Comparison of Service Learning and Research Projects in an Introductory Biology Class

Amy E. Kulesza, Kelsie M. Bernot, Judith S. Ridgway, Corrie Pieterson

Center for Life Sciences Education
The Ohio State University, Columbus, OH

Course Description: Honors Biology 1113

- Cellular & Molecular Introductory course for majors
- Team taught by faculty and post-docs
- Labs taught by TA and similar to non-honors in content
- Honors requires smaller (~60 students) class size and additional thought-provoking component

Rationale for Study

As a result of students expressing a disconnect between biology and the real world, an instructor and course coordinator developed a service learning project

	Research Project	Service Learning
Think Deeply	Inside lab	

Rationale for Study

As a result of students expressing a disconnect between biology and the real world, an instructor and course coordinator developed a service learning project

	Research Project	Service Learning
Think Deeply	Inside lab	Outside the classroom

Rationale for Study

As a result of students expressing a disconnect between biology and the real world, an instructor and course coordinator developed a service learning project

	Research Project	Service Learning
Think Deeply	Inside lab	Outside the classroom
Make Connections	Between course work and a lab experiment	

Rationale for Study

As a result of students expressing a disconnect between biology and the real world, an instructor and course coordinator developed a service learning project

	Research Project	Service Learning
Think Deeply	Inside lab	Outside the classroom
Make Connections	Between course work and a lab experiment	Between course work and helping society

Rationale for Study

As a result of students expressing a disconnect between biology and the real world, an instructor and course coordinator developed a service learning project

	Research Project	Service Learning
Think Deeply	Inside lab	Outside the classroom
Make Connections	Between course work and a lab experiment	Between course work and helping society
Problem Solving	Established	

Rationale for Study

As a result of students expressing a disconnect between biology and the real world, an instructor and course coordinator developed a service learning project

	Research Project	Service Learning
Think Deeply	Inside lab	Outside the classroom
Make Connections	Between course work and a lab experiment	Between course work and helping society
Problem Solving	Established	Novel

Rationale for Study

As a result of students expressing a disconnect between biology and the real world, an instructor and course coordinator developed a service learning project

	Research Project	Service Learning
Think Deeply	Inside lab	Outside the classroom
Make Connections	Between course work and a lab experiment	Between course work and helping society
Problem Solving	Established	Novel
Relationships	Peers and TA	

Rationale for Study

As a result of students expressing a disconnect between biology and the real world, an instructor and course coordinator developed a service learning project

	Research Project	Service Learning
Think Deeply	Inside lab	Outside the classroom
Make Connections	Between course work and a lab experiment	Between course work and helping society
Problem Solving	Established	Novel
Relationships	Peers and TA	Peers, Instructors, Community members

Two practices (treatments) in Honors Biology 1113

Research Project (RP)

- 1 project per lab section
- As a class, students design an experiment on osmosis & diffusion in potatoes
- TA's facilitate students' experimental design
- Students conduct experiment during lab and analyze data
- Small groups of students write a journal paper

Service Learning (SL)

- 3 service opportunities
- Selected to compliment course content and community needs
- Students approach service from the perspective of the scientific method
- Students complete a service activity and a learning activity
- Small groups of students present at a poster session

Research Study

Sample:

Class	# Enrolled	# Participants in Study
RP 1 (Autumn 2013)	60	23
RP 2 (Autumn 2013)	56	26
RP 3 (Spring 2014)	43	23
SL (Spring 2014)	38	23
Total	197	95

48% participation rate

Research Questions How do the two treatments differ in:	Research Method		

Research Questions How do the two treatments differ in:	Research Method		
RQ1 Perception of the relevance of biology to their lives?			

Research Questions How do the two treatments differ in:	Research Method		
RQ1 Perception of the relevance of biology to their lives?			
RQ2 Student learning gains associated with scientific literacy?			

Research Questions How do the two treatments differ in:	Research Method		
RQ1 Perception of the relevance of biology to their lives?			
RQ2 Student learning gains associated with scientific literacy?			
RQ3 Student perceptions of learning gains associated with course learning outcomes?			

