Assessment Outcomes Report: SEA-PHAGES Program 2015-2016

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The Assessment Approach

SEA-PHAGES → Measure psychological states relevant to being involved in a research experience → Relevance to persistence and retention

Identification of Instruments

Instrument Name	Feature Measured	Reference
Project Ownership	Degree of ownership and emotional engagement the student feels over their laboratory research work	Hanauer & Dolan, 2014
Self-Efficacy	Degree of student confidence in functioning as a scientist	Estrada, Woodcock, Hernandez, & Wesley Schultz, 2011; Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011
Science Identity	Degree to which a student thinks about her/himself as a scientist	
Scientific Community Value	Degree of student's affinity to the values of the scientific community	
Networking	Degree to which a student discusses their research in personal, social and scientific communities	Hanauer & Hatfull, 2015

Persistence in the Sciences (PITS) Survey
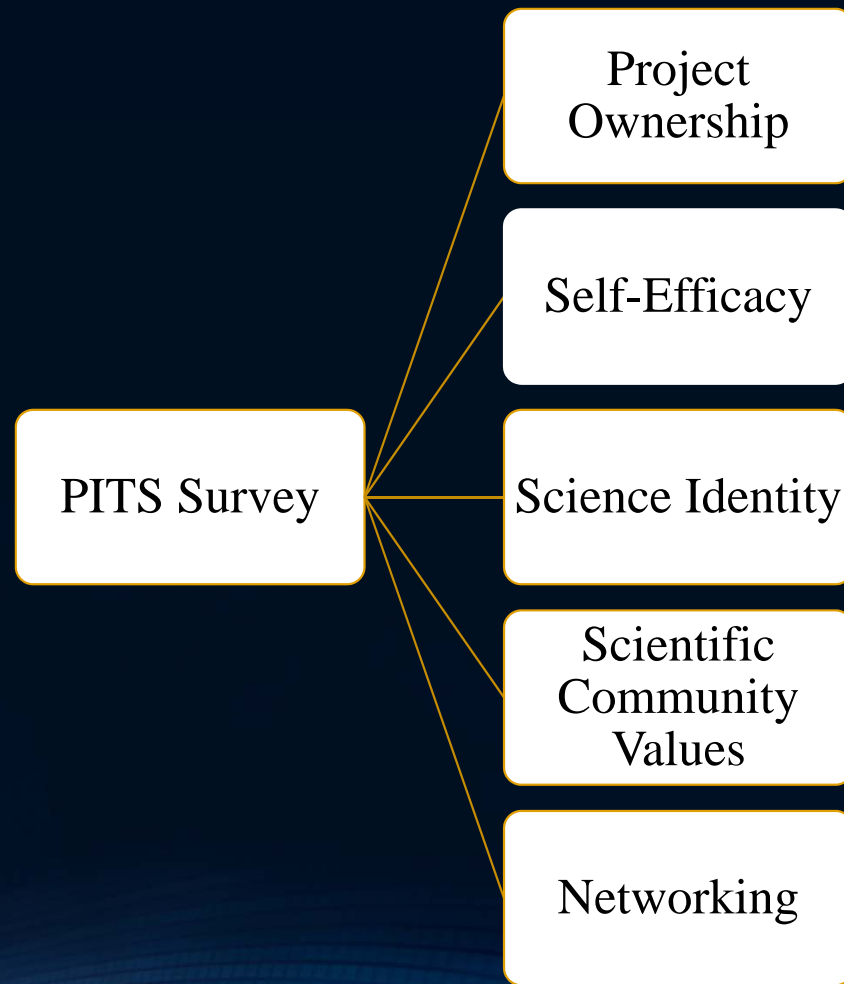
Reporting - The Instructor's Class Outcomes Report

Persistence in the Sciences Survey: Class Outcomes Report

Surveys Completed: 14; Class Participation Rate: 68.8% of total enrollment
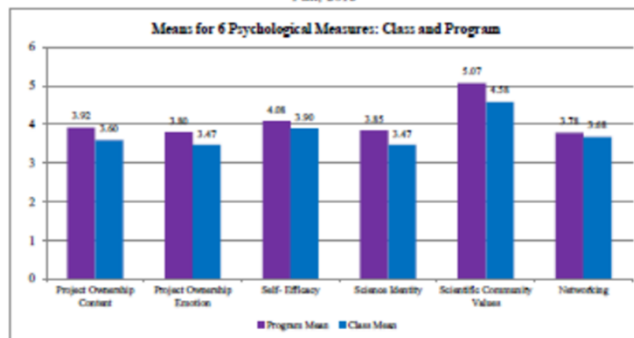*Fall, 2015*

Figure 1 compares average institutional class outcomes with averaged outcomes for the whole of the SEA-PHAGES program for the 6 psychological measures on the Persistence in the Sciences (PITS) survey. Research has shown that persistence in the sciences is related to the following psychological states measured on the PITS survey:

Variable	Construct Measured
Project Ownership Content	Measures the degree of personal ownership and engagement a student feels in relation to the research they have conducted in a specific class
Project Ownership Emotion	Measures the degree to which a student has a positive emotive response to the research they have conducted in a specific class
Self-Efficacy	Measures the degree to which a student feels confident in functioning as a scientist.
Science Identity	Measures the degree to which a student thinks about her/himself as a scientist.
Scientific Community Values	Measures the degree to which a student has affinity to the values of the scientific community.
Networking	Measures the degree to which students are talking about their research in both professional and personal networks

For each of the PITS measures, threshold levels for groups of students who have a high likelihood of staying in the sciences or a low likelihood of staying in the sciences were established. These threshold levels were established empirically by characterizing levels of the PITS measures used by groups of students with high and low intent to stay in the sciences and then using a bootstrapping-resampling method to extrapolate population estimates. These threshold levels were used to characterize the students in your class in terms of the percentage of students who are likely, indeterminate or not likely to continue in the sciences.

Figure 2: Percentage of students in your class likely to continue or not continue in the sciences by psychological measures on the PITS survey
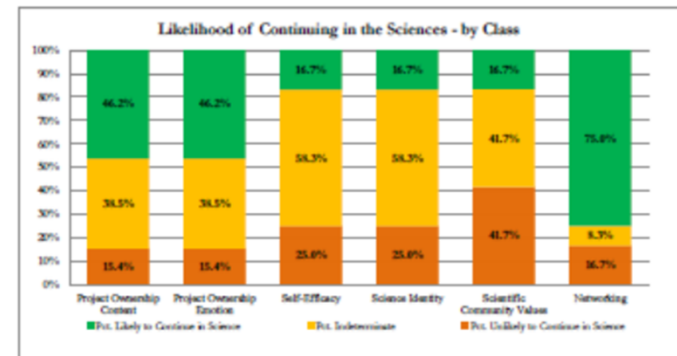

Table 1: Frequency, Mean, z-score and Percentage of Students High, Indeterminate and Low Likelihood of Continuing in the Sciences and Threshold Levels*

