

Interactive Online Interventions for improving belonging and performance in introductory physics

KATHY KOENIG, ALEX MARIES

UNIVERSITY OF CINCINNATI

ROBERT TEESE

PROFESSOR EMERITUS, ROCHESTER INSTITUTE OF TECHNOLOGY



Rationale for Interactive Online Interventions (IOIs):

Calculus-based Intro Physics

- primarily in-coming engineering majors
- 16 sections of 135 each/yr (~2000 students)
- Lab and recitation taught by graduate TAs

Wide variation in students' academic preparation, motivation, mindset, etc.

Wide variation in approaches to teaching, willingness to teach beyond content, etc.



Supplement with resources to personalize instruction and attempt to level the playing field.

Interactive Video-Enhanced Tutorials (problem solving): compadre.org/IVET

Sense of belonging

- Feelings of inclusion in a community (learning environment)
- Can impact students' motivation for learning and self-efficacy
- Belonging uncertainty more likely during transition to college



Freeman, Scott, et al. "Active learning increases student performance in science, engineering, and mathematics." *PNAS* 111.23 (2014): 8410-8415.

Theobald, Elli J., et al. "Active learning narrows achievement gaps for underrepresented students in undergraduate science, technology, engineering, and math." *PNAS* 117.12 (2020): 6476-6483.

Create 4 Interactive Online Interventions (IOIs)

SS25: Launched 3 IOIs as pilot in intro calculus-based physics ($n = 800$)

FS25 & SS26: Launched 3 revised + 1 new IOI

Yeager, David S., and Gregory M. Walton. "Social-psychological interventions in education: They're not magic." *Review of educational Research* 81.2 (2011): 267-301.



Create 4 Interactive Online Interventions (IOIs)

SS25: Launched 3 IOIs as pilot in intro calculus-based physics ($n = 800$)

FS25 & SS26: Launched 3 revised + 1 new IOI

RQ1: What is the **impact** of an intervention (online vs in-person) on students' sense of belonging and achievement in introductory physics?

- Use belonging survey (pre/post) and exam scores

RQ2: To what extent is the impact in RQ1 moderated by student demographics and the use of EBAE strategies by the instructor?



Week 1 IOI: What Worries You?

Purpose:

Assist students in reframing concerns as normal and surmountable.

In-class Version: Two questions projected on screen

What are you concerned about in terms of college, this course, your major, etc?

How do you think these concerns will change over time?

3-5 minutes at end of First Class

Provide quarter sheet of blank paper, Anonymous

Submit on way out the door, no credit given

Share results & quotes from student testimonials (next class)

Show students the common concerns that emerged:

~60% not smart enough/do not have *right* knowledge/others smarter

~50% time management/keeping up with classes

~20% not being successful

~15% finding friends

~5% concerned cost

Concerns will change

As I get in a rhythm

Through practice, experience, hard work

If I set up good habits

Take-away message:

We share many of the same concerns.

We are ALL in this together.

I stay focused

As I figure things out

Work with classmates

I don't expect things to get better

Online Intervention: *What worries you?*



[← Back to Previous Page](#)

Options ▾

[Continue to Next Page →](#)

Hosted by sciencetutorials.net

[Credits](#)

Copyright © 2021, [RIT](#)

This material is based in part upon work supported by National Science Foundation (NSF) grant [DUE-2416548](#). Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.



