

Framework for understanding the outcomes of IPLS* course ecosystems

**introductory physics for the life sciences*

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SWARTHMORE COLLEGE

APS GLOBAL PHYSICS SUMMIT, 17 MARCH 2026



Project goal:

*How does our IPLS course accomplish its
outcomes?*

This is a work in progress!
A “humble theory” under development ...

Grounded theory:

Charmaz, K. (2019). *Sociological Focus*, 52(2), 87–90.

“Humble theories:”

Allie, S. (2016). PER Conference invited talk

1. Prior work: Swarthmore IPLS course and outcomes
2. Current project: *How* Swarthmore's course accomplishes these outcomes
3. Emergent framework for comparative analysis

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IPLS goal

Help life science students engage with (intro) physics by showing how physics is valuable and meaningful in the work of life scientists and physicians

IPLS design principles

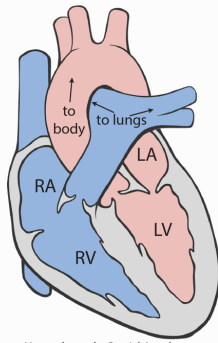
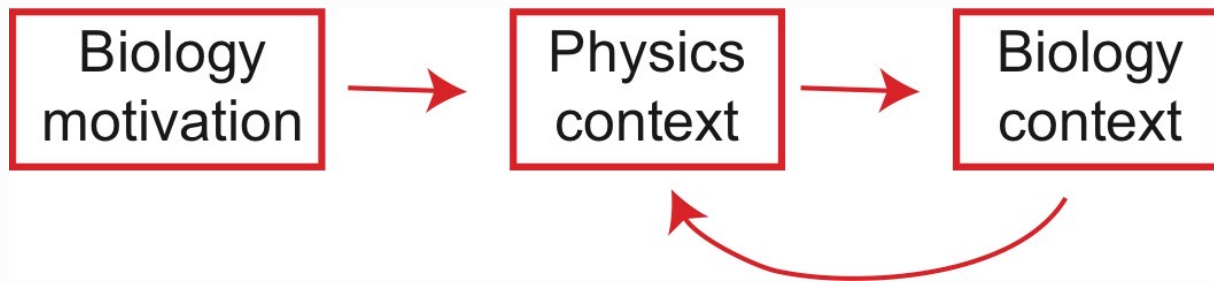
- ❖ Use research-based active learning!
- ❖ Foreground authentic* connections between physics and the life sciences
- ❖ Expansive framing†

**Watkins, Hall, Coffey, Cooke, and Redish, PRST-PER 2011.*

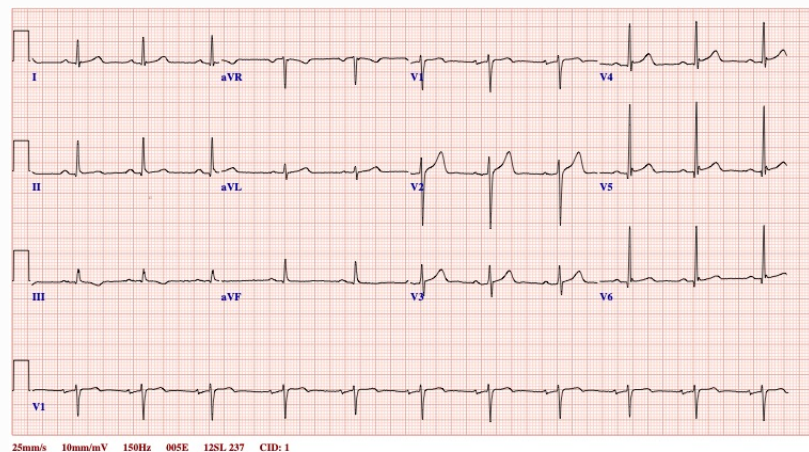
† Engle, Nguyen, and Mendelsohn, Instructional Science 39, 603 (2011).

IPLS instructional rhythm

Organize each unit around authentic connections



Heart drawn by Patrick Lynch,
CC BY 2.5. Annotated by CHC.



Fifteen years of research ...



Stephen Hackler
(Swarthmore Physics)



Ben Geller
(Swarthmore Physics)



Catherine Crouch
(Swarthmore Physics)



Sara Hiebert Burch
(Swarthmore Bio)



Ann Renninger
(Swarthmore Ed.)



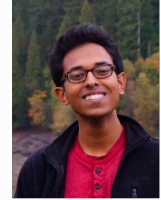
Jack
Rubien '20



Jonathan
Solomon '20



Haley
Gerardi '17



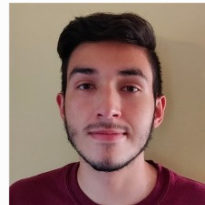
Aqil
MacMood '20



Nikhil
Tignor '24



Rain
White '24



Brandon
Daniel-Morales '24



NSF 1710875



NSF 2142074



Maya
Tipton '23



Gwendolyn
Rak '22



Nathaniel
Peters '18



Angelina Tjia '26



Drake
Roth '25



Lundy
Zheng '26



Wilber Valente-
Gutierrez '28



Carlos
Benavides '28



IPLS outcomes

IPLS students:

- Gain enduring interest and sense of relevance of physics to biology (1+ years after course ends)
- Display enduring skill and concept learning

Crouch, Wisittanawat, Cai, and Renninger, Phys Rev PER 14, 010111 (2018).