Research Questions How do the two treatments differ in:	Research Method		
	Open Ended Questions Student Survey (Pre and Post Instruction)		
RQ1 Perception of the relevance of biology to their lives?			
RQ2 Student learning gains associated with scientific literacy?			
RQ3 Student perceptions of learning gains associated with course learning outcomes?			

Research Questions How do the two treatments differ in:	Research Method		
	Open Ended Questions Student Survey (Pre and Post Instruction)		
RQ1 Perception of the relevance of biology to their lives?	✓ 2 open ended questions		
RQ2 Student learning gains associated with scientific literacy?	✓ 1 open ended question		
RQ3 Student perceptions of learning gains associated with course learning outcomes?			

Research Questions How do the two treatments differ in:	Research Method		
	Open Ended Questions Student Survey (Pre and Post Instruction)	**Colorado Learning Attitudes about Science Survey-Biology (CLASS) (Semsar et al. 2011)** (Pre and Post Instruction)	
RQ1 Perception of the relevance of biology to their lives?	✓ 2 open ended questions		
RQ2 Student learning gains associated with scientific literacy?	✓ 1 open ended question		
RQ3 Student perceptions of learning gains associated with course learning outcomes?			

Research Questions How do the two treatments differ in:	Research Method		
	Open Ended Questions Student Survey (Pre and Post Instruction)	**Colorado Learning Attitudes about Science Survey-Biology (CLASS) (Semsar et al. 2011)** (Pre and Post Instruction)	
RQ1 Perception of the relevance of biology to their lives?	✓ 2 open ended questions	✓ Real World Connection ✓ Enjoyment	
RQ2 Student learning gains associated with scientific literacy?	✓ 1 open ended question	✓ CLASS overall and category scores	
RQ3 Student perceptions of learning gains associated with course learning outcomes?			

Research Questions How do the two treatments differ in:	Research Method		
	Open Ended Questions Student Survey (Pre and Post Instruction)	**Colorado Learning Attitudes about Science Survey-Biology (CLASS) (Semsar et al. 2011)** (Pre and Post Instruction)	**Student Assessment of Learning Gains Survey (SALG)** at end of term
RQ1 Perception of the relevance of biology to their lives?	✓ 2 open ended questions	✓ Real World Connection ✓ Enjoyment	✓ Open ended responses
RQ2 Student learning gains associated with scientific literacy?	✓ 1 open ended question	✓ CLASS overall and category scores	
RQ3 Student perceptions of learning gains associated with course learning outcomes?			✓ Course Learning Outcomes

Data Analysis: Open ended Questions

A. How would you use what you've learned in biology in the world outside of the classroom?

B. How would you explain to your English major roommate why he or she should understand biology?

Rubric Category	Link to Relevance
Specificity • Gives a specific mechanism or process in their response	Articulate their reasoning using biological language and examples

Data Analysis: Open ended Questions

A. How would you use what you've learned in biology in the world outside of the classroom?

B. How would you explain to your English major roommate why he or she should understand biology?

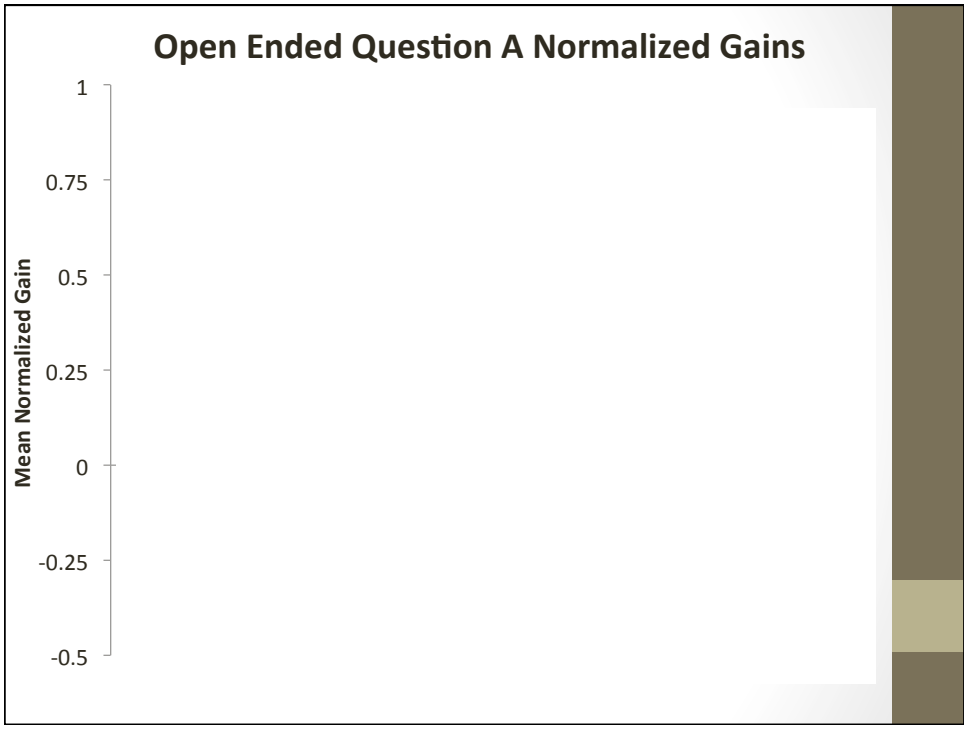
Rubric Category	Link to Relevance
Specificity • Gives a specific mechanism or process in their response	Articulate their reasoning using biological language and examples
Show Change • change in action (save lives, wash hands more, prevent illnesses, grow plants) over change in attitude (increase in self-awareness)	Illustrate relevance by changing either their attitude or actions

