Practice Makes Pretty Good: Assessment of Primary Literature Reading Abilities across Multiple Large Enrollment Biology Laboratory Courses

Brian Sato, Pavan Kadandale, Wenliang He

UC Irvine

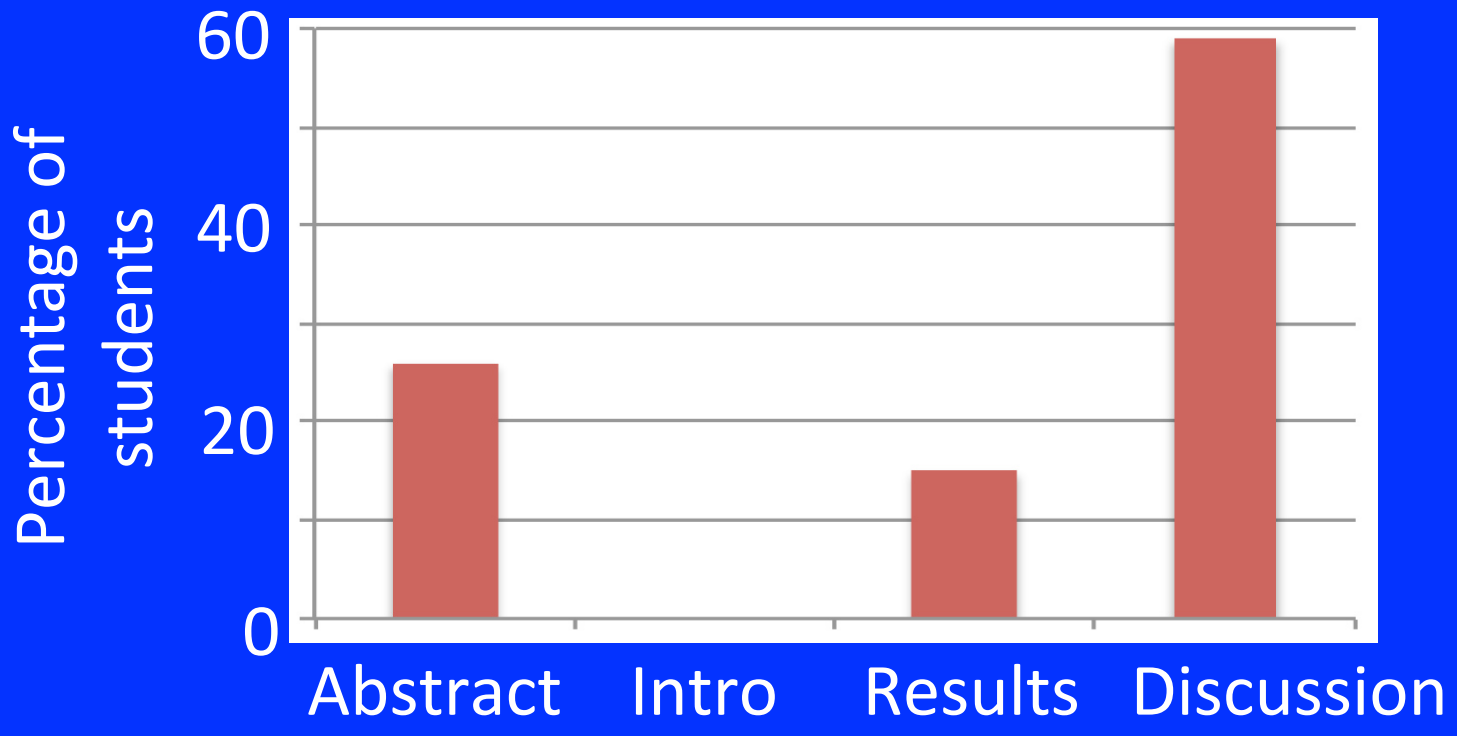
Bio Sci Students and Primary Literature

- Over 90% of students in lab courses have been exposed to primary literature
- 75% of students agree that primary literature is important for their future

Bio Sci Students and Primary Literature

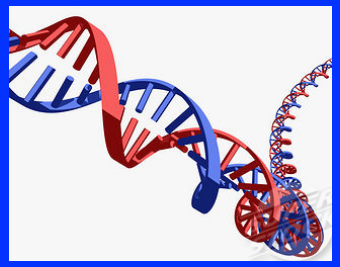
- Yet understanding of primary literature is lacking

What is the most important section of a paper?