Geller, Turpen, and Crouch, Phys. Rev. PER 14, 010118 (2018).

Rak, Geller, and Crouch, poster at PERC 2020.

Geller, Tipton, Crouch, et al, Phys. Rev. PER 18, 010131 (2022).

Geller, Rubien, Hiebert, and Crouch, Phys. Rev. PER 18, 010120 (2022).

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*Research question
(affective/motivational outcomes):
How do the elements of Swarthmore's
IPLS course contribute to building
“physics affinity”?*



“Physics affinity”

- ❖ Self-efficacy
- ❖ Interest in physics
- ❖ Relevance of physics to the life sciences

Surveyed students pre-post

H. Fencil and K. Scheel, AIP Conf. Proc. 720, 173 (2004).

Michaelis and Nathan, 2015 ASEE Annual Conference and Exposition Proceedings (2015).

Hall, Watkins, Coffey, Cooke, and Redish, arXiv:1105.6349 (2011).

Experience check-in surveys

Multiple times during semester

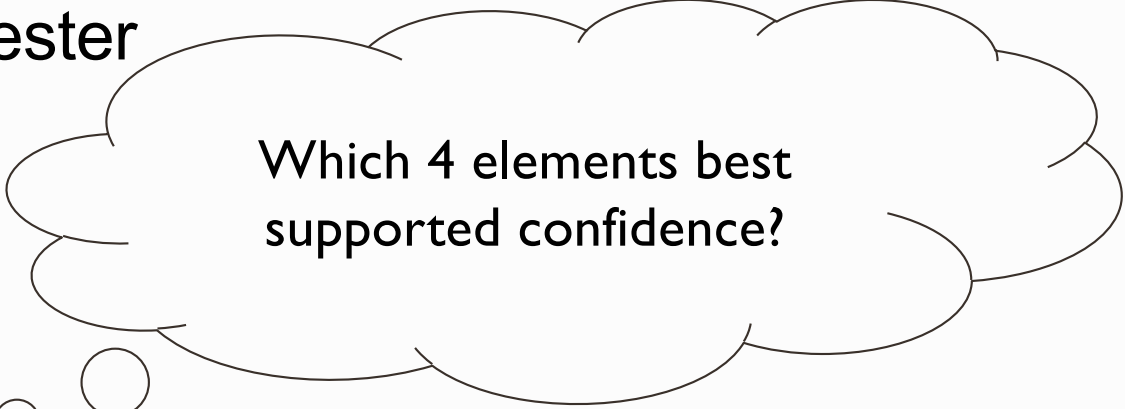
Course Element List

☐ Homework problems
analyzing biological systems

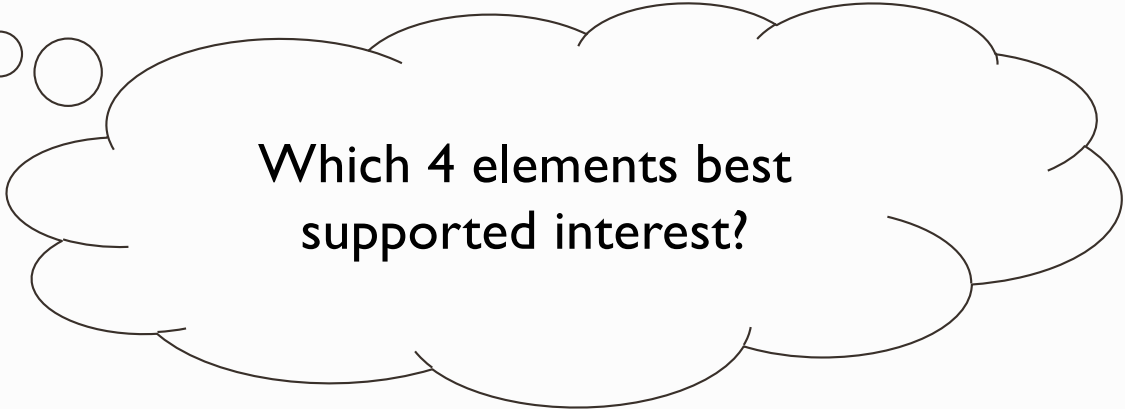
☐ The opportunity to get
help from the instructor
during office hours

.....

10 items total



Which 4 elements best
supported confidence?



Which 4 elements best
supported interest?