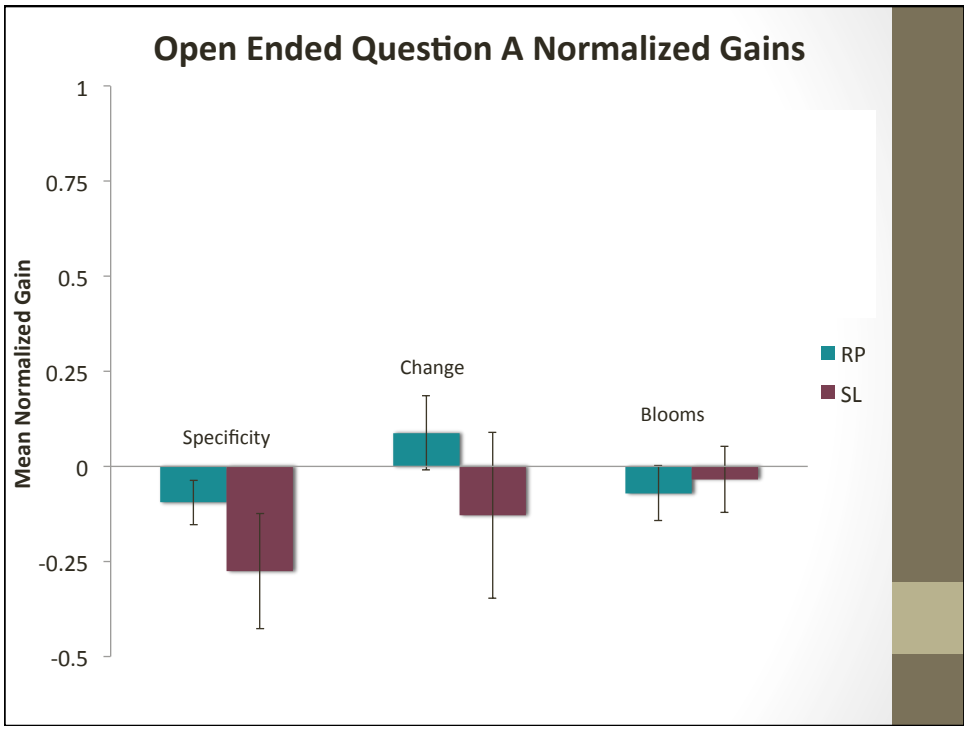
Data Analysis: Open ended Questions

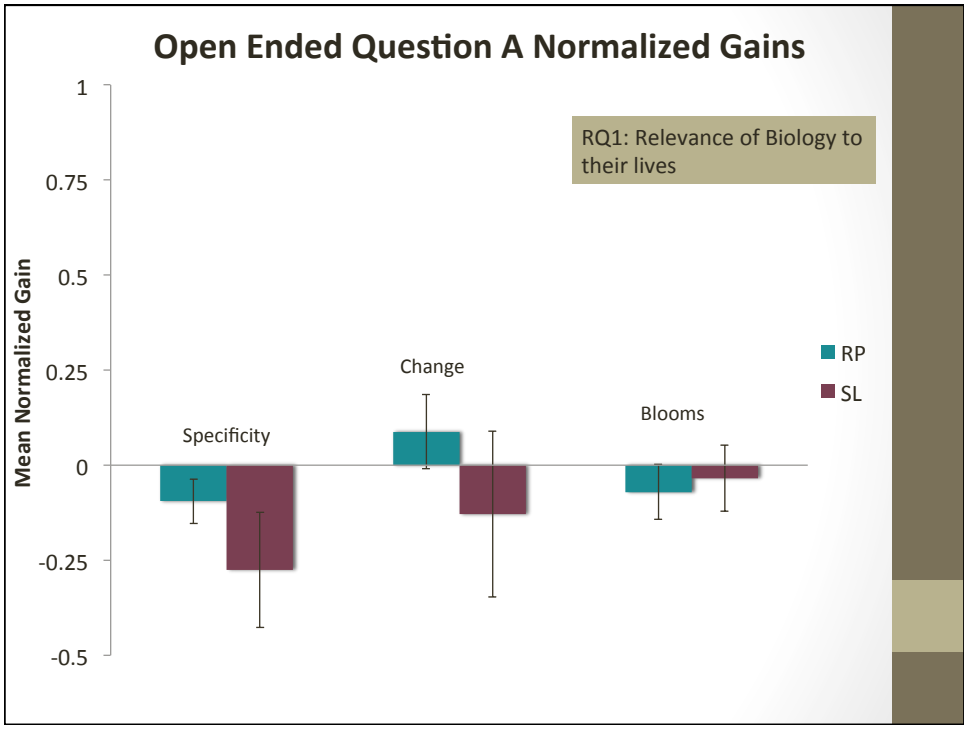
A. How would you use what you've learned in biology in