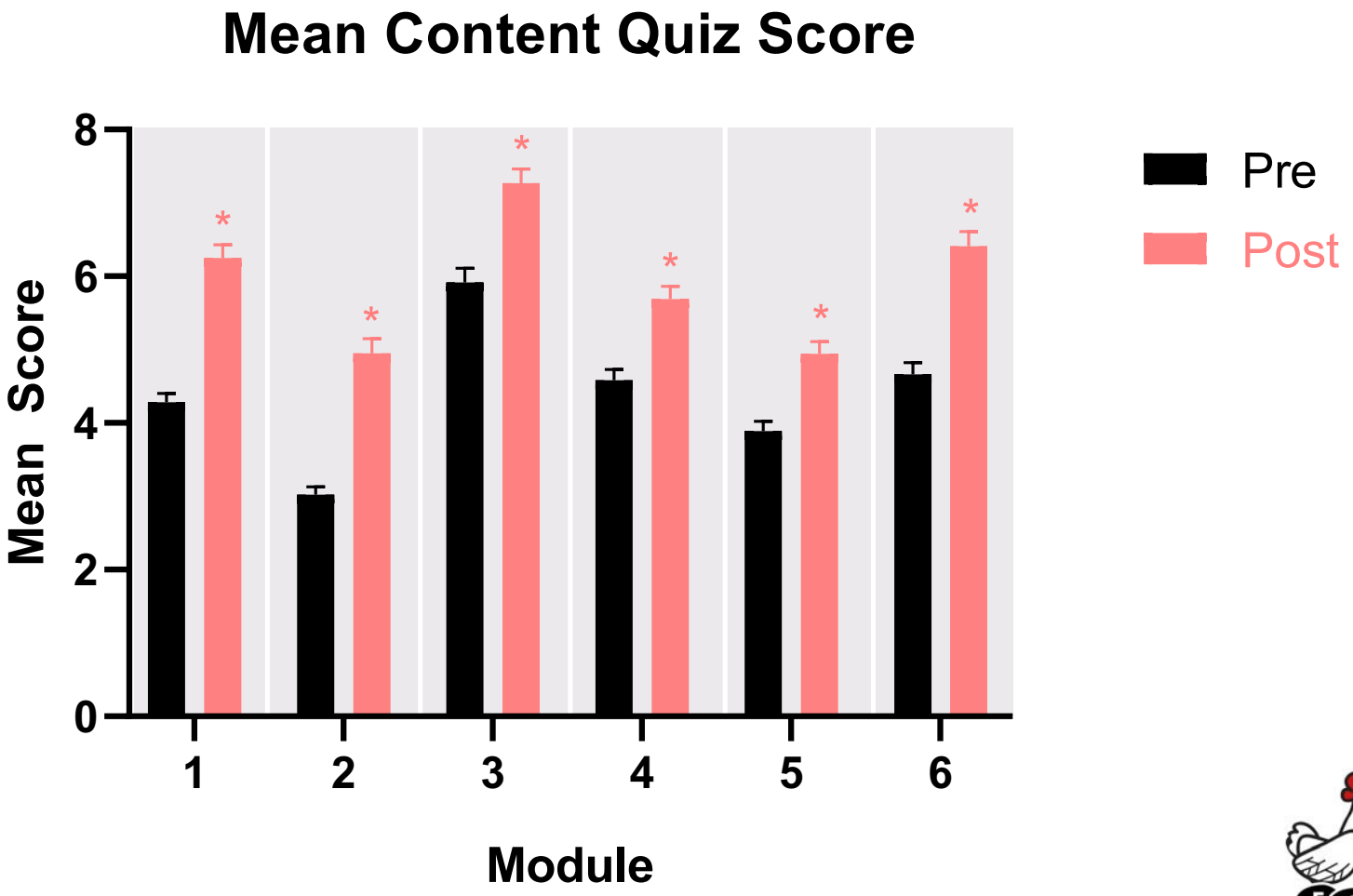
Qualitative

- Thematic coding of student and teacher responses[1]

[1]Braun and Clarke, 2006

Results

Content Learning


Mean Content Quiz Score
Mean Score
0
2
4
6
8
1
2
3
4
5
6
Module
Pre
Post
*

Content Quizzes

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

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

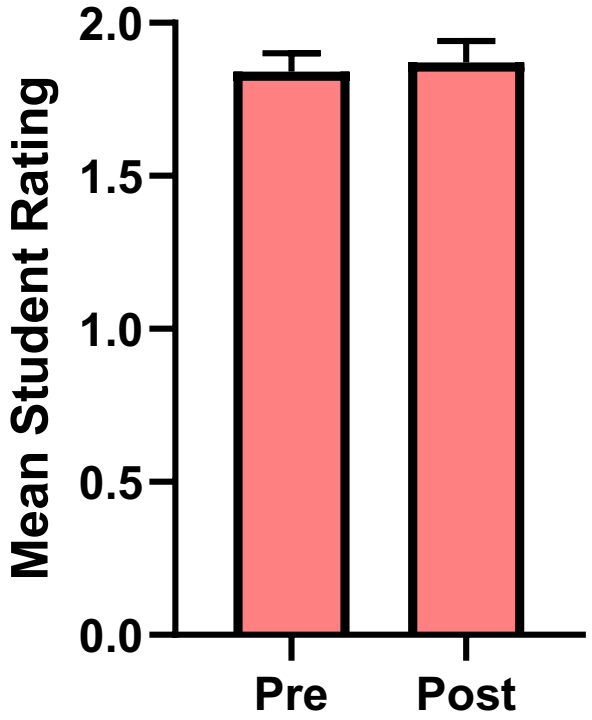
"It taught me about the welfare and needs of poultry."