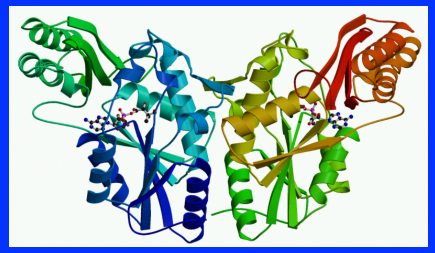


Primary Literature and Bio Sci Labs

Microbiology



Molecular Biology



Biochemistry

Paper #1 → Paper Assignment #1 → In Class Discussion

Paper #2 → Paper Assignment #2 → In Class Discussion

Paper #3 → Paper Quiz

Paper Assignments

- Assignment #1 - 4 Q's
  - Why was the experiment performed?
  - How was the experiment performed?
  - What were the results obtained?
  - What conclusions were made?
- Assignment #2 - Summary paragraphs

PNAS

Carcinogenic bacterial pathogen *Helicobacter pylori* triggers DNA double-strand breaks and a DNA damage response in its host cells

Isabella M. Toller[a,1], Kai J. Neelsen[a,1], Martin Steger[a], Mara L. Hartung[a], Michael O. Hottiger[b], Manuel Stucki[b], Behnam Kalali[c], Markus Gerhard[c], Alessandro A. Sartori[a], Massimo Lopes[a,2], and Anne Müller[a,2]

[a]Institute of Molecular Cancer Research and [b]Institute of Veterinary Biochemistry and Molecular Biology, University of Zürich, 8057 Zürich, Switzerland; and [c]Department of Medicine, Technical University Munich, 81675 Munich, Germany

Edited by Jeffrey W. Roberts, Cornell University, Ithaca, NY, and approved July 28, 2011 (received for review January 24, 2011)

I have a very strong understanding of this paper.

A. Strongly disagree
B. Disagree
C. Neutral
D. Agree
E. Strongly agree

What is the main question the authors are asking?

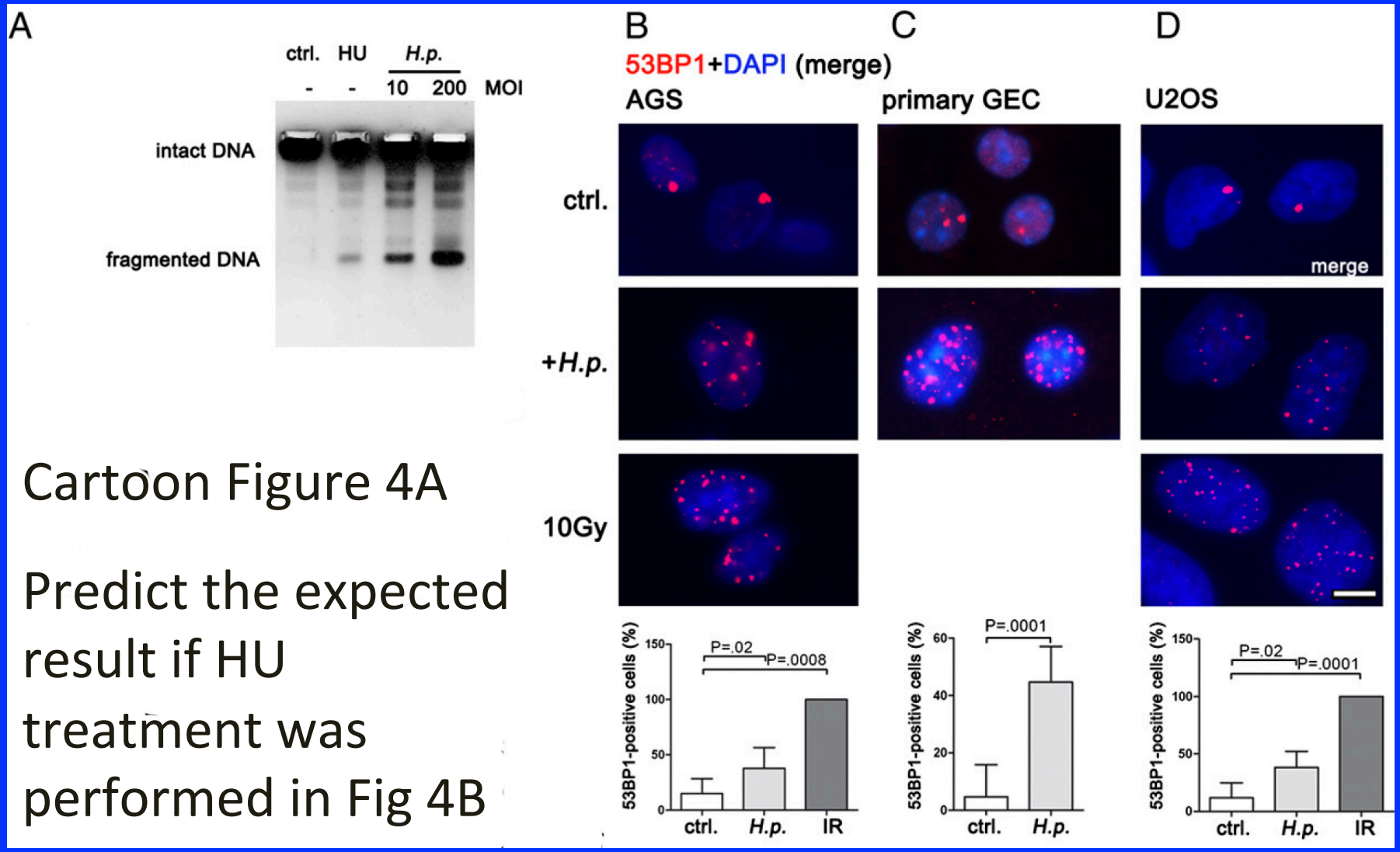
A. Why is *H. pylori* a cause of gastric cancer?
B. How does *H. pylori* affect chromosome stability?
C. How does the DNA repair machinery fix double stranded breaks?