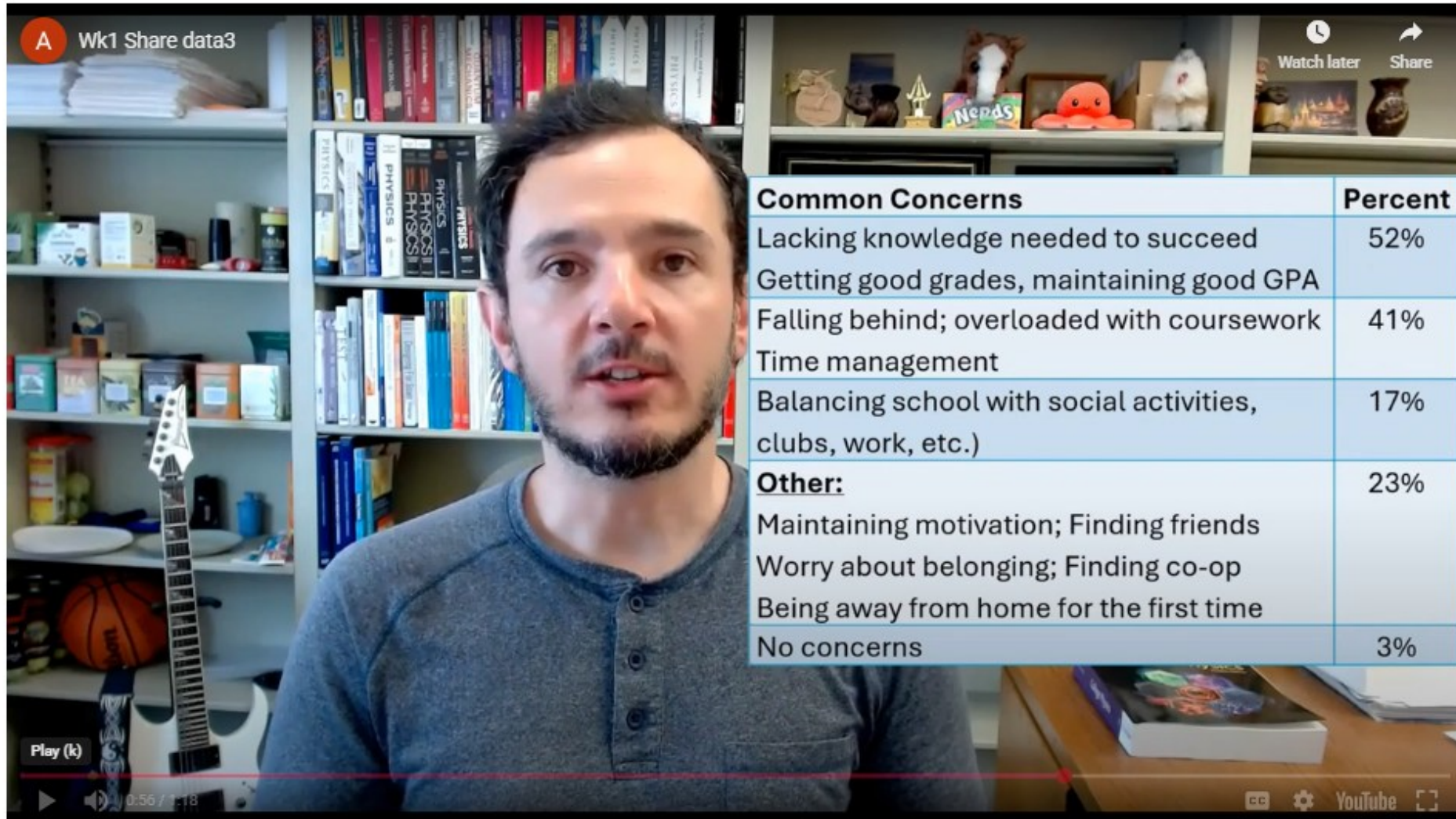
In the textbox, type a few sentences about how your worries will get resolved over time.

Enter your answer here

Next, Alex shares data from prior semesters

What Worries You?

Interactive Video Vignettes



A man with a beard and dark hair, wearing a grey button-down shirt, is speaking directly to the camera. He is in a room with bookshelves filled with books and various items in the background. A white electric guitar is visible on the left side of the frame. The video player interface shows a title 'Wk1 Share data3' and a 'Play (k)' button. A table of 'Common Concerns' is overlaid on the right side of the video.