	Project Ownership Content	Project Ownership Emotion	Self-Efficacy	Science Identity	Scientific Community Values	Networking
High Likelihood	46.2% (6)	46.2% (6)	16.7% (2)	16.7% (2)	16.7% (2)	75% (9)
Indeterminate	38.5% (5)	38.5% (5)	58.3% (7)	58.3% (7)	41.7% (5)	8.3% (1)
Low Likelihood	15.4% (2)	15.4% (2)	25% (3)	25% (3)	41.7% (5)	16.7% (2)
Class Mean, Z-score and Threshold Levels						
Z-score	-0.51	-0.4	-0.3	-0.49	-0.54	-0.12
Class Mean	3.6	3.47	3.9	3.47	4.58	3.68
Program Mean	3.92	3.8	4.08	3.85	5.07	3.78
High Likelihood	≥3.50	≥4.18	≥4.10	≥5.49	≥4.10	≥3.49
Low Likelihood	≤3.03	≤3.03	≤2.76	≤3.77	≤4.64	≤2.76

* Exact distance of class mean in standard deviations from the SEA-PHAGES program mean.
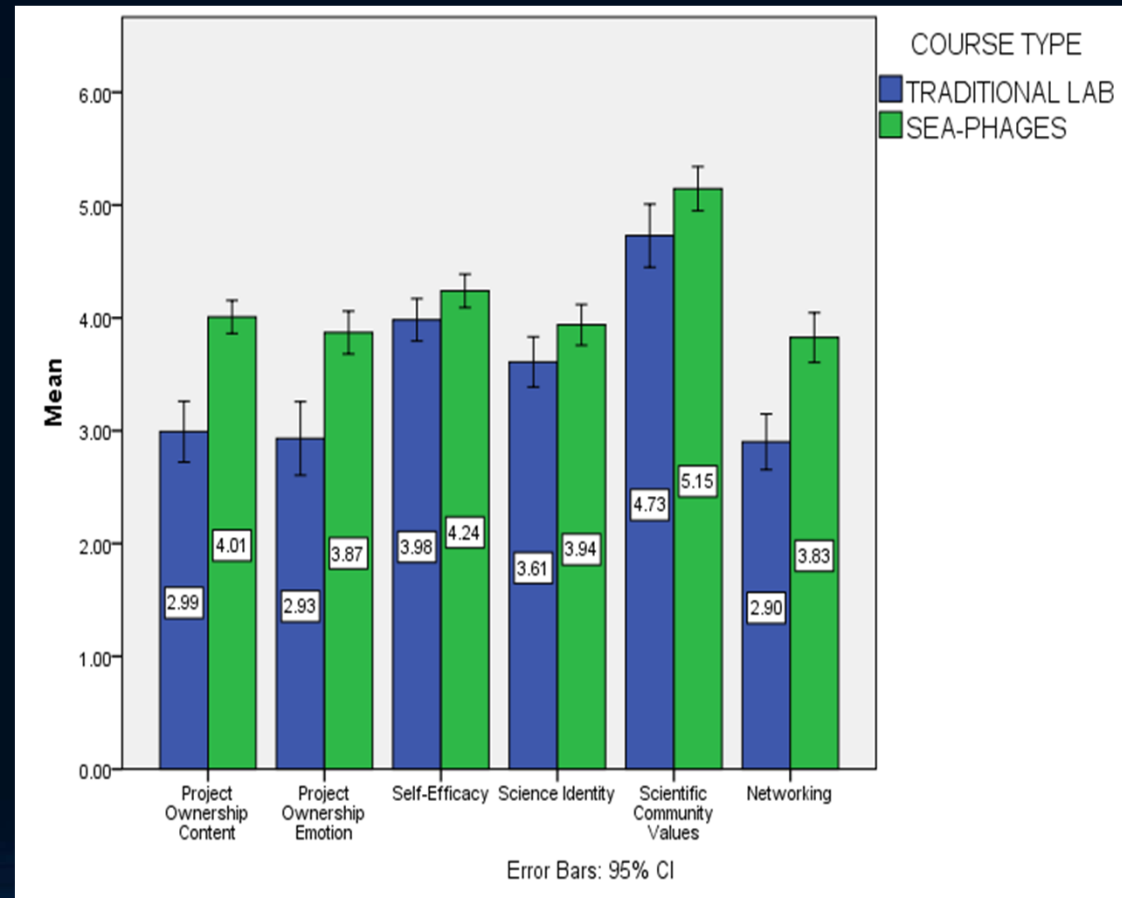
Research Questions

| AIM	Question
PROGRAM ASSESSMENT	Does the SEA-PHAGES program work? • *Is the SEA-PHAGES course significantly different from a traditional laboratory course?*
	Does the SEA-PHAGES program work equally well for different genders, ethnicities, GPA levels, types of institution and years of study?
	Are their differences in the different versions of the SEA-PHAGES program (one semester wet lab; one semester bioinformatics; two semesters Fall/Spring; two semester Spring-summer break– Fall)?

Does SEA-PHAGES work?

- Is the SEA-PHAGES course significantly different from a traditional laboratory course?

- Comparison of matched groups from random sample (propensity score matching) to isolate the variable of course type (n=117)

- Significantly higher ratings for SEA-PHAGES on all variables except self-efficacy

	Coef. (Treatment Effect)	Std. Err.	z	Sig.
Project Ownership Content	**1.01**	.15	6.74	.0001
Project Ownership Emotion	.96	.2	4.84	.0001
Self-Efficacy	.17	.12	1.38	.16
Science Identity	.31	.15	1.96	.05
Scientific Community Values	.57	.2	2.74	.006
Networking	.92	.19	4.84	.0001