Purpose?

Conclusion?

How does it work?

Future Directions?

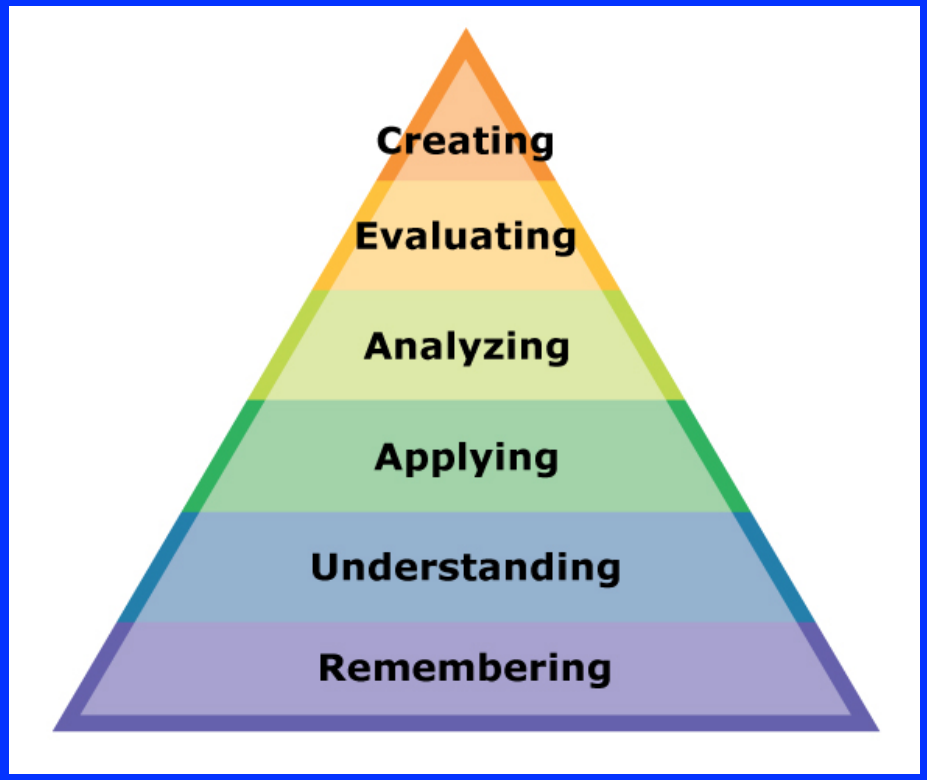


Cartoon Figure 4A

Predict the expected result if HU treatment was performed in Fig 4B

Paper Quiz - Assesses Student Comprehension of Primary Literature

- How well do students understand primary literature?