the world outside of the classroom?

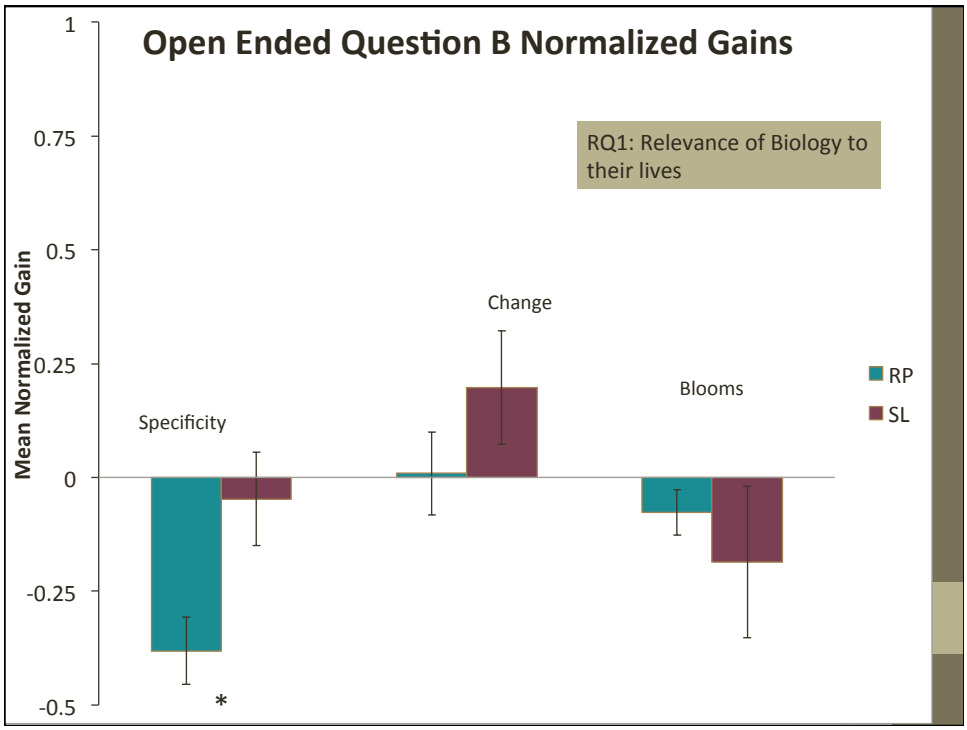
B. How would you explain to your English major roommate why he or she should understand biology?