Bar chart of Mean by Course Type (Traditional Lab vs SEA-PHAGES). Error Bars: 95% CI.
Project Ownership Content: 2.99 / 4.01; Project Ownership Emotion: 2.93 / 3.87; Self-Efficacy: 3.98 / 4.24; Science Identity: 3.61 / 3.94; Scientific Community Values: 4.73 / 5.15; Networking: 2.90 / 3.83.
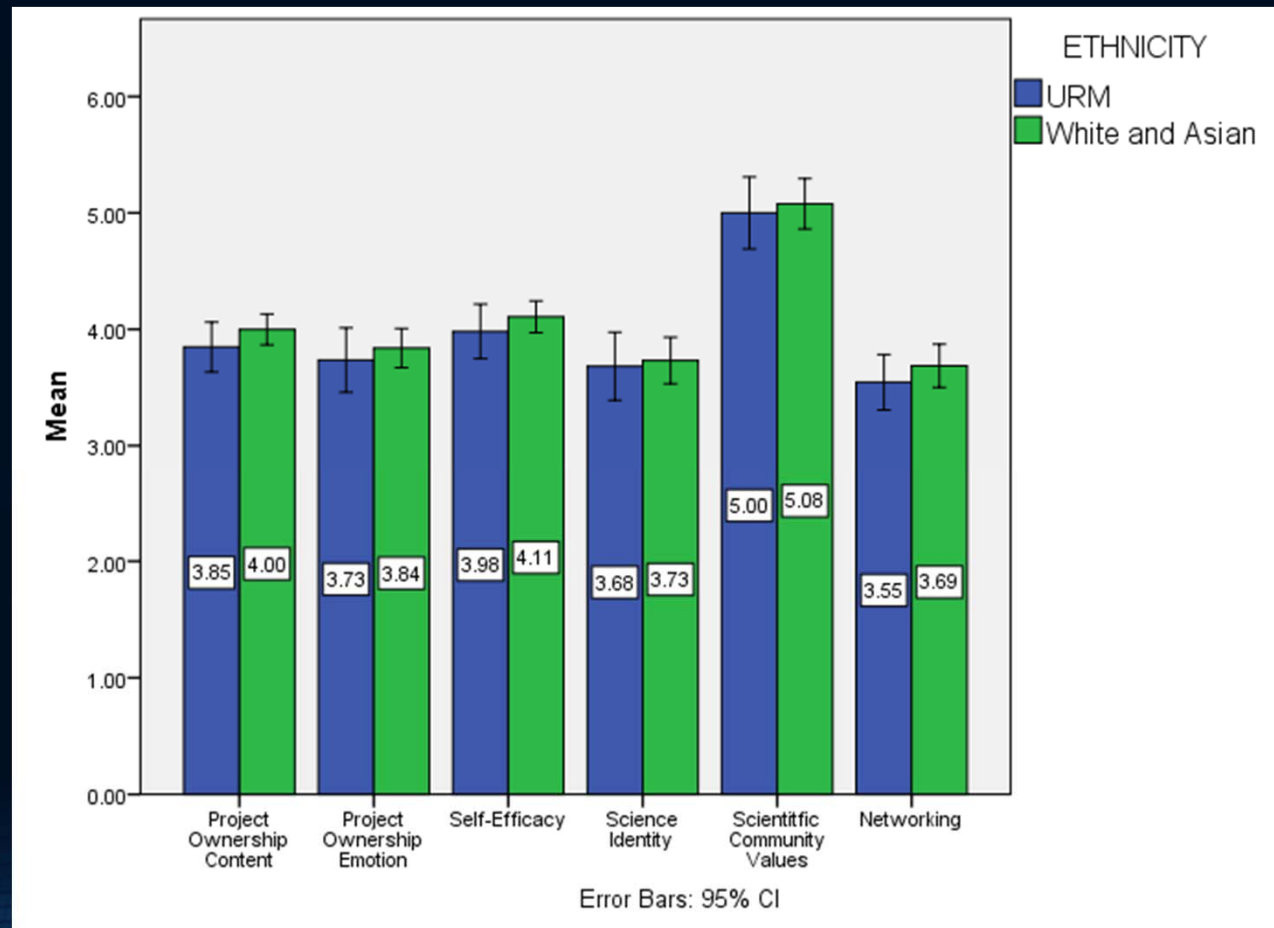
Does the SEA-PHAGES program work equally well for men and women?

- Random sample self-identified male and female students n=160)

- A **non-statistically** significant MANOVA effect was obtained, Wilks' Lambda = .95, F(6, 141) = 1.157, p < .33

- Women do not perform significantly differently from men in the SEA-PHAGES program.
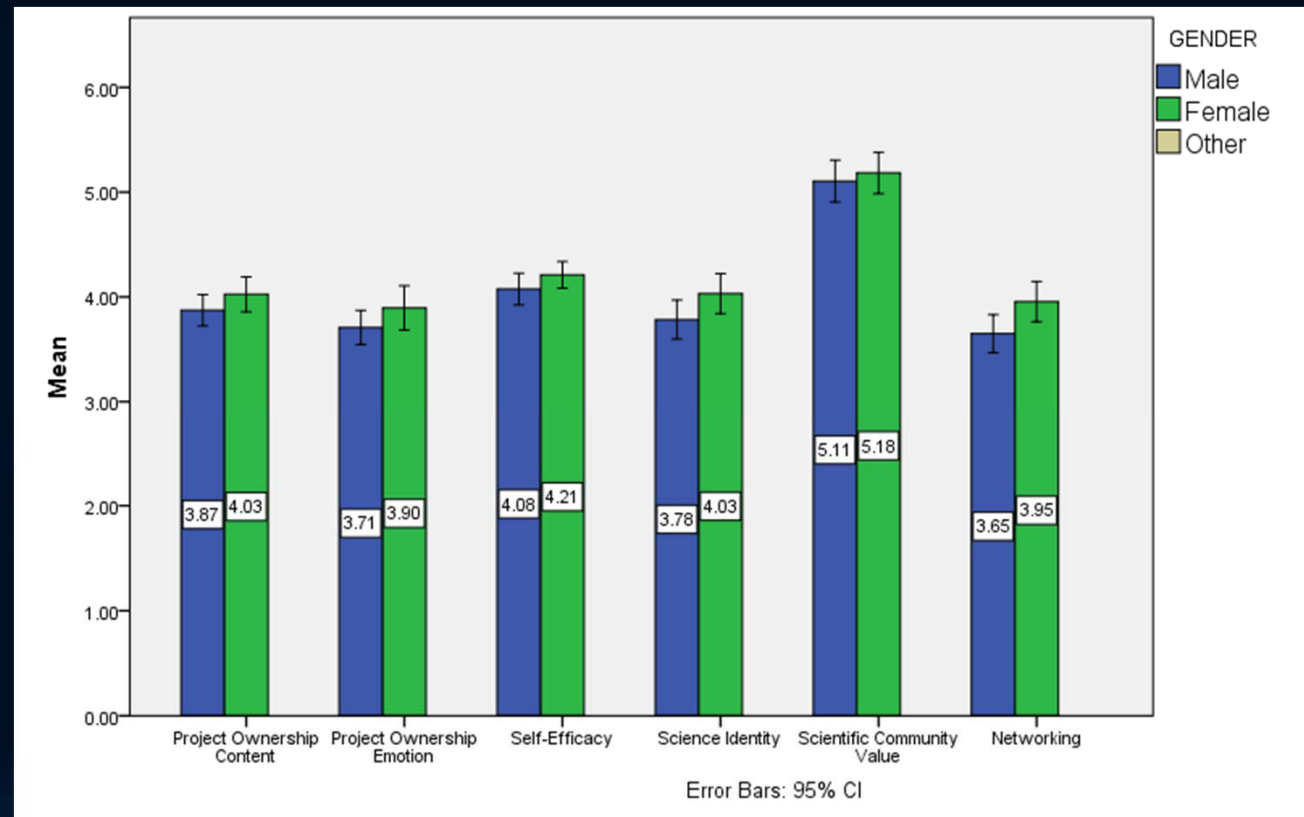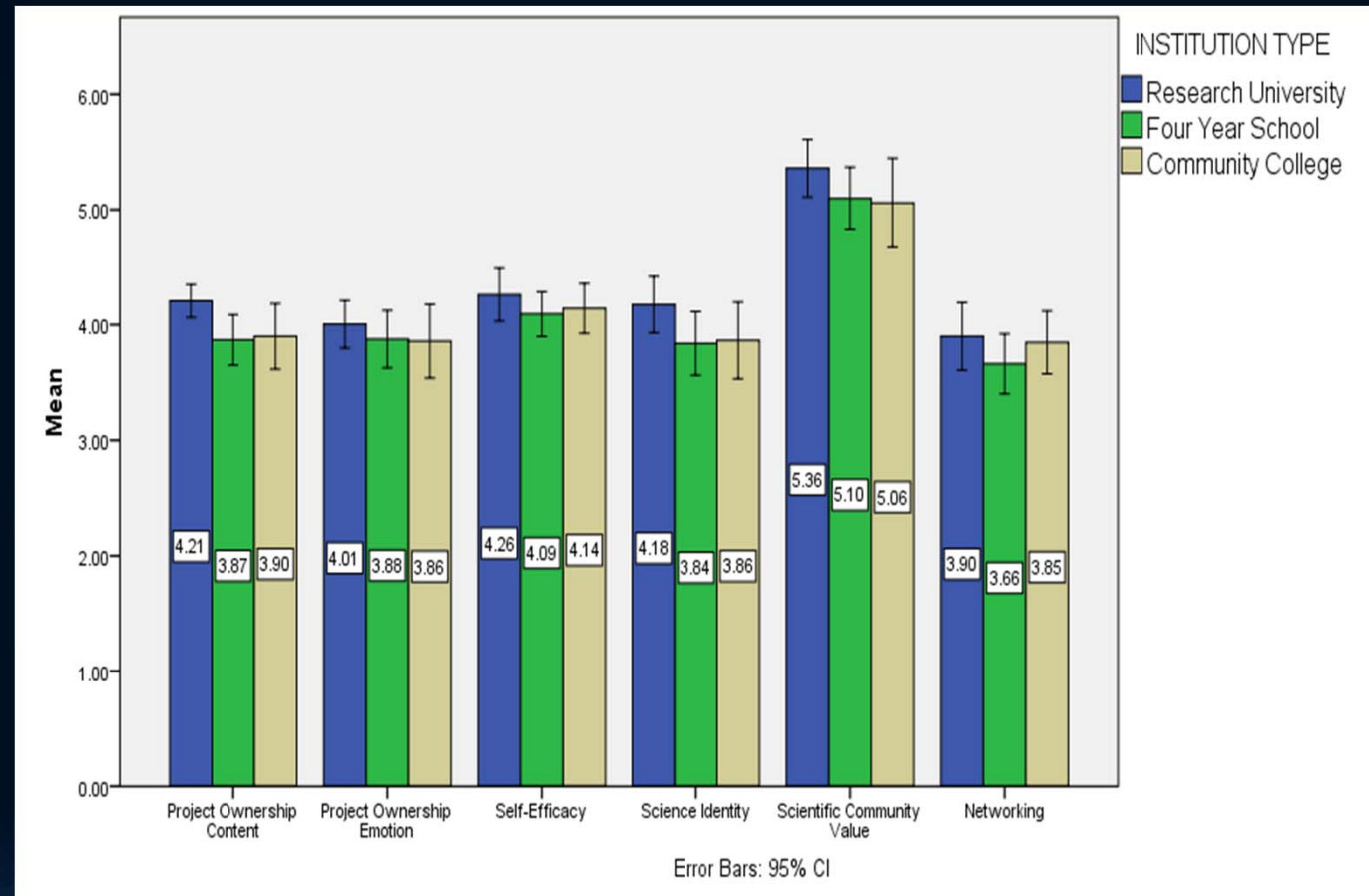
Does the SEA-PHAGES program work equally well for different ethnicities?