Bloom's Taxonomy

Paper Quiz

6. Answer the following questions (a-c) regarding Figure 6B.

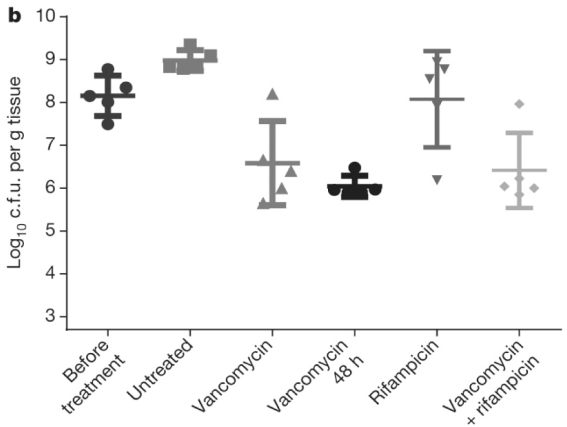


Fig 6. ADEP4 in combination with rifampicin eradicates a deep-seated mouse biofilm infection. **b.** Single day (rifampicin 30mg per kg once, vancomycin 110mg per kg twice) treatments with rifampicin and vancomycin. A second day of vancomycin treatment (vancomycin 48h) reveals an antibiotic tolerant subpopulation.

a. What is a biofilm? (1 pt)

b. Imagine ADEP4 was added to the vancomycin treatments (both 24 and 48hrs). Draw the expected results from this experiment in the Vancomycin and Vancomycin 48 h lanes of the graph above. (2 pt)

c. This figure (**DOES/DOES NOT**) contribute to the main question of the paper (Q1 of this qhiz). **Briefly explain**. (1.5 pt)

7. Based on the results in this paper, propose a relevant future experiment the authors could conduct (identifying other activators of ClpP or other bacterial proteases are not acceptable answers as they are mentioned in the discussion of the paper). (2 pt)

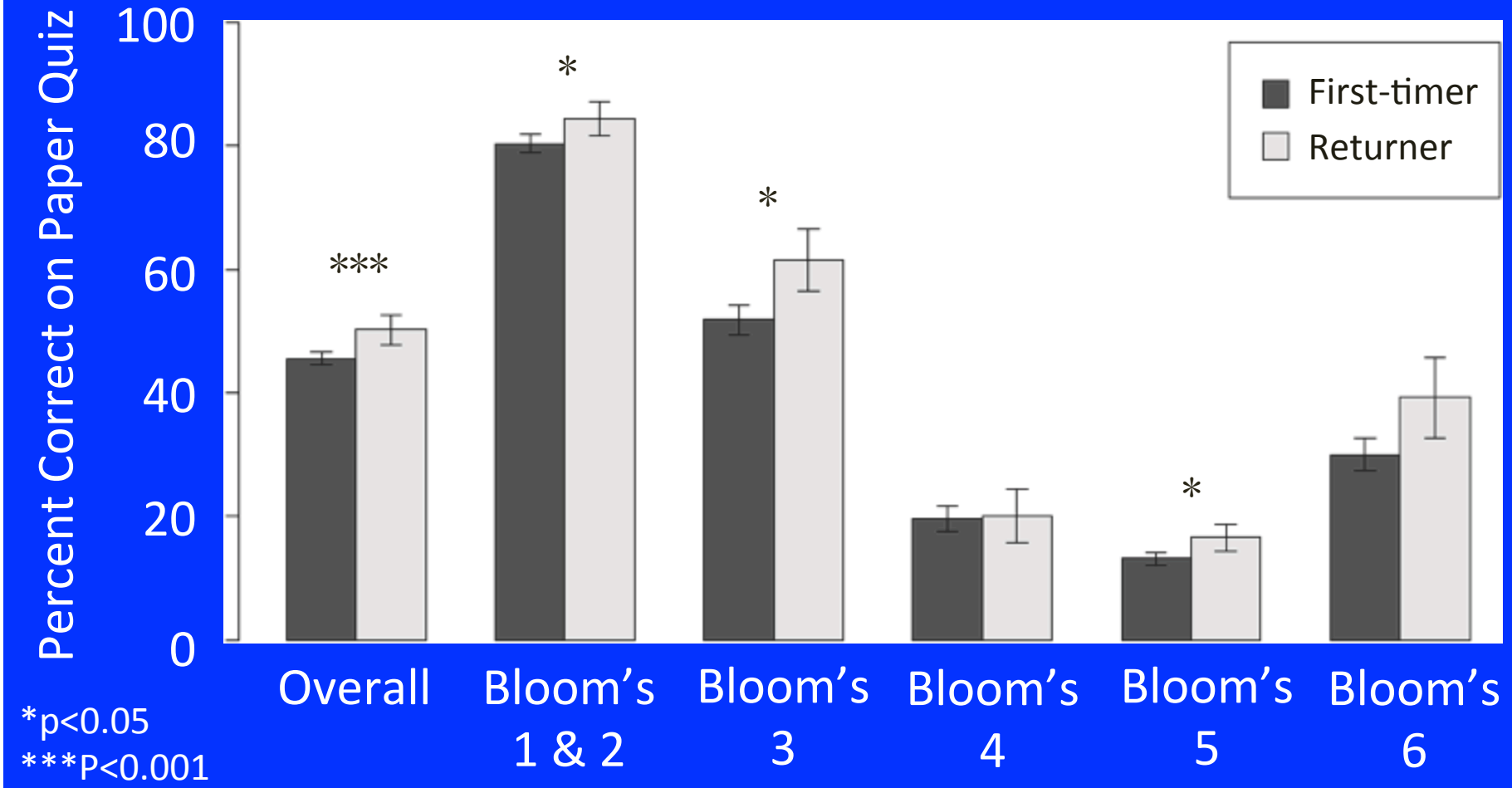
Does this module increase paper reading abilities in later courses?