Followed up with case study interviews

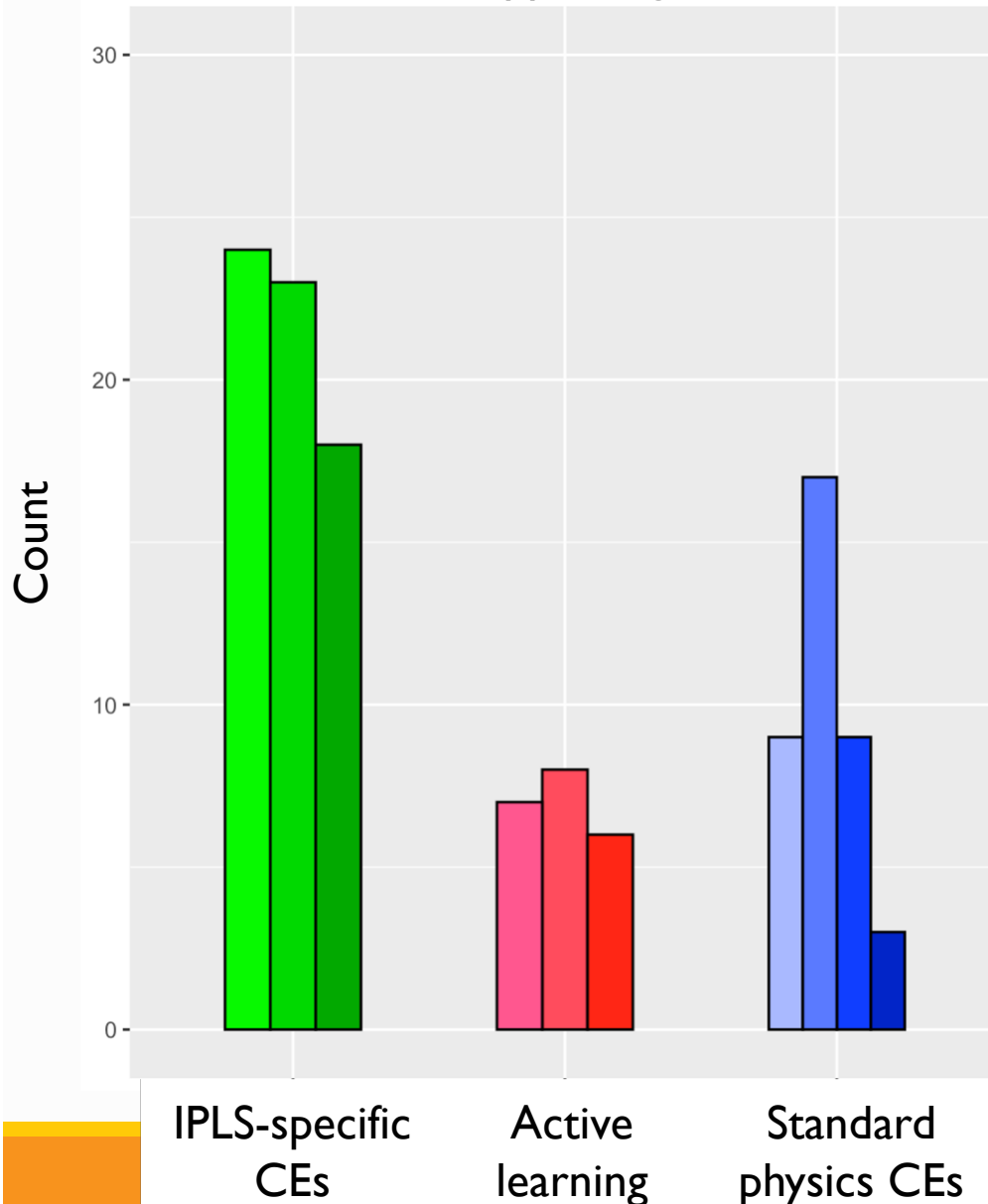


Spring Y2 Results

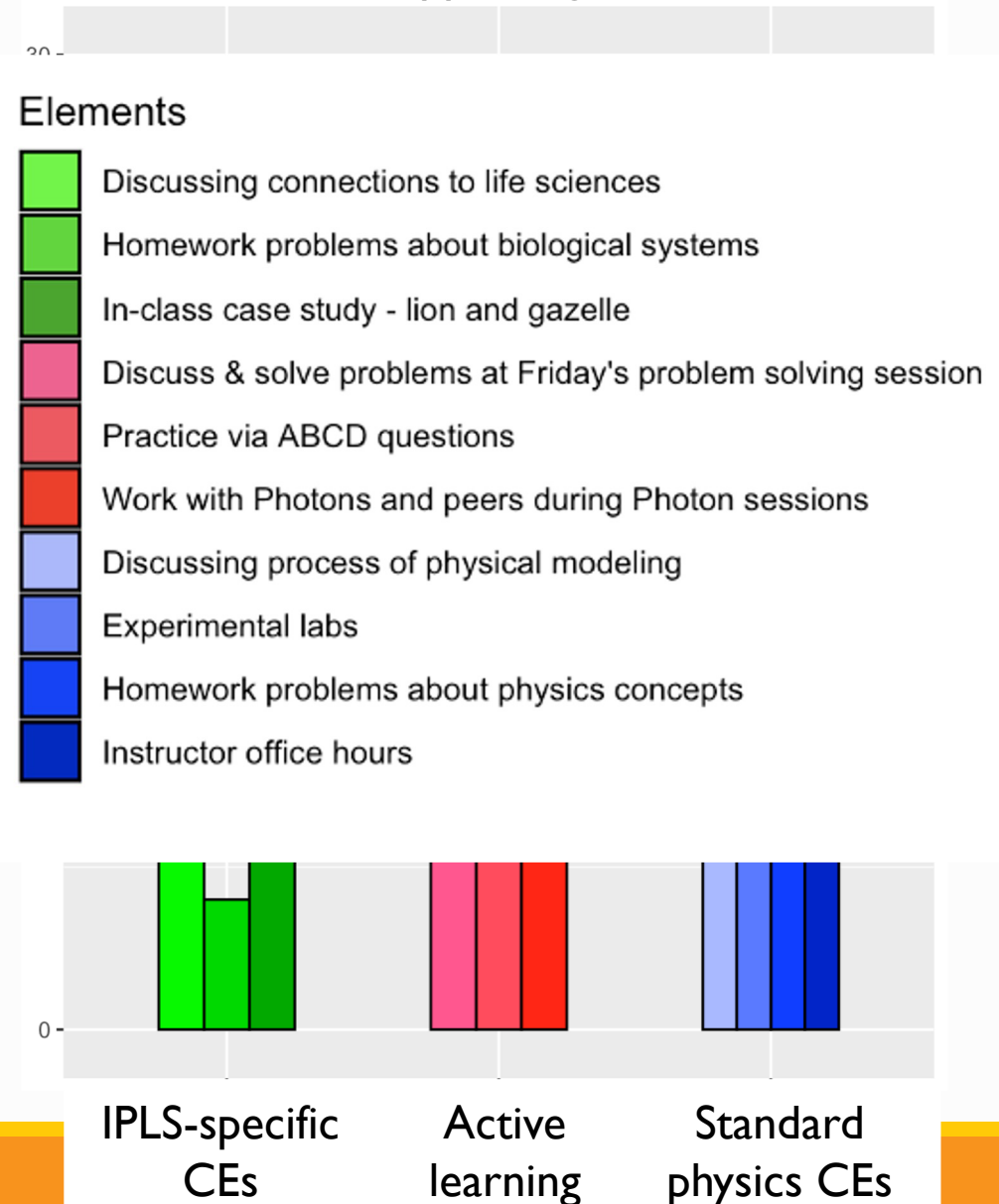


Zheng *et al*, “Key Features of a Successful IPLS Course Ecosystem,” PERC 2024

Elements Supporting Interest



Elements Supporting Confidence



**Challenge: multiple instructors,
variation in student responses**

How do we analyze results from different
instructors with different approaches?

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Framework for characterizing IPLS courses