- Random sample of self-identified underrepresented (African American and Hispanic Latino) and White and Asian students (n=111)

- A **non-statistically** significant MANOVA effect was obtained, Wilks' Lambda = .96, F(6, 104) = .55, p < .77.

- Overall, underrepresented minority and White and Asian students seem to function equally well in the SEA-PHAGES program.

Error Bars: 95% CI

Does the SEA-PHAGES program work equally well for different institution types?

- Random sample of students from 3 institution types (n=103)

- A **non-statistically** significant MANOVA effect was obtained, Wilks' Lambda = .91, $F(12, 188) = .76$, $p < .69$.

- The different types of institution seem to function equally well in the SEA-PHAGES program.

Error Bars: 95% CI

Does the SEA-PHAGES program work equally well for different GPA levels?

- Random samples three levels of self reported GPA (2.6-3; 3.1-3.5; 3.6-4) (n=243)

- Significant overall effect:

  Wilks' Lambda = .88, F (12, 470) = 2.67, p<.002

  Post-hoc Analyses – difference situated in mean difference of low and high GPA in relation to Networking

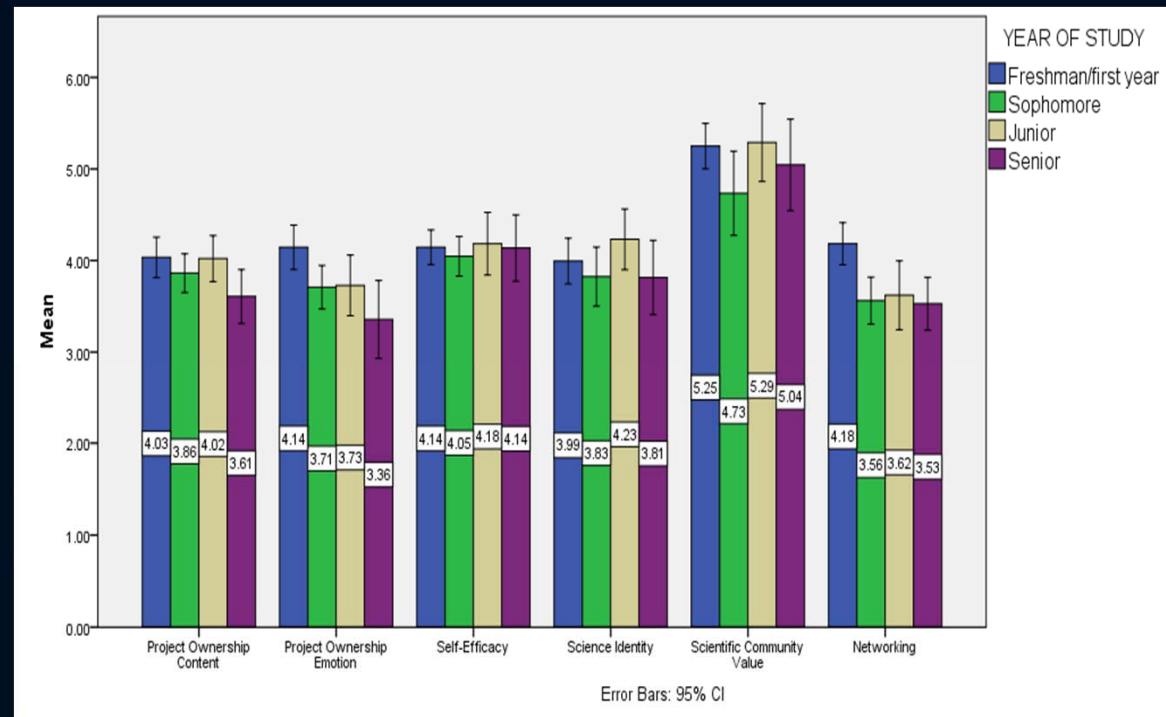|	df	F	Partial Eta Squared	Sig.
Project Ownership Content	**2**	**.3**	**.003**	**.74**
Project Ownership Emotion	2	2.29	.019	.1
Self-Efficacy	2	.55	.005	.57
Science Identity	2	.76	.006	.47
Scientific Community Values	2	.89	.007	.41
Networking	**2**	6.18	.049	.002