Fall Quarter 2012	Winter Quarter 2013	Spring Quarter 2013
Microbiology Lab	Microbiology Lab	Microbiology Lab
Molecular Biology Lab	Molecular Biology Lab	Molecular Biology Lab
Biochemistry Lab	Biochemistry Lab	Biochemistry Lab

First-timer – Student taking our labs for the 1st time

Returner – Student who has taken one of our labs previously

Returner students exhibit longitudinal learning gains



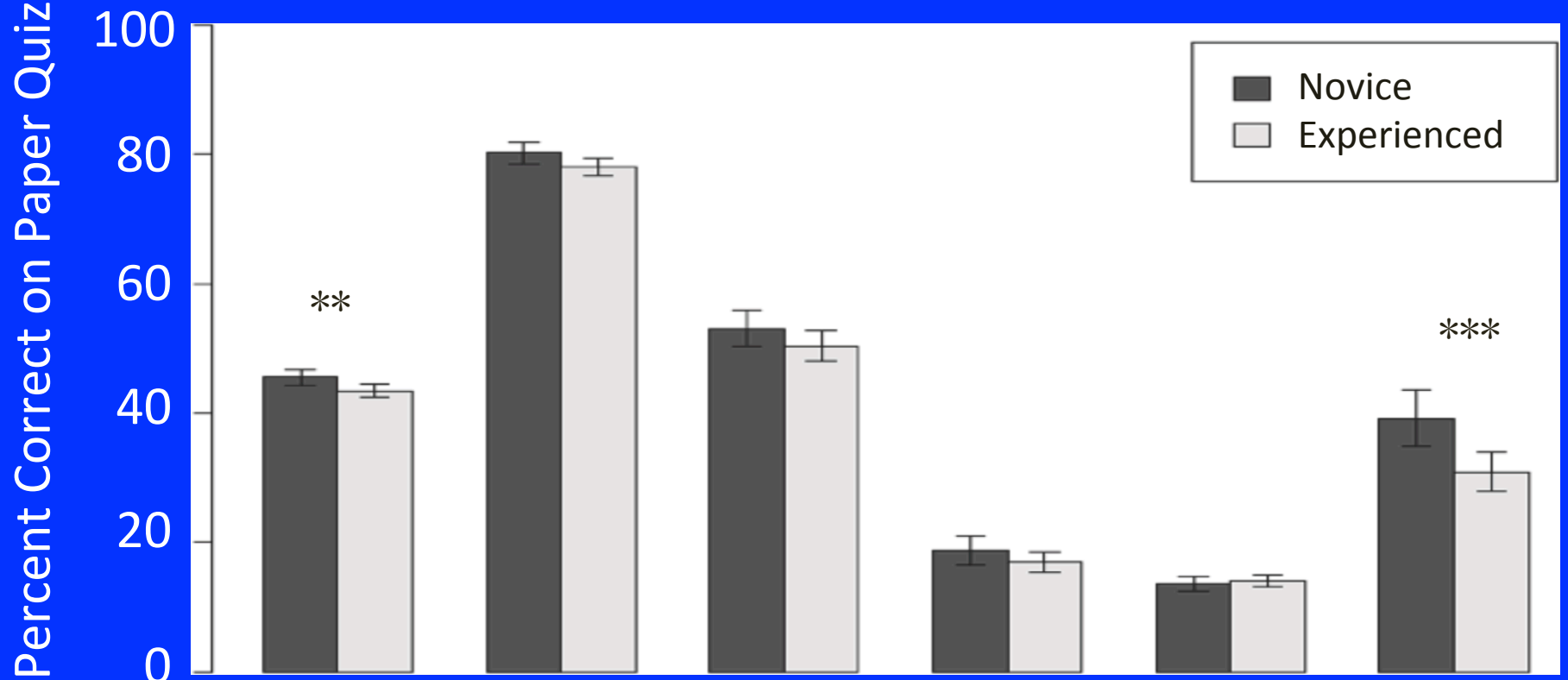
Are learning gains dependent on the primary literature module?