Wk1 Share data3

Watch later Share

Common Concerns	Percent
Lacking knowledge needed to succeed	52%
Getting good grades, maintaining good GPA	
Falling behind; overloaded with coursework	41%
Time management	
Balancing school with social activities, clubs, work, etc.)	17%
Other:	23%
Maintaining motivation; Finding friends	
Worry about belonging; Finding co-op	
Being away from home for the first time	
No concerns	3%

Play (k)

0:56 / 1:18

CC YouTube

Select the video you would like to watch first, then click the *Next Page* button.



**Meet Nathan,
Computer Engineering senior.**



**Meet Allison,
Mechanical Engineering senior.**

[← Back to Previous Page](#)

Options ▾

[Continue to Next Page →](#)

Nathan discusses his challenges transitioning to college and strategies he used to overcome them.



[← Back to Previous Page](#)

Options ^

[Continue to Next Page →](#)



Think back to the concerns you wrote earlier. In the textbox below, write at least two specific actions you plan to take immediately to help address those concerns.

Enter your answer here

← Back to Previous Page

Options ▾

Continue to Next Page →

Research Focus Past 12 months

How do students engage with the IOIs?

Goal: Use findings to continue to revise IOIs.

1. Analyze written responses from intervention

- Compare In-person responses on paper to IOI textboxes

2. Video viewing time and choices within IOI

- Analyze log files for patterns of student behavior

Some concerns about using IOI for interventions:

Not Anonymous

Not timed

Typed responses

Submit for completion credit

Analyzing the written responses: Paper

1. I'm
people on
time this
going to

2. I t
with

1) I'm scared of failure/inadequacy, burning out, or having taken on more than I can handle. Maybe I'm not cut out for my major, who knows?

2) Maybe they won't, but if that's the way it is, maybe I belong on a different path. But I'm going to try my best, and that's all I can do.

I'll manage my
gh time to
stuff?
ajor for me.
also a firm
b an but I'm
k on.