Error Bars: 95% CI
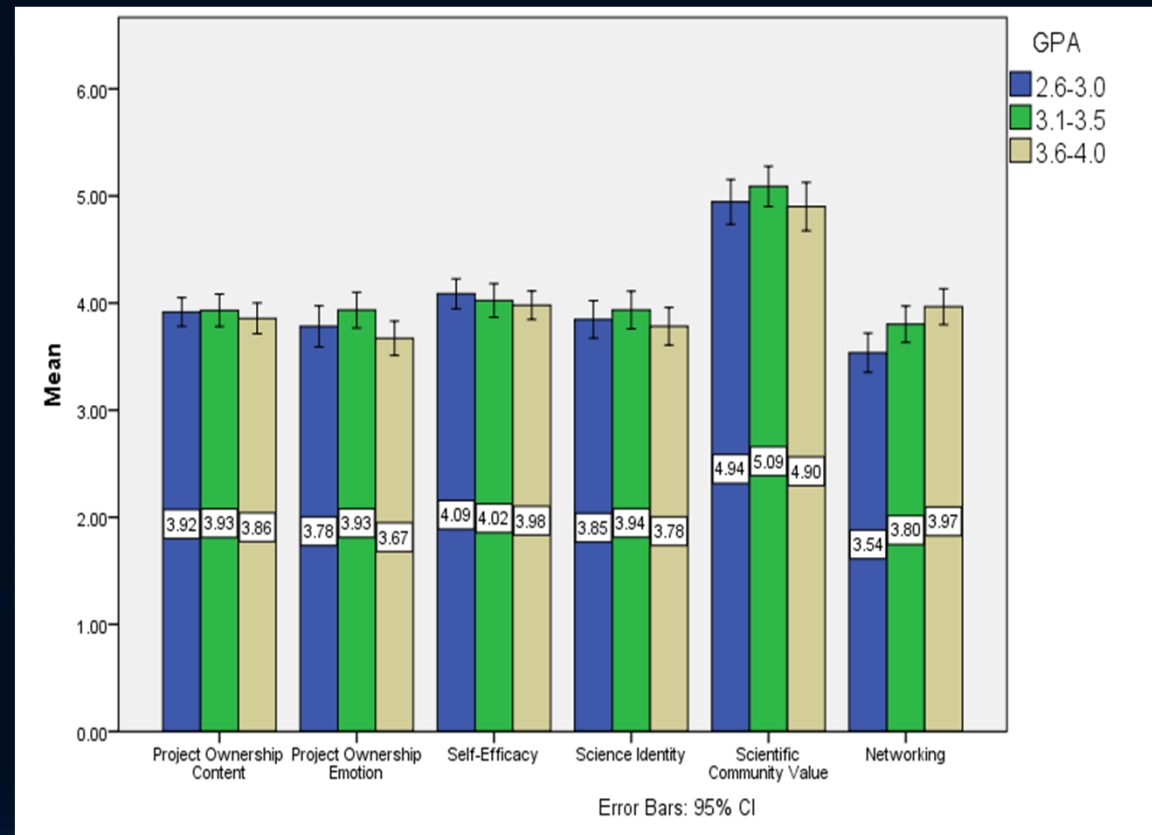
Does the SEA-PHAGES program work equally well for different years of study?

- Random samples of four years of study (Freshman, Sophomore, Junior & Senior) (n=117)

- Significant overall effect:

  Wilks' Lambda = .66, F (18, 330) = 2.69, p<.001.

  Post-hoc Analyses – difference situated in mean difference between Freshman and Sophmores/Seniors in relation to Project Ownership and Networking

|	df	F	Partial Eta Squared	Sig.
Project Ownership Content	3	2.65	.07	.05
Project Ownership Emotion	3	5.18	.12	.002
Self-Efficacy	3	.18	.005	.9
Science Identity	3	1.16	.03	.32
Scientific Community Values	3	1.66	.04	.18
Networking	3	6.28	.14	.001

Do the different versions of the SEA-PHAGES program work equally well on the project ownership content variable?

- Random samples of 4 SEA-PHAGES program versions (one semester: wet lab; one semester bioinformatics; two semesters wet lab and bioinformatics fall/spring; two semesters wet lab bioinformatics spring-summer-Fall) and traditional lab (n=601)

- Significant overall effect:

  Wilks' Lambda = 10.47, F (6, 24) = 2.67, p<.0001

  One way ANOVA: F (4,548) = 41.57, p<.0001

  Post-hoc Analyses – difference situated in mean difference between traditional lab and all SEA-PHAGES groups

Project Ownership Content Means for 5 Groups
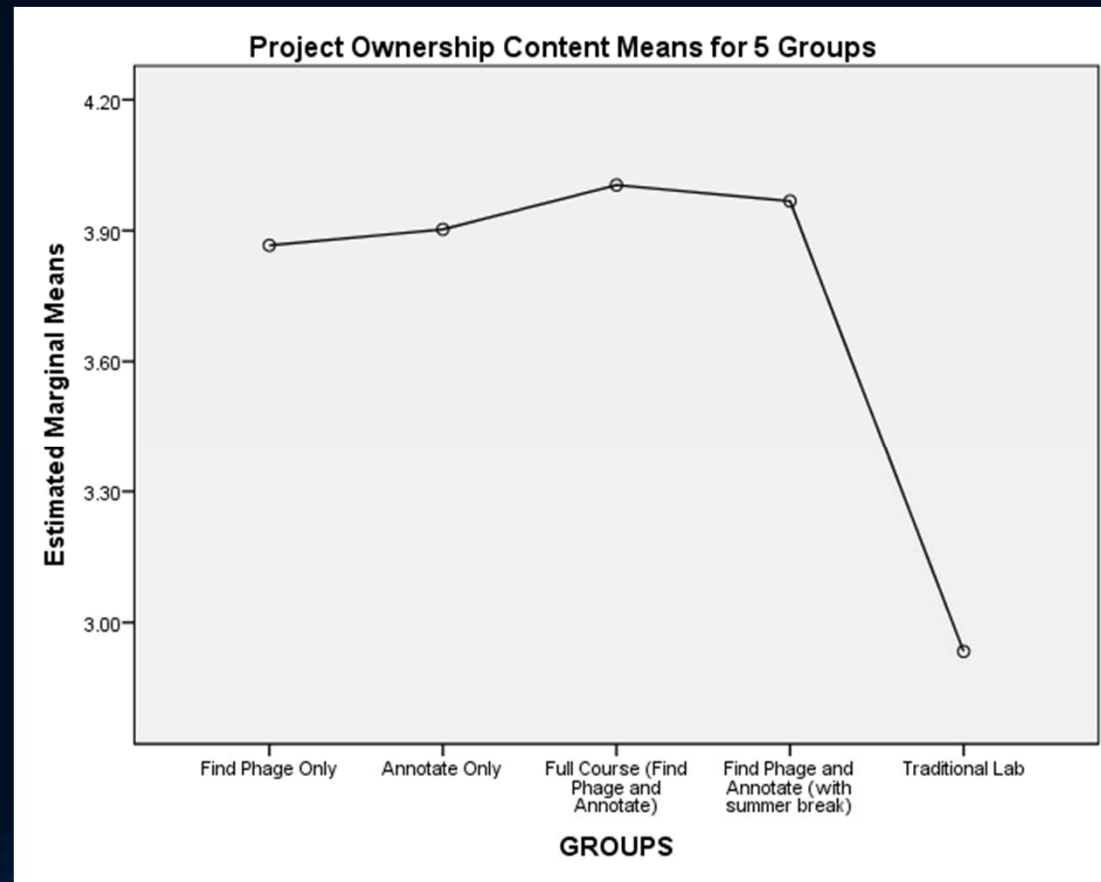
Do the different versions of the SEA-PHAGES program work equally well on the project ownership emotion variable?