Rubric Category	Link to Relevance
Specificity • Gives a specific mechanism or process in their response	Articulate their reasoning using biological language and examples
Show Change • change in action (save lives, wash hands more, prevent illnesses, grow plants) over change in attitude (increase in self-awareness)	Illustrate relevance by changing either their attitude or actions
Use of Bloom's to describe the process • No verbs<Knowledge and Comprehension<Application<Evaluate <Create	Demonstrate relevance through level of Bloom's


Open Ended Question A Normalized Gains
Mean Normalized Gain
1
0.75
0.5
0.25
0
-0.25
-0.5


Open Ended Question A Normalized Gains
Mean Normalized Gain
1
0.75
0.5
0.25
0
-0.25
-0.5
Specificity
Change
Blooms
RP
SL


Open Ended Question A Normalized Gains
RQ1: Relevance of Biology to their lives
Mean Normalized Gain
1
0.75
0.5
0.25
0
-0.25
-0.5
Specificity
Change
Blooms
RP
SL

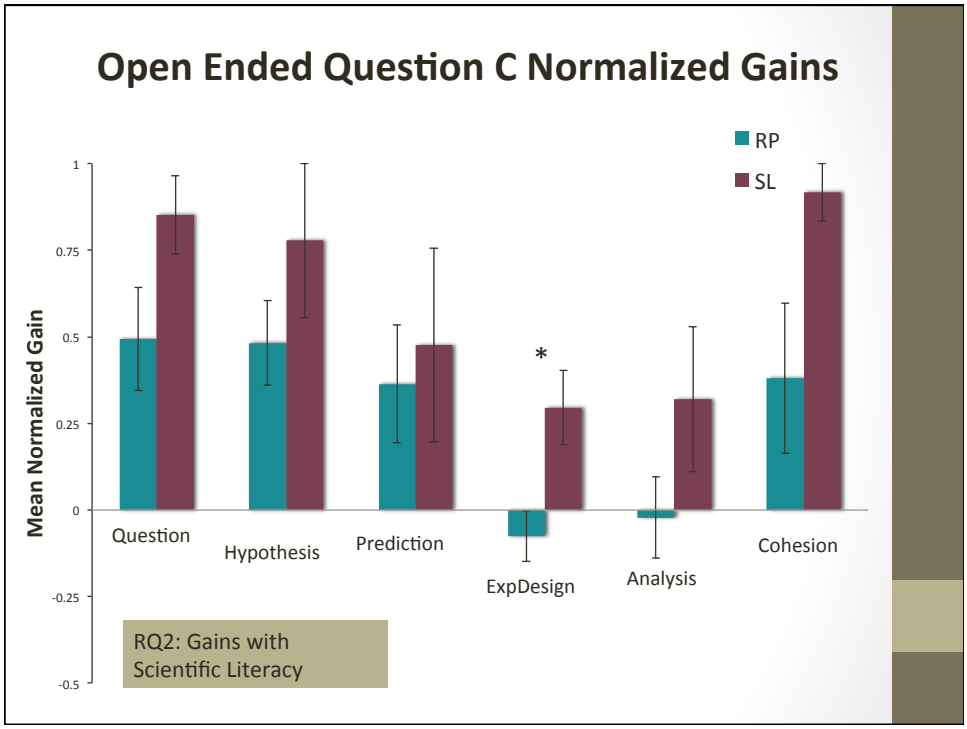

Open Ended Question B Normalized Gains
RQ1: Relevance of Biology to their lives
Mean Normalized Gain
1
0.75
0.5
0.25
0
-0.25
-0.5
Specificity
Change
Blooms
RP
SL
*

Research Questions How do the two treatments differ in:	Research Method		
	Open Ended Questions Student Survey (Pre and Post Instruction)	**Colorado Learning Attitudes about Science Survey-Biology (CLASS) (Semsar et al. 2011)** (Pre and Post Instruction)	**Student Assessment of Learning Gains Survey (SALG)** at end of term
RQ1 Perception of the relevance of biology to their lives?	✓ 2 open ended questions	✓ Real World Connection ✓ Enjoyment	✓ Open ended responses
RQ2 Student learning gains associated with scientific literacy?	✓ 1 open ended question	✓ CLASS overall and category scores	
RQ3 Student perceptions of learning gains associated with course learning outcomes?			✓ Course Learning Outcomes

Data Analysis: Open-ended questions

C. How would you use the process of science to investigate the following observation? Be specific and explain each step (question, hypothesis, prediction, experiment, anticipated analysis).