"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

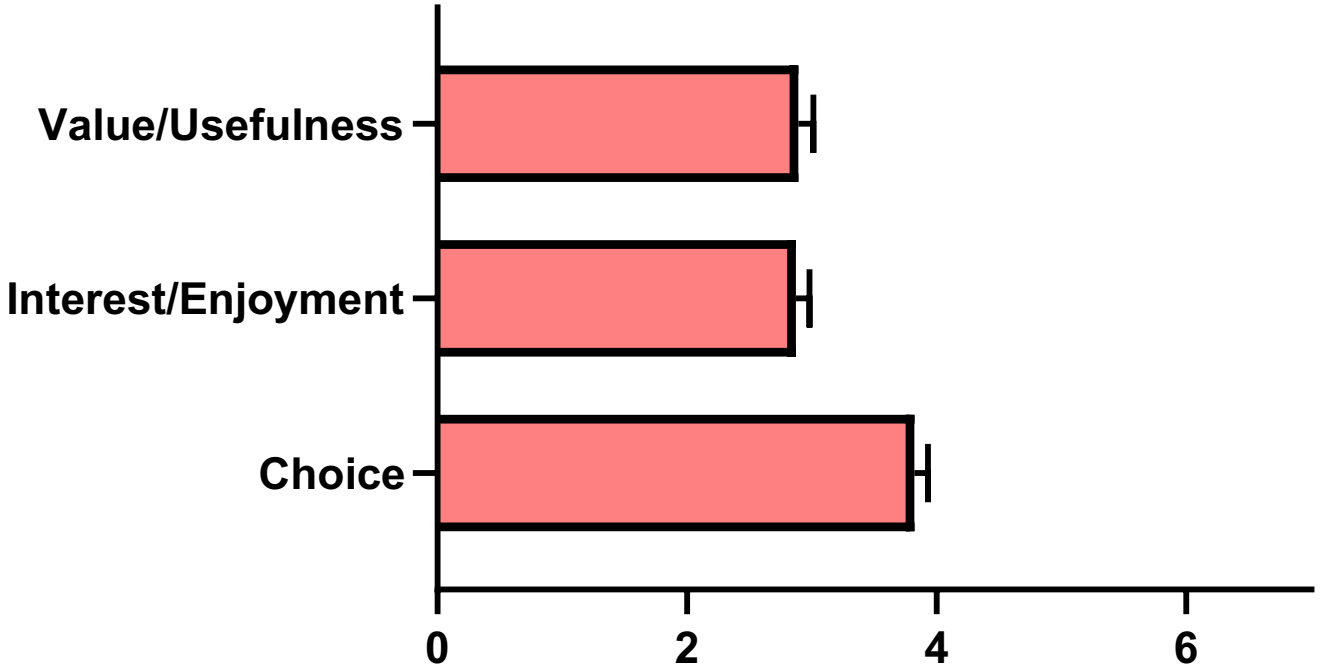
Interest in Poultry



Paired t-test
p = 0.67
df = 168

Likert scale (1 – not true at all, 5 – very true for me)

Motivation During Modules (IMI)



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

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Significant improvement in content score with each module

Qualitative data support increases in knowledge and awareness

Program Conclusions

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Improve student interest and motivation toward poultry and STEM learning

Program Results

Improve student interest and motivation toward poultry and STEM learning

?

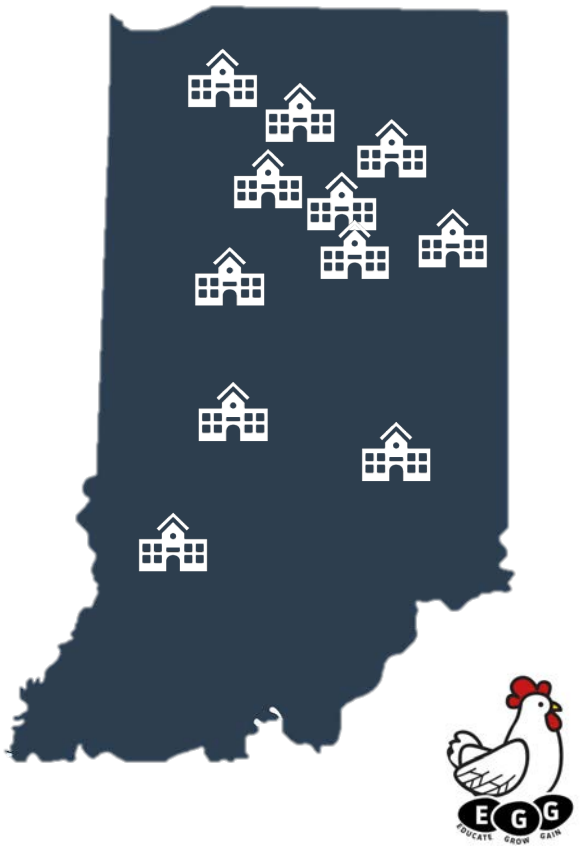
No quantitative change in individual interest

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?

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