- Random samples of 4 SEA-PHAGES program versions (one semester: wet lab; one semester bioinformatics; two semesters wet lab and bioinformatics fall/spring; two semesters wet lab bioinformatics spring-summer-Fall) and traditional lab (n=601)

- Significant overall effect:

Wilks' Lambda = 10.47, F (6, 24) = 2.67, p<.0001

One way ANOVA: F (4,548) = 30.03, p<.0001

Post-hoc Analyses – difference situated in mean difference between traditional lab and all SEA-PHAGES groups
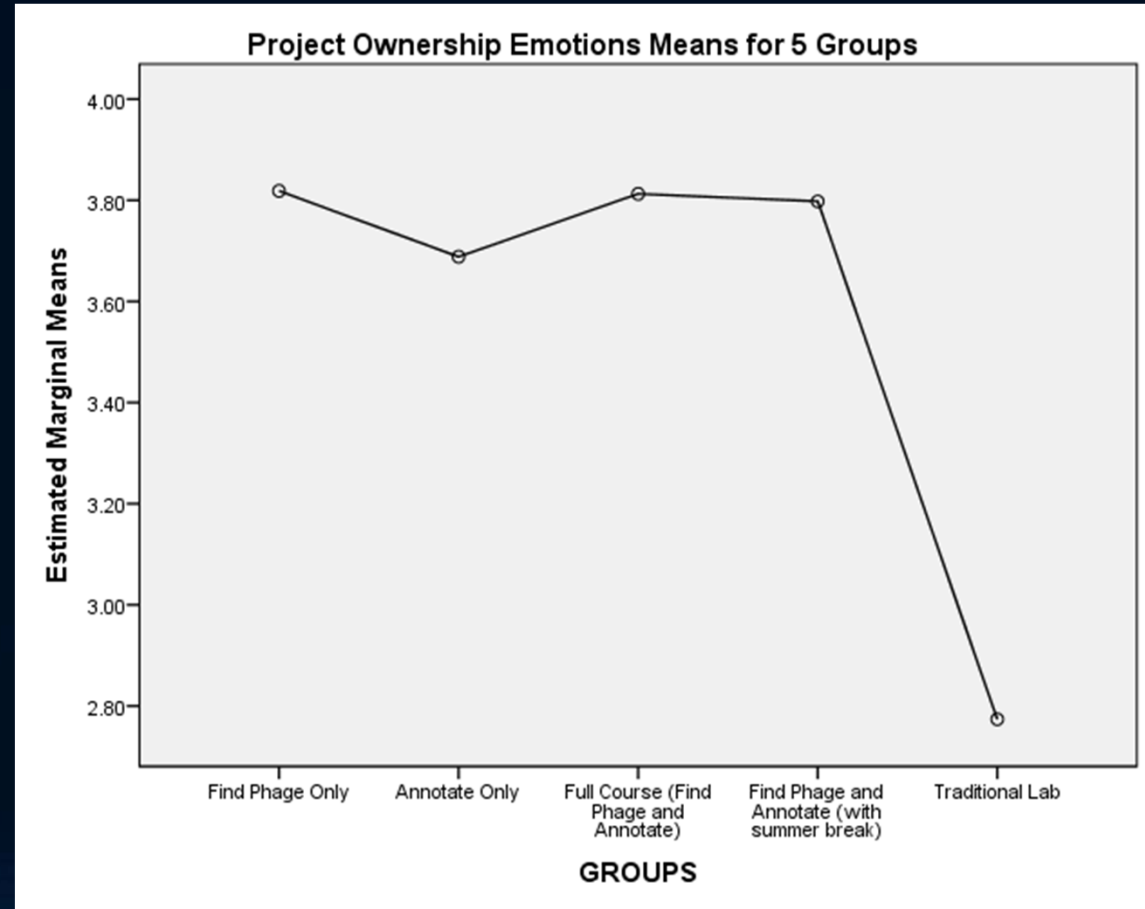
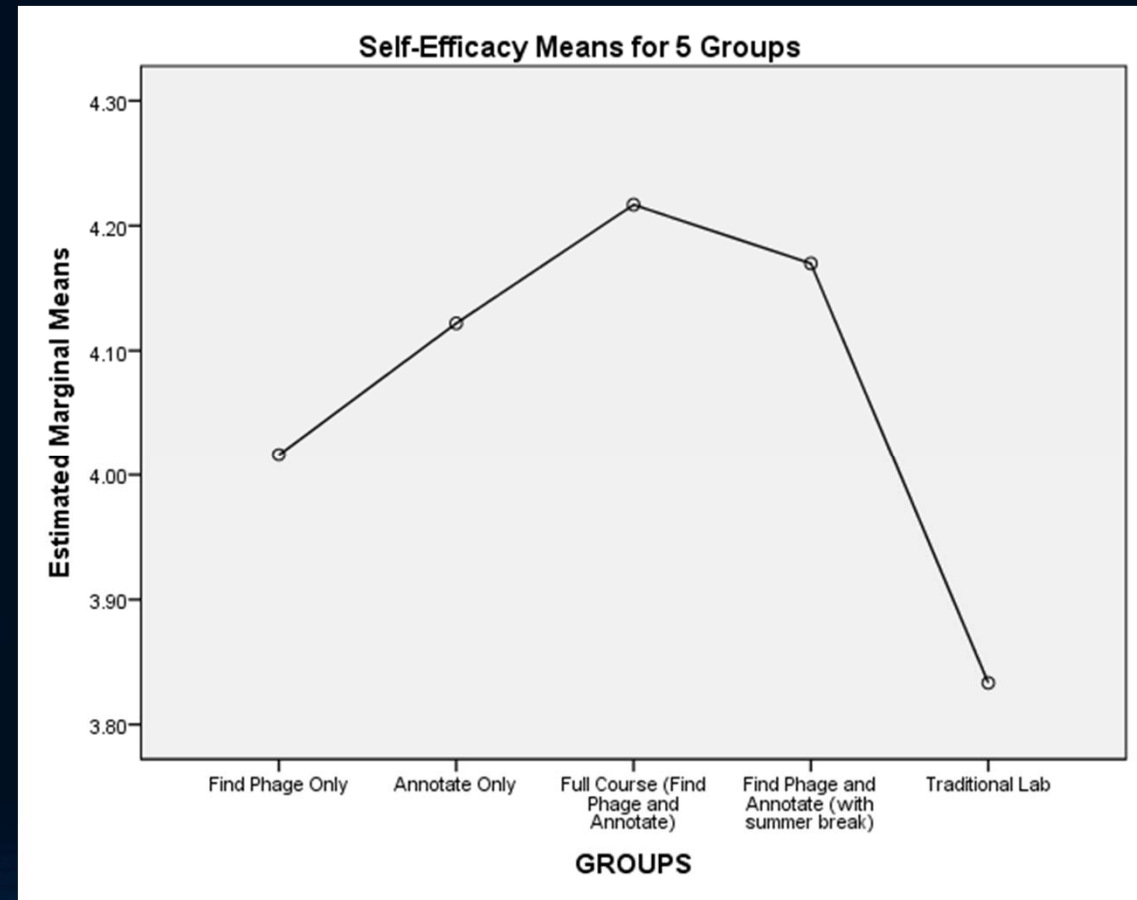# Do the different versions of the SEA-PHAGES program work equally well on the self-efficacy variable?