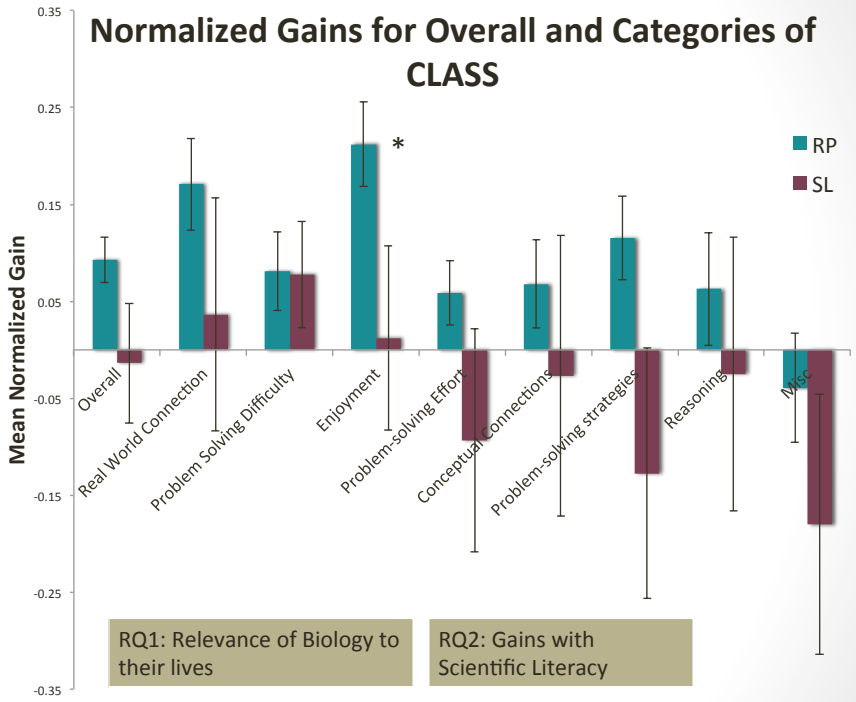
Rubric Category	Description
Question	Directly related to the hypothesis and clearly identifies a problem that needs to be solved in a specific way
Hypothesis	Proposes a specific answer to the question; is testable
Prediction	Includes a specific action that directly tests the hypothesis and includes a measurable outcome
Experimental Design	Tests the proposed hypothesis with appropriate controls; considers replication and randomization
Analysis	Clear, logical, measures outcome proposed in design
Cohesiveness	Logical flow throughout response; builds on previous part



Research Questions How do the two treatments differ in:	Research Method		
	Open Ended Questions Student Survey (Pre and Post Instruction)	**Colorado Learning Attitudes about Science Survey-Biology (CLASS) (Semsar et al. 2011)** (Pre and Post Instruction)	**Student Assessment of Learning Gains Survey (SALG)** at end of term
RQ1 Perception of the relevance of biology to their lives?	✓ 2 open ended questions	✓ Real World Connection ✓ Enjoyment	✓ Open ended responses
RQ2 Student learning gains associated with scientific literacy?	✓ 1 open ended question	✓ CLASS overall and category scores	
RQ3 Student perceptions of learning gains associated with course learning outcomes?			✓ Course Learning Outcomes

CLASS instrument

- Measures of how "expert-like" students are
  - Pre/Post changes are frequently measured as shifts towards agreement with experts (% favorable)
- We chose to look at overall normalized gains
  - To capture both positive and negative shifts
  - We are aware of negative shifts in introductory courses and we didn't want to lose that part of the picture