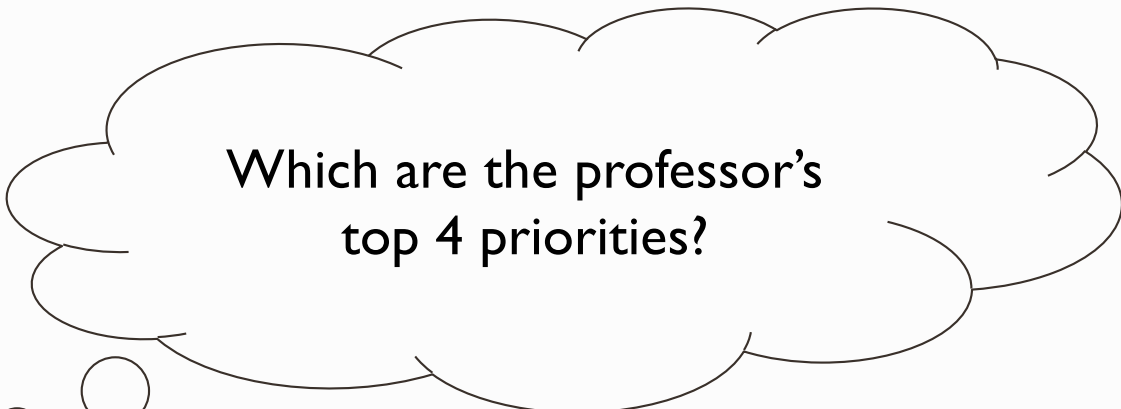
1. Instructor artifacts
 - a. Observing classes
 - b. Course materials
 - c. Instructor interviews
2. Experience check-in questions, followed up in case study interviews
 - a. Supporting confidence and interest
 - b. “Instructor priorities”

Instructor Priorities Checklist

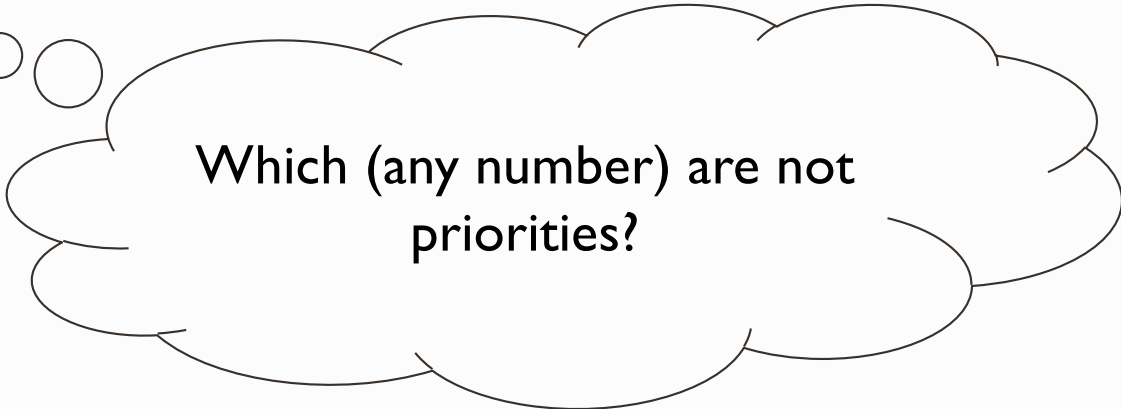
- ☐ Helping students develop problem solving skills
- ☐ Conveying excitement about physics as a science

.....

12 items total



Which are the professor's
top 4 priorities?