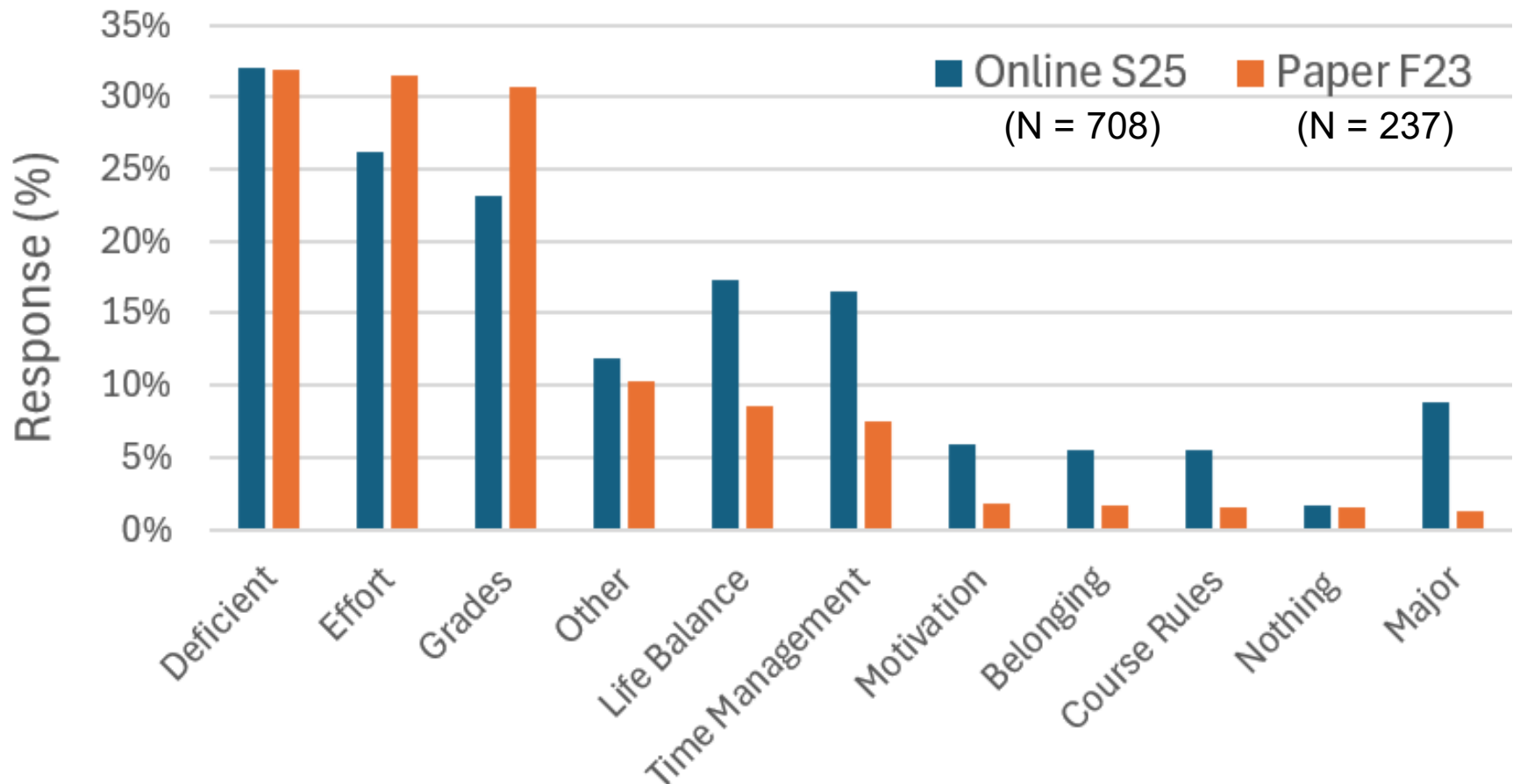
Analyzing Textbox Responses: IOI

In the textbox, type a few sentences about what you are most concerned or worried about right now.

I'm worried about not being able to keep up with everyone else and falling behind even though I put in the work. I also worry that I won't be able to make friends in my classes and I am concerned as to whether I chose the right major.

Textbox responses were downloaded into an Excel log file for analysis.