Are learning gains dependent on the primary literature module?

Experienced – Previously taken another upper division Bio lab

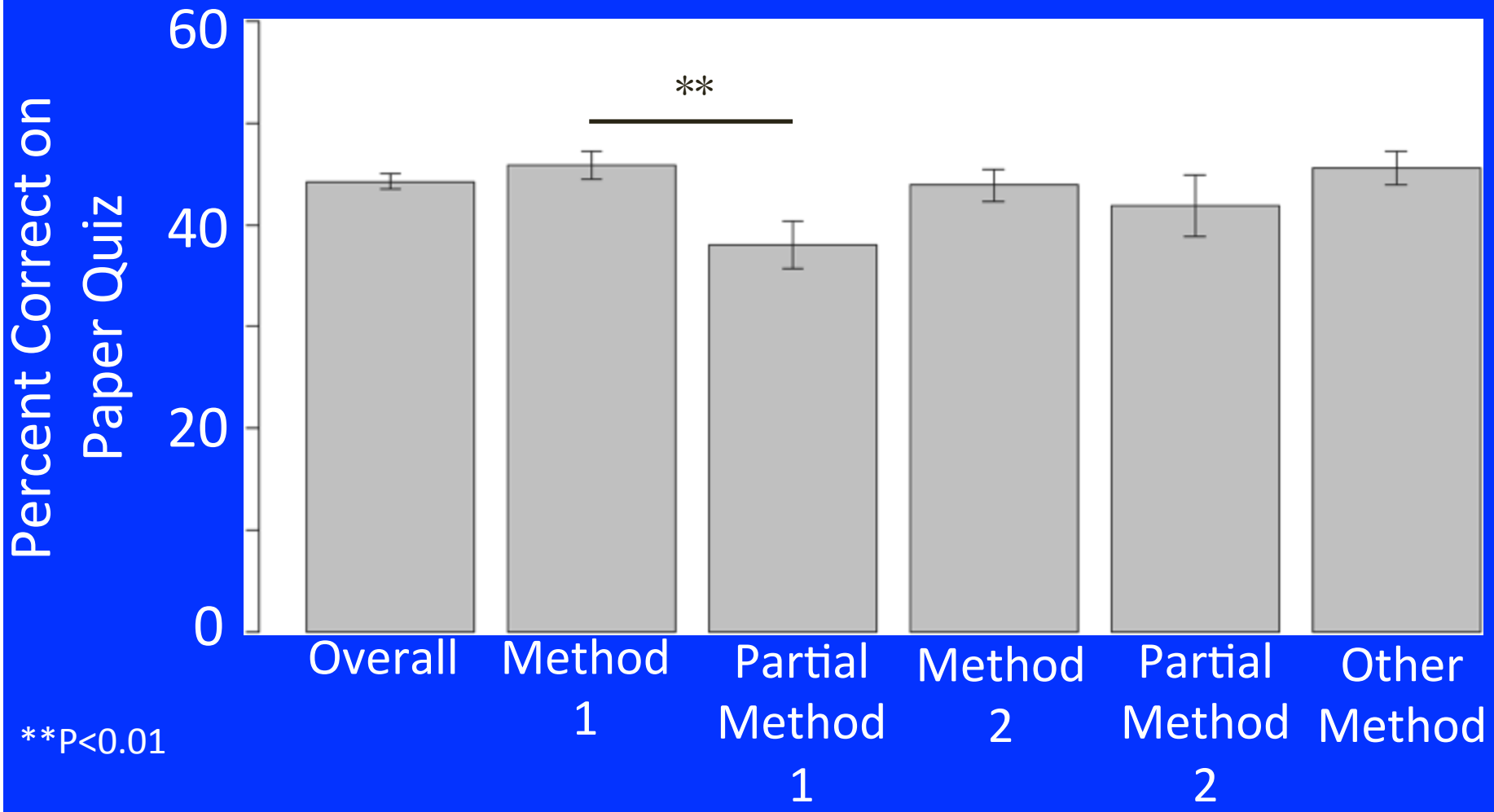
Novice – One of our labs is their 1st lab experience