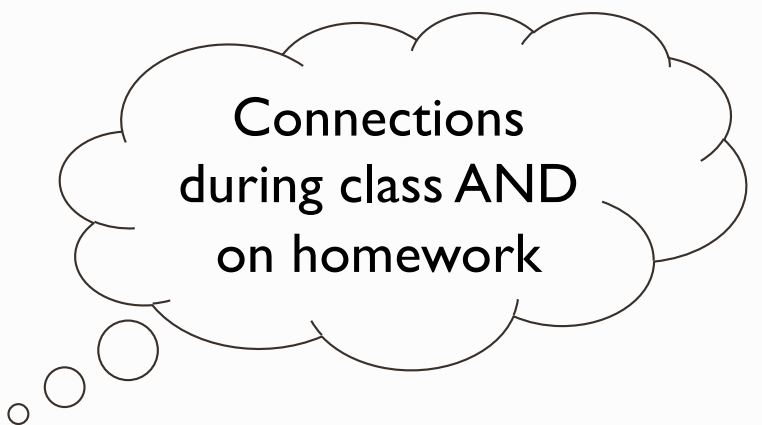
Which (any number) are not
priorities?

Framework for characterizing IPLS course ecosystems

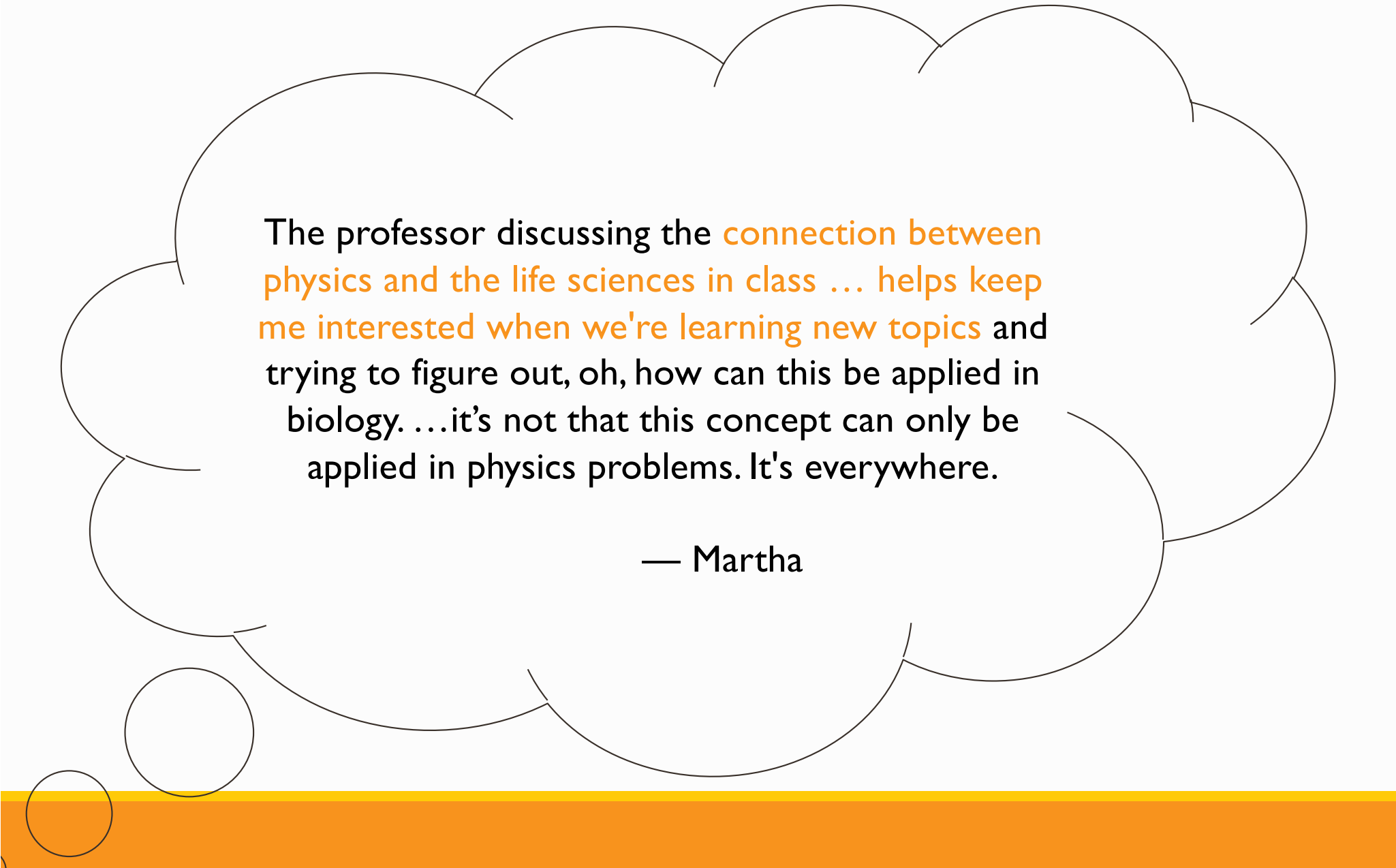
1. Use of life science content
2. Supporting novice learning in physics
3. Belonging and care

Framework

- I. Use of life science content
 - a. in which parts of the course
 - b. how frequently, consistently
 - c. how it is framed