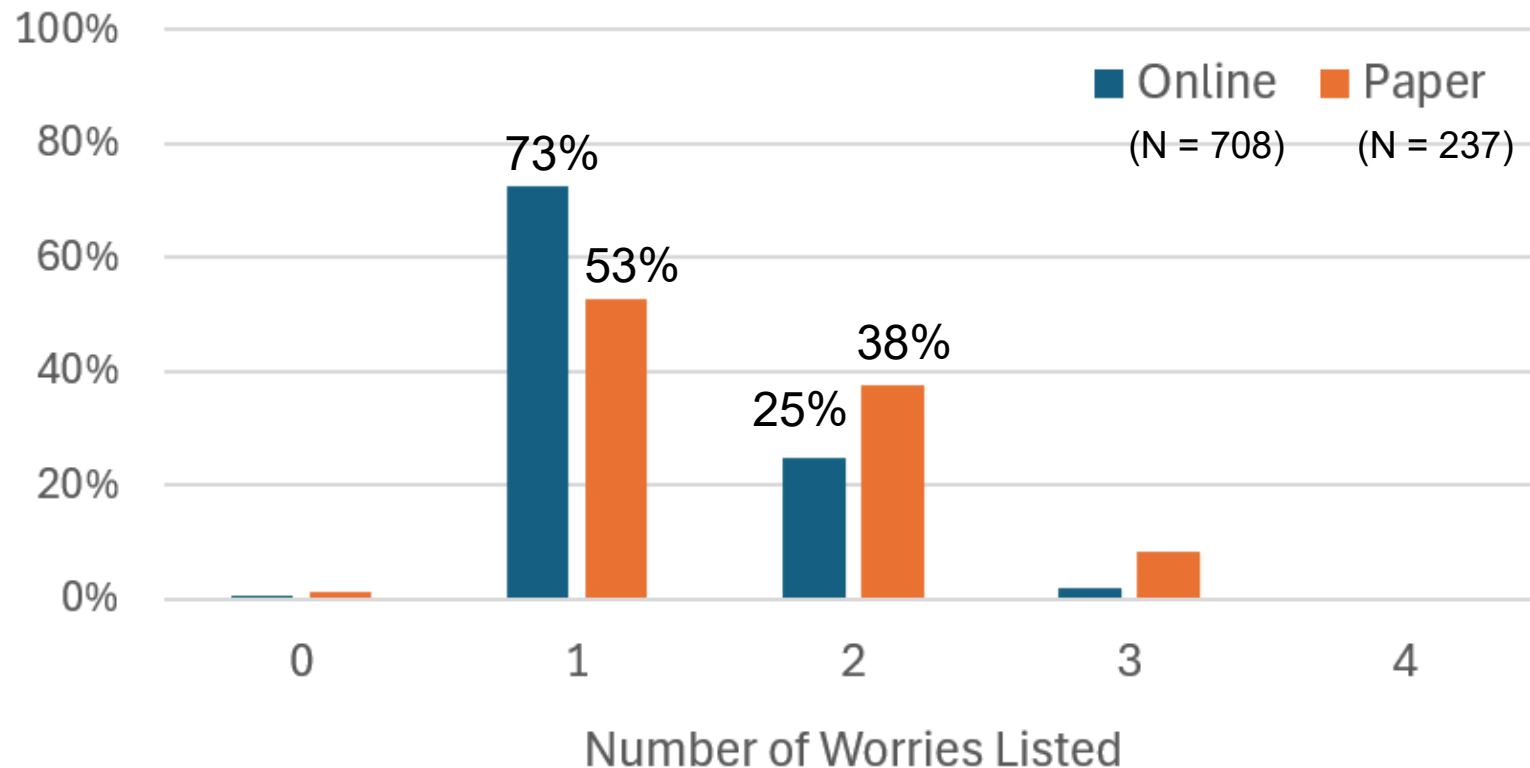
Distribution of Worries



Note: S25 IOI students were in their 2nd semester of college.

Average Wordcount: IOI = 24.7; Paper = 21.6

Number of Worries Listed



IOI revision: Students are now encouraged to write down multiple worries.

Engagement with Textboxes

Week 1: What Worries You? IOI included three textboxes:

What are you worried about right now?

How will these worries get resolved?

What are two actions you can take immediately to address concerns?

High Textbox Completion Rates:

98% completed all three textboxes with appropriate responses

1% completed two of the three textboxes with appropriate responses

Patterns of Student Behavior within IOI

Log File Analysis

1. Textbox responses

- 98% completed textboxes with appropriate responses

2. Branching choices (ex. student testimonial selected)

- appear to choose testimonial based on major

3. Time spent viewing videos

Video Time Log Analysis (SS25)

What Worries You? IOI - 4 videos essential to IOI messaging

Video Length (min)	Video Description
3:36	Student data shared: “What worried about right now?”
0:45	Nathan or Allison Testimonial (picture voiceover)
3:08	Narrator Testimonial (Alex and grad school)
1:45	Wrap Up – Action Steps

*Did not include videos that had textboxes in above analysis

Video Time Log Analysis (SS25)

What Worries You? IOI - 4 videos essential to IOI messaging

Video Length (min)	Video Description
3:36 1:40	Student data shared: “What worried about right now?”
0:45 0:40	Nathan or Allison Testimonial
3:08 2:00	Narrator Testimonial (grad school)
1:45 1:30	Wrap Up – Action Steps



Identified minimum viewing time needed to hear message.