Research Questions How do the two treatments differ in:	Research Method		
	Open Ended Questions Student Survey (Pre and Post Instruction)	**Colorado Learning Attitudes about Science Survey-Biology (CLASS) (Semsar et al. 2011)** (Pre and Post Instruction)	**Student Assessment of Learning Gains Survey (SALG)** at end of term
RQ1 Perception of the relevance of biology to their lives?	✓ 2 open ended questions	✓ Real World Connection ✓ Enjoyment	✓ Open ended responses
RQ2 Student learning gains associated with scientific literacy?	✓ 1 open ended question	✓ CLASS overall and category scores	
RQ3 Student perceptions of learning gains associated with course learning outcomes?			✓ Course Learning Outcomes

SALG instrument

- Self-reported combination of Likert scale items and open responses
- Administered in all our biology courses at end of term
- Questions about content, skills, course components, and student attitudes

Data Analysis: Mean SALG scores- Course Learning Outcomes

Mean SALG Score for Learning Outcome Categories (with Standard Deviation in Parentheses)

Treatment	Chemistry of Life	Cell	Genetics	Nature of Biological Science and Society
RP (N=50)	4.3 (0.83)	4.2 (0.70)	3.9 (0.89)	3.6 (0.92)
SL (N=23)	4.2 (0.94)	4.2 (0.72)	4.0 (0.86)	3.6 (1.2)

No significant differences between gains in knowledge related to course learning outcomes.

RQ3: Course Learning Gains

Data Analysis: Mean SALG scores- Skills

Mean student responses to the item: "How much did each of the following aspects of the class help your learning?"(1= no help, 5= much help, *standard deviation in parentheses*)

Treatment	Writing Documents in discipline-appropriate style and format*	Designing Lab Experiments**	Participating in your Service Learning Project	Participating in the Service Learning Poster Session	Group Journal Paper
Service Learning (n=23)	2.65 (1.58)	3.52 (1.12)	2.39 (0.99)	1.90 (0.97)	N/A
Research Project (n=50)	3.66 (1.00)	3.50 (1.14)	N/A	N/A	2.8 (1.10)

* p = 0.002, ** not significant

RQ3: Course Learning Gains

Data Analysis: SALG Open Ended

What will you CARRY WITH YOU into other classes or other aspects of your life?

SL

"The service learning also encouraged me to volunteer for non-profit work in the future."

RP

"I will also carry the basics of experimental design and knowledge for hopefully writing/contributing to a research paper of my own someday."

RQ1: Relevance of Biology to their lives

Results Summary

- SL students were better able to provide more specific examples using biological language than their RP peers.
- Students from both courses cited relevance examples in the SALG.
- SL supports scientific literacy in relation to problem solving.
- RP students felt that writing discipline style documents was more help to their learning than the SL students
- Students in both courses perceived their final projects as only "some help" to their learning.

What does it all mean?

- RP is more traditional and has been in place for a long time
  - Not surprising that students responded positively
- In the SL project, students performance indicates that they are learning about the scientific process but they do not appear to be aware of those learning gains
- We need to modify existing course components
  - In the RP to increase scientific literacy
  - In the SL to increase relevance
- Lasting effect
  - Development of MMORE (community partner) club
  - Involvement of last year's students

What is the fate of SL in the course?

- In many areas, gains were smaller or more negative in SL than RP, however, they were not significant in most areas.
- The SL course has only been administered twice.
  - Impressive instructor involvement in the SL course compared to the RP.
  - The SL takes a lot of effort for instructors, staff, and students.
- We'll review again after further revision of the SL and RP courses.
- Are there better measures to determine if SL is providing what we set out to accomplish?

Acknowledgements

- Community Service and Learning Partners
  - Nancy Kaufmann and Steve Fink, PhD (MMORE co-founders)
  - Laura Wieks (*Celebrate*MMORE gala volunteer coordinator)
  - Don Benson, MD, David Ciarilello, Matt Hare
  - Candice Hines (Red Cross Coordinator, OSU)
  - American Red CrossCentral-Southeast Ohio Region
  - Tiffany Hughes, PhD
  - Ohio State's Center for Advanced Robotic Surgery
  - Michael Caliguiri, MD, Bethany Mundy-Bosse, PhD and Sabrina Garman
  - Glenn Mills (Farm Manager, Waterman Farms)
- Center for Life Sciences Education
  - Dr. Caroline Breitenberger, Director
  - Matt Misicka, Assistant Director
- Biology 1113H Instructors TAs and Students