Connections
during class AND
on homework

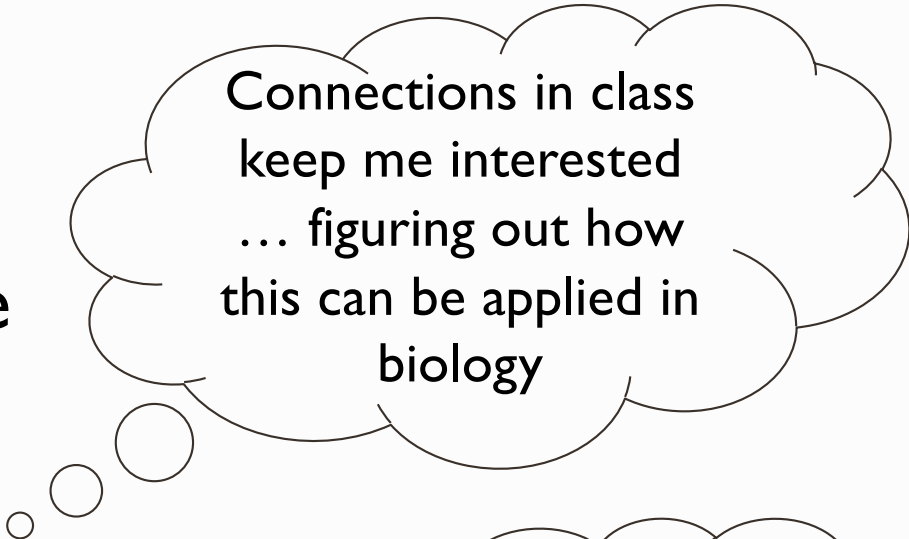


The professor discussing the connection between physics and the life sciences in class ... helps keep me interested when we're learning new topics and trying to figure out, oh, how can this be applied in biology. ...it's not that this concept can only be applied in physics problems. It's everywhere.

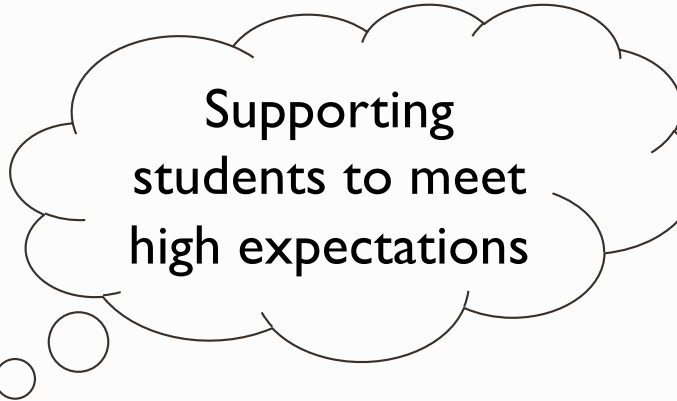
— Martha

Framework

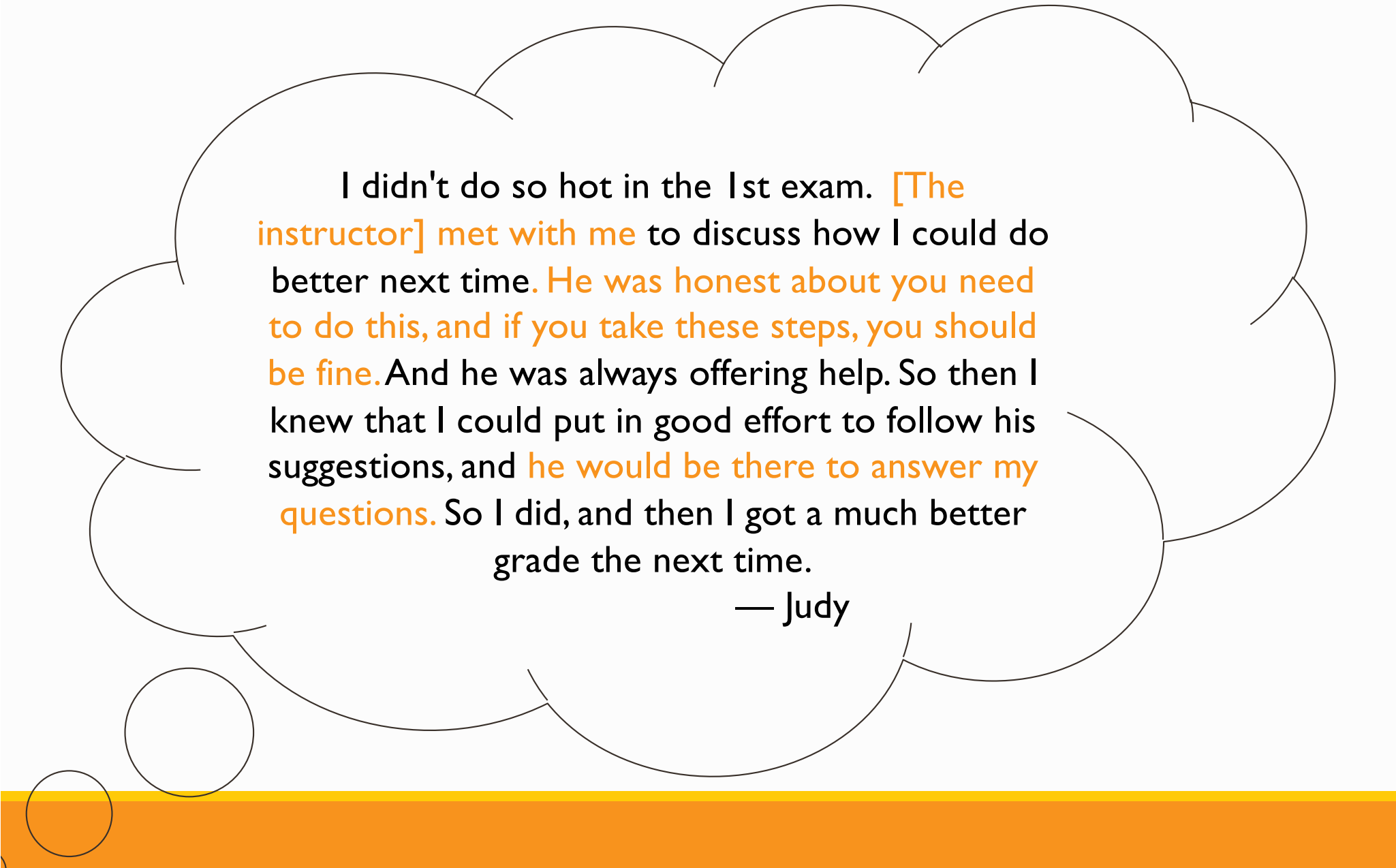
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 - b. how frequently, consistently
 - c. how it is framed
2. Supporting novice learning in physics
 - a. Developmental instruction
 - b. Clear expectations with support
 - c. Attend to non-LS interest development