Video Time Log Analysis (SS25)

What Worries You? IOI - 4 videos essential to IOI messaging

Watched Minimum	Video Description
54%	Student data shared: “What worried about right now?” (1:40)
17% , 37%	Nathan or Allison Testimonial (0:40)
37%	Narrator Testimonial (grad school) (2:00)
34%	Wrap Up – Action Steps (1:30)

Video Time Log Analysis

What Worries You? IOI - 4 videos essential to IOI messaging

# Videos Watched to Minimum Time	Percent of Students
0	35%
1	17%
2	14%
3	15%
4	19%

IOI Revision: Need to focus on how to engage students in videos.

SS25 IOI Design: Used Lightboard in PER Lab

What Worries You?

Interactive Online Interventions



- New, unfamiliar experiences
- Isolation

[← Back to Previous Page](#)

Options ▾

[Continue to Next Page →](#)

Lessons Learned & Next Steps

1. High engagement when asked to do a task

- 98% completed textboxes and took them seriously (similar to paper)

2. Students tend to skip videos, even short ones

- Revise script to include a **“need to know”** from a video (take notes)
- **Revise videos:** clarify purpose; convey “we care”; connect to UC/course; use student narrators to engage peers; use faculty for *research* slides

3. Choices driven by topic

- Most selected videos: testimonials by students in similar majors & exam prep strategies

Psychological Interventions to Enhance Belonging, Growth Mindset and Metacognition

2. Saying is Believing (2nd or 3rd week of class)

Purpose: Reinforce messages from first activity.

- Students hear testimonials from upper-class students about their own struggles and specific strategies they used to overcome them.
- Use advice to write a letter to a future student facing a similar situation. Letter is uploaded to Canvas for completion credit.

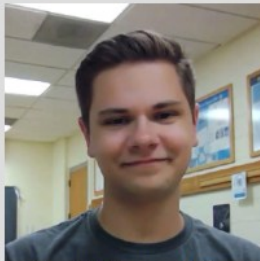


Psychological Interventions to Enhance Belonging, Growth Mindset and Metacognition

Saying is Believing (second week of class)

Purpose: Reinforce messages from first activity.

- Students hear testimonials from upper-class students about their own struggles and specific strategies they used to overcome them.
- Use advice to write a letter to a future student facing a similar situation.



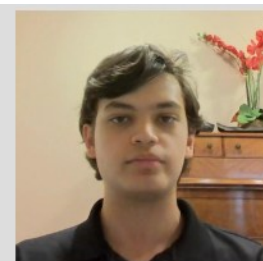
Grant, Physics Major



Pawan, Chemical Engineering



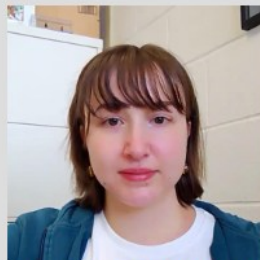
Anna, Aerospace Engineering



Michael, Electrical Engineering



Amit, Biomedical Engineering



Maria, Civil Engineering



Cole, Astrophysics

Psychological Interventions to Enhance Belonging, Growth Mindset and Metacognition

3. Exam Wrapper (after first exam is returned)

Purpose: Guide students in reflecting on exam performance, comprehending mistakes, and formulating strategies for improvement.

- Hear other student testimonials to indicate learning takes time and effort and isn't a measure of capability or talent.
- Learn about strategies that can adopt to improve on the next exam.

4. End-of-Term Reflection (last week of course)

Purpose: Help students interpret overall course performance

- Students reflect on what learning strategies worked or didn't work for them and help them choose new strategies moving forward.

Research Questions – Stay Tuned!

RQ1: What is the **impact** of an intervention (online vs in-person) on students' sense of belonging and achievement in introductory physics?

- Use belonging survey (pre/post) and exam scores

RQ2: To what extent is the impact in RQ1 moderated by student demographics and the use of EBAE strategies by the instructor?

kathy.koenig@uc.edu

compadre.org/ivet (problem solving tutorials)

sciencetutorials.net/IOI/ (psychological interventions)