Longitudinal learning gains are specific for paper module labs



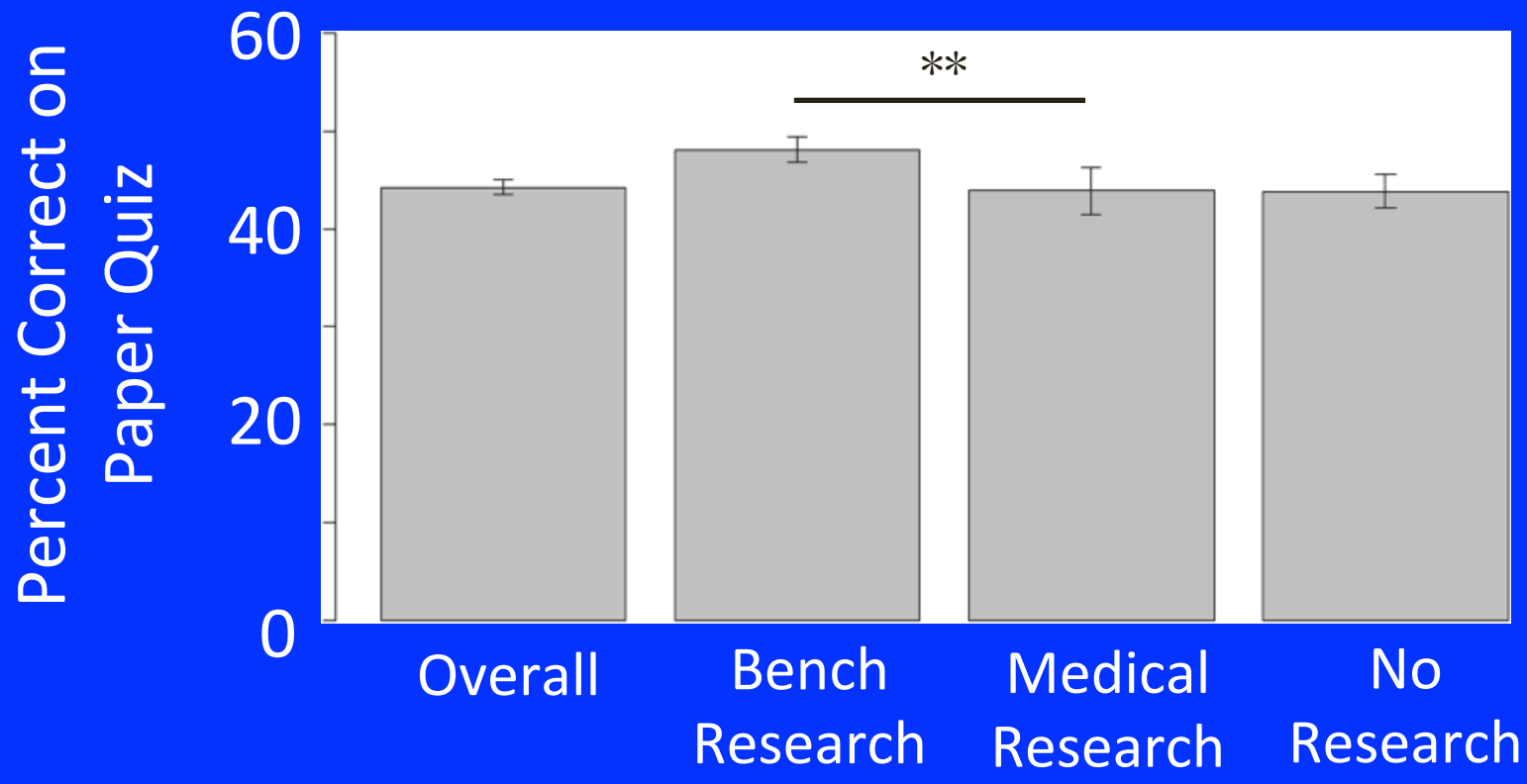
**p<0.01
***P<0.001

Paper Comprehension and Study Method



**P<0.01

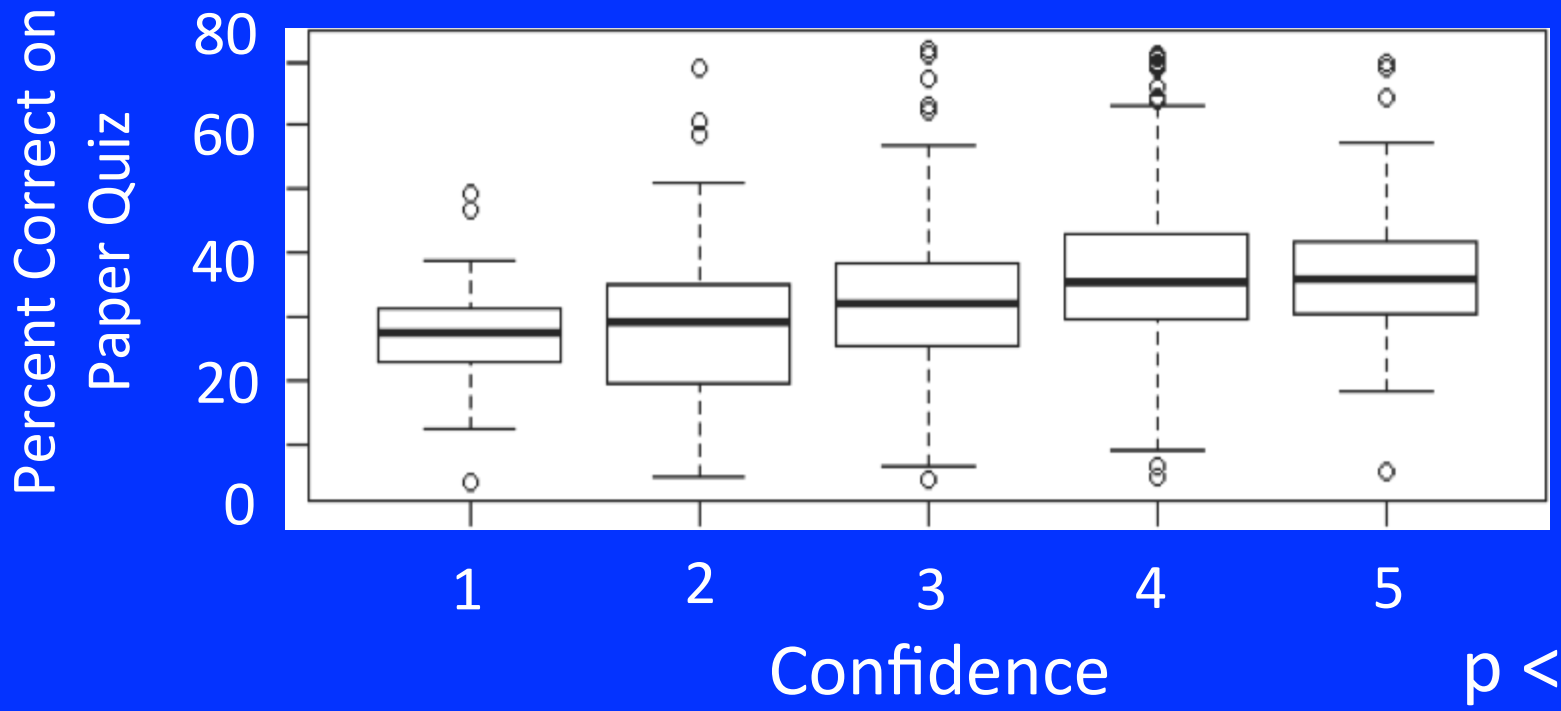
Paper Comprehension and Research Experience



**P<0.01

Performance on Paper Quiz and Confidence

- I am very confident that I understand the paper being tested 1 = Strongly Disagree 5 = Strongly Agree



$p < .0001$

Conclusions

- Our lab module significantly increased student performance in a paper-based quiz in a longitudinal manner
- Benefits were not dependent on prescribed study methods
- Research experience did not result in increased comprehension of primary literature
- Paper Quiz performance and student confidence positively correlated
- All conclusions were seen in individual courses

Future Directions

- What is confidence?

$$\text{Confidence} = \frac{\text{Prior Experience} + \text{Present Work}}{\text{Self-Expectation}} + \text{Perception}$$

- Open v. Closed note test taking

Future Directions

- Expansion of module
  - Other Bio Sci lab courses
  - Other departments, institutions?
- Bio Sci M126 – Intro to Primary Literature
- Program redesign?
  - Need to focus on critical thinking as opposed to memorization
  - Ex. Data analysis, Experimental design

Questions?