Connections in class
keep me interested
... figuring out how
this can be applied in
biology



Supporting
students to meet
high expectations

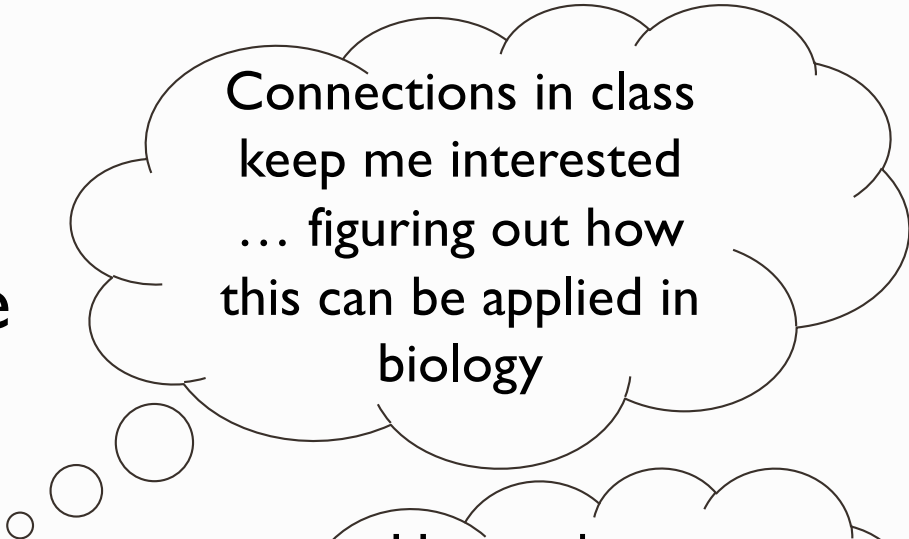


I didn't do so hot in the 1st exam. [The instructor] met with me to discuss how I could do better next time. He was honest about you need to do this, and if you take these steps, you should be fine. And he was always offering help. So then I knew that I could put in good effort to follow his suggestions, and he would be there to answer my questions. So I did, and then I got a much better grade the next time.

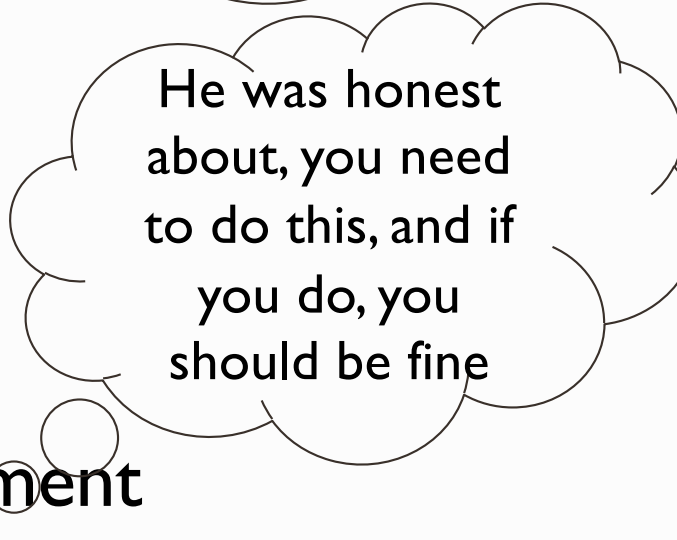
— Judy

Framework

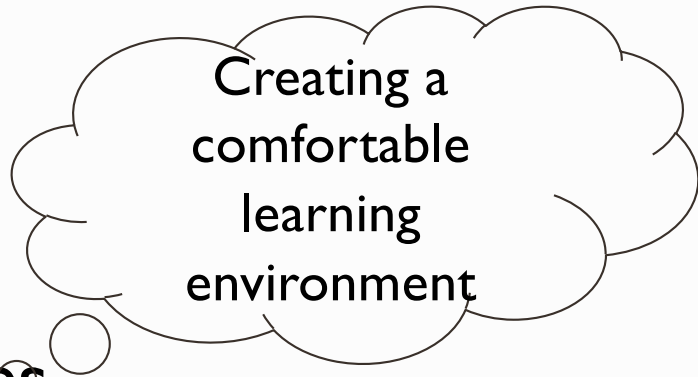
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3. Belonging and care
 - a. Messaging about belonging
 - b. Patient, encouraging instructor
 - c. Warm relationships with classmates