- Random samples of 4 SEA-PHAGES program versions (n=601)

- Significant overall effect:

Wilks' Lambda = 10.47, F (6, 24) = 2.67, p<.0001

One way ANOVA: F (4,548) = 6.04, p<.0001

Post-hoc Analyses – difference situated in mean difference between traditional lab and full course (fall/spring; spring-summer-Fall) & one semester bioinformatics.

Self-Efficacy Means for 5 Groups

Do the different versions of the SEA-PHAGES program work equally well on the science identity variable?

- Random samples of 4 SEA-PHAGES program versions (n=601)

- Significant overall effect:
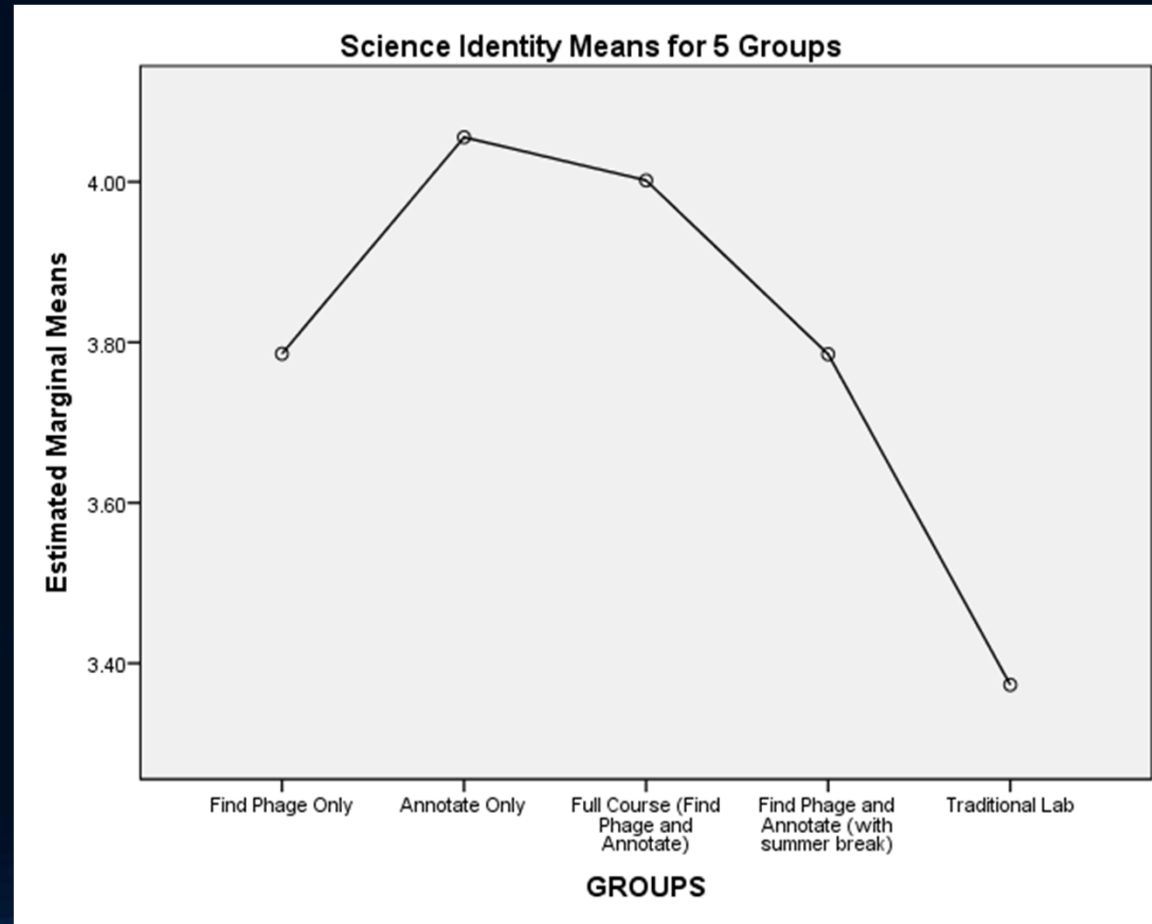
Wilks' Lambda = 10.47, $F_{(6, 24)}$ = 2.67, $p<.0001$

One way ANOVA: $F_{(4,548)}$ = 12.44, $p<.0001$

Post-hoc Analyses – difference situated in mean difference between traditional lab and all SEA-PHAGES groups

Science Identity Means for 5 Groups

Do the different versions of the SEA-PHAGES program work equally well on the scientific community values variable?