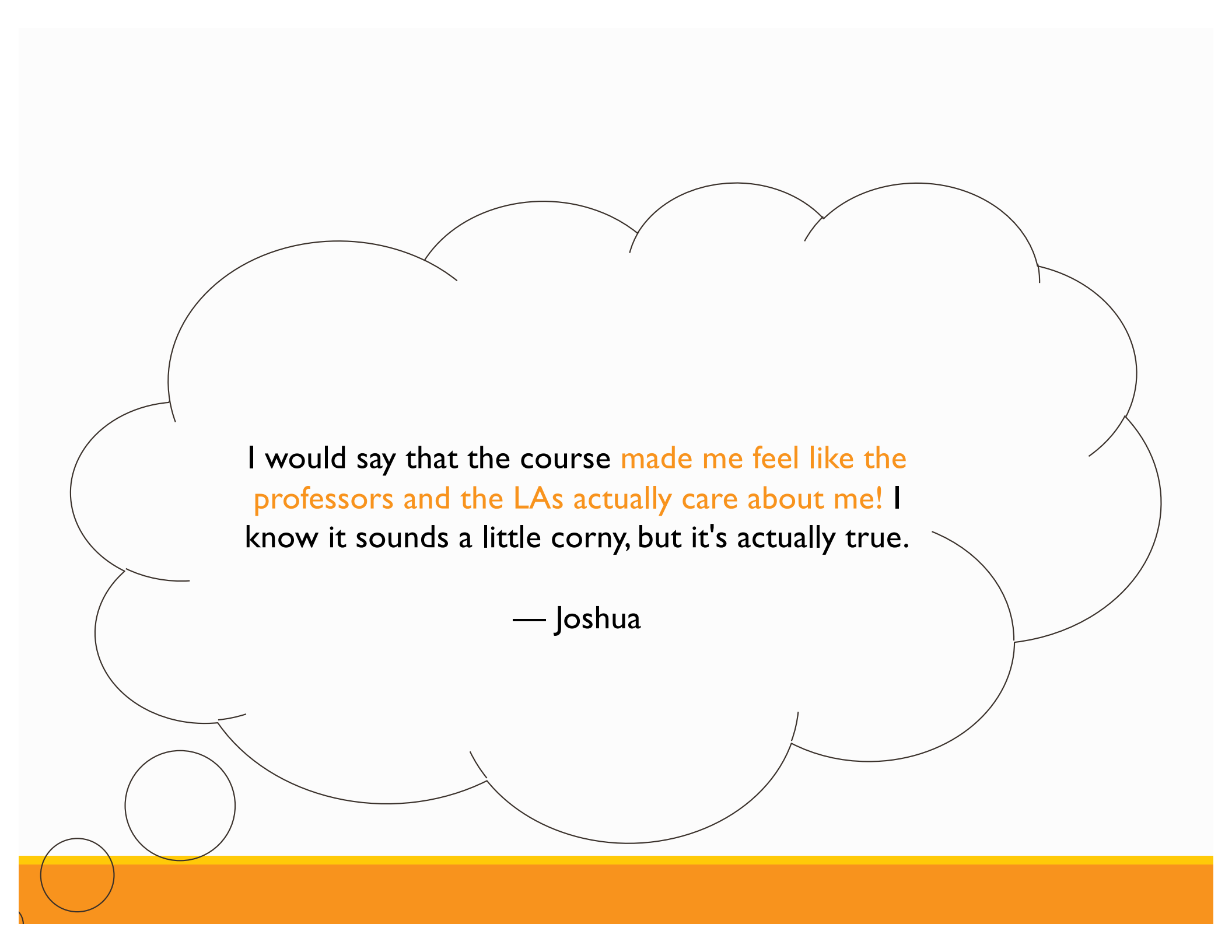
Connections in class
keep me interested
... figuring out how
this can be applied in
biology



He was honest
about, you need
to do this, and if
you do, you
should be fine



Creating a
comfortable
learning
environment



I would say that the course **made me feel like the professors and the LAs actually care about me!** I know it sounds a little corny, but it's actually true.

— Joshua

Using the framework

Characterize and distinguish IPLS offerings

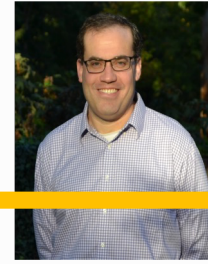
- ❖ Different courses
- ❖ Different instructors of same course
- ❖ Changes made to a given course

Understand how differences in physics affinity outcomes emerge from implementation

We invite your input and feedback!



Thanks to ...



NSF 2142074
(Geller PI)



Lundy
Zheng '26



Wilber Valente-
Gutierrez '28



Carlos
Benavides '28

Poster today (MAR-H00-07)
2-3:30 PM: “Physics affinity
development during IPLS”

Project scientist: K. Ann Renninger (Swarthmore Educational Studies)

Advisors:

Andrew Boudreaux, Eric Brewe, Isaura Gallegos, Eric Kuo, Tim Nokes-Malach, Laura Rios

Collaborators/instructors:

Lili Cui, Natasha Holmes, Stephen Hackler, Eleanor Hodby, Jeff Hyde, Steve Pollock, Alfredo Sanchez, Dan Young, Charlotte Zimmerman