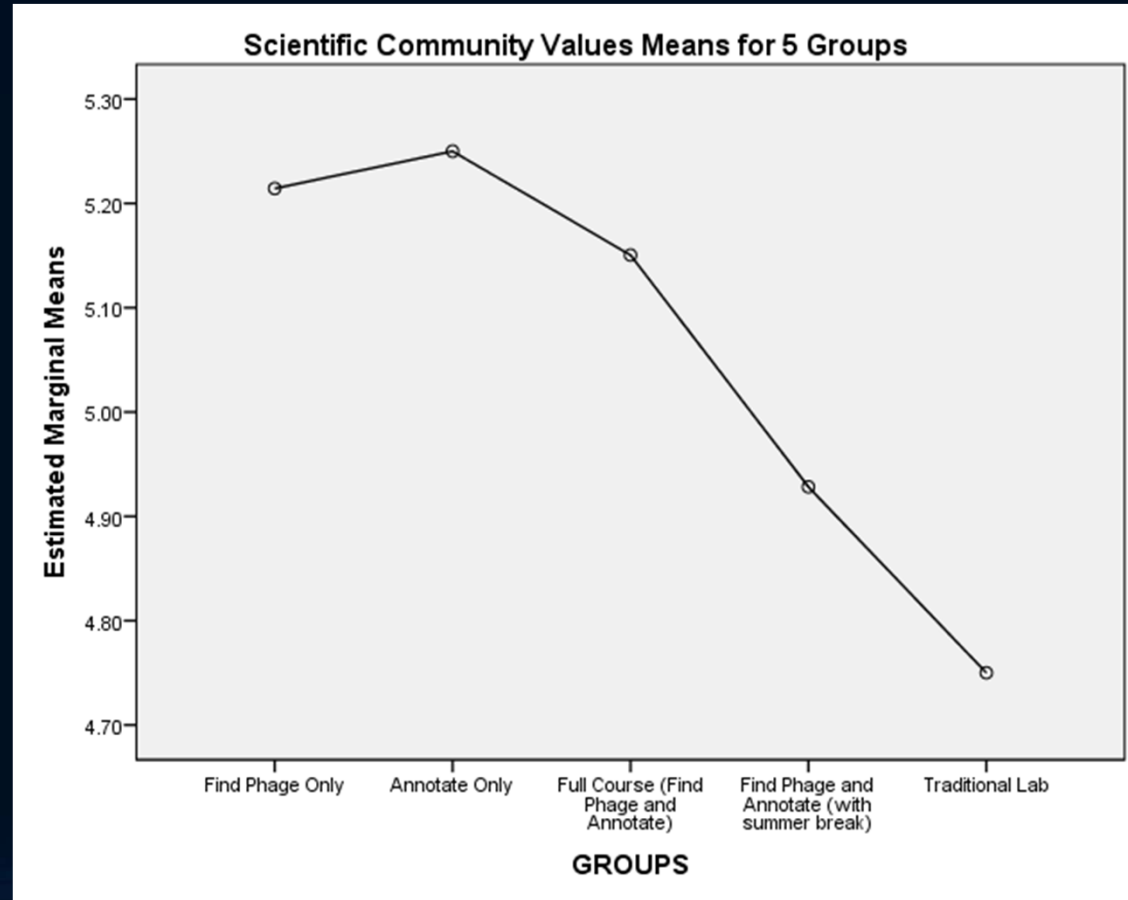- Random samples of 4 SEA-PHAGES program versions (n=601)

- Significant overall effect:

Wilks' Lambda = 10.47, $F_{(6, 24)}$ = 2.67, $p<.0001$

One way ANOVA: $F_{(4,548)}$ = 32.19, $p<.0001$

Post-hoc Analyses – difference situated in mean difference between traditional lab and one semester bioinformatics; one semester wet lab and full course (fall/spring)

No difference Traditional Lab and Full course with summer break.

Scientific Community Values Means for 5 Groups

Do the different versions of the SEA-PHAGES program work equally well on the networking variable?

- Random samples of 4 SEA-PHAGES program versions (n=601)

- Significant overall effect:

Wilks' Lambda = 10.47, $F_{(6, 24)}$ = 2.67, $p < .0001$

One way ANOVA: $F_{(4,548)}$ = 6.24, $p < .0001$

Post-hoc Analyses – difference situated in mean difference between traditional lab and all SEA-PHAGES groups

Networking Means for 5 Groups
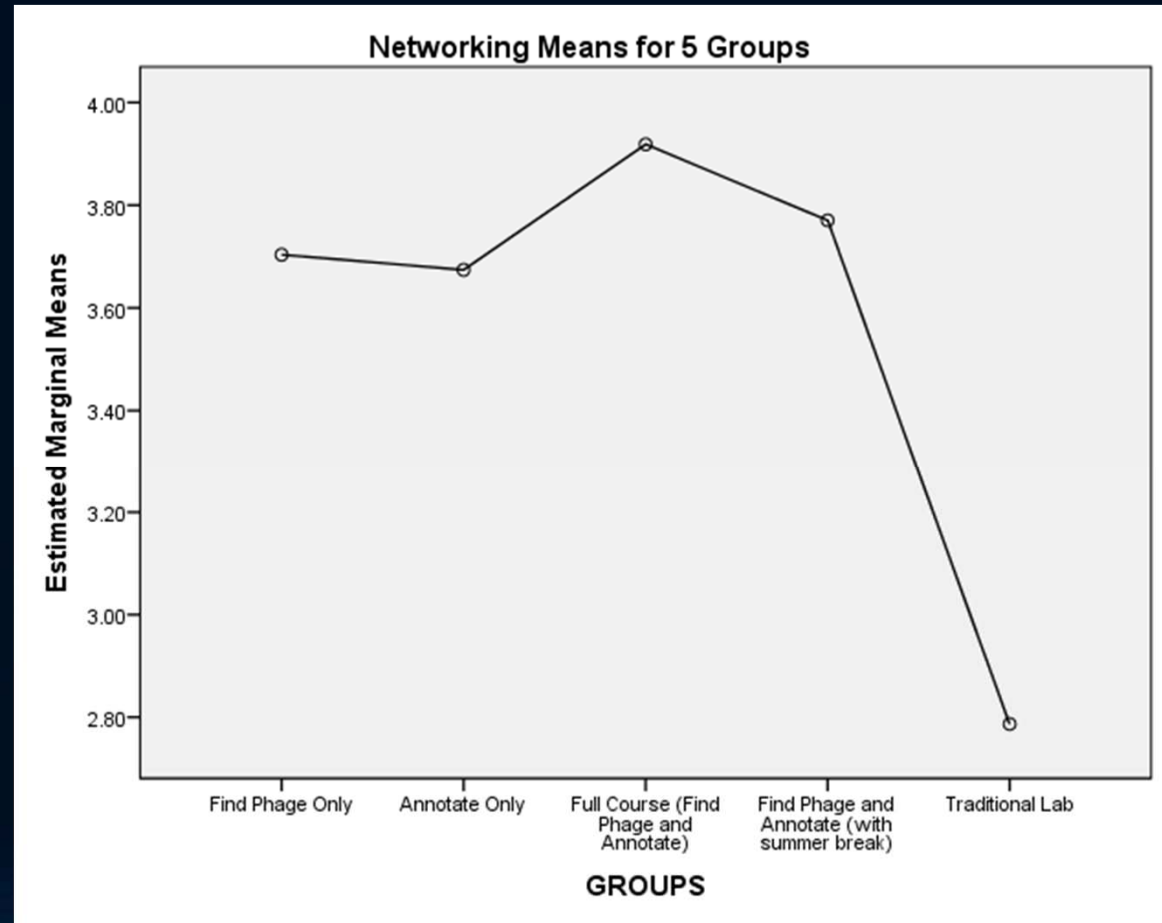
SEA-PHAGES Program Conclusions

- On the outcome variables of the PITS survey, the SEA-PHAGES program outperforms the traditional (procedure focused) laboratory course

- Overall, the SEA-PHAGES program works equally well for men and women, underrepresented minorities, various GPA levels and different types of educational institution making it a scalable approach for improving science education for a wide range of students.

- The SEA-PHAGES program seems to work best in the Freshman year.

- There may be some differences between the versions of the SEA-PHAGES program:

  - Full year (Fall/Spring) performs well for Project Ownership Content, Emotion, Self-Efficacy and Networking

  - Self-efficacy seems to involve an accumulative effect resulting from two semesters of SEA-PHAGES work.

  - Bioinformatics seem to enhance science identity and scientific community values but involve a drop in emotional responses.

  - The full year regular course (Fall/Spring) outperforms the Full course with a summer break (Spring/Fall) on all variables

Acknowledgements

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- My thanks to ALL SEA-PHAGES faculty for helping me to motivate students to participate in the PITS survey data collection process!

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THANK YOU

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Questions

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