Student engagement in and out of the science classroom

Brian Frank

Department of Physics and Astronomy

MIDDLE TENNESSEE STATE UNIVERSITY

Collaborators

Leslie
Atkins

Rance
Solomon

Jacquelyn
Colton

Paul
Mittura

Kendra
Hayes

John
Pierce

Engagement **as Means** to an End

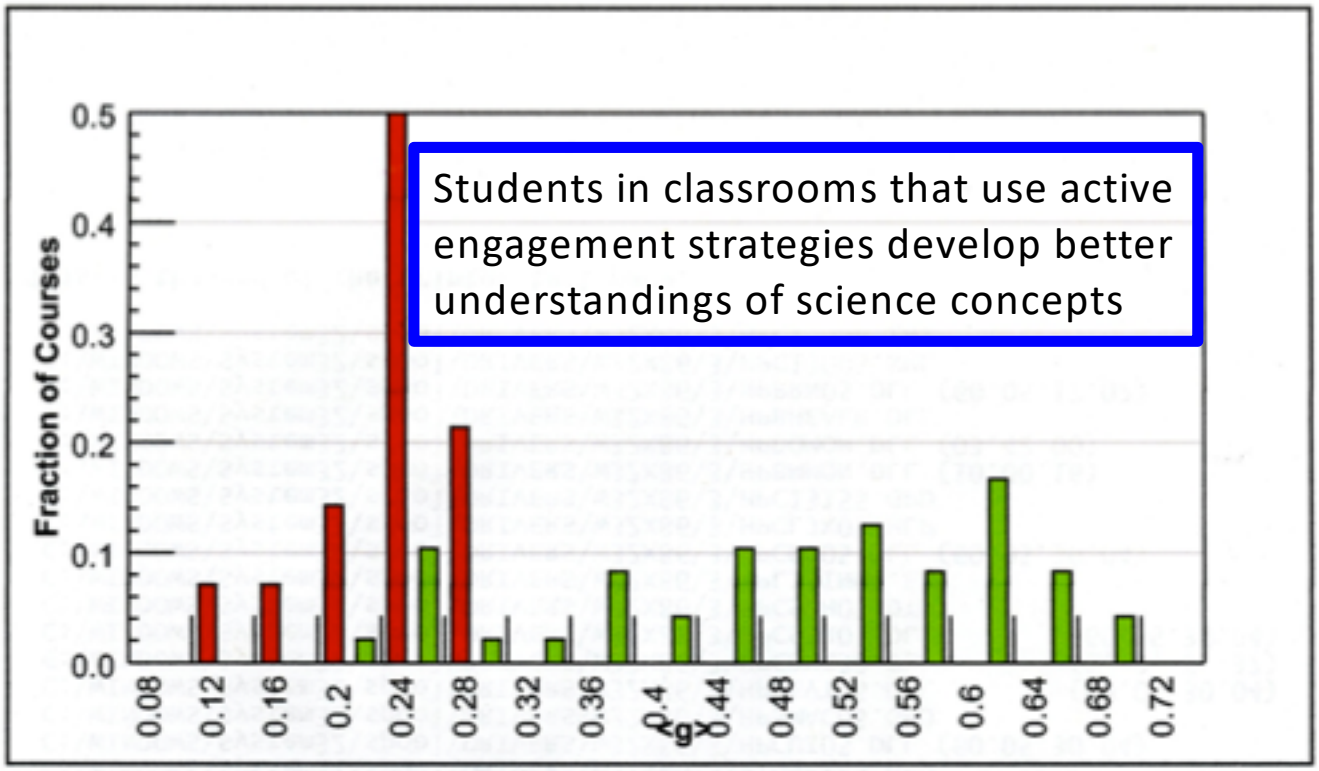


Fig. 2. Histogram of the average normalized gain <g>: dark (red) bars show the *fraction* of 14 traditional courses (N = 2084), and light (green) bars show the *fraction* of 48 interactive engagement courses (N = 4458), both within bins of width $\delta\langle g\rangle = 0.04$ centered on the <g> values shown.

Hake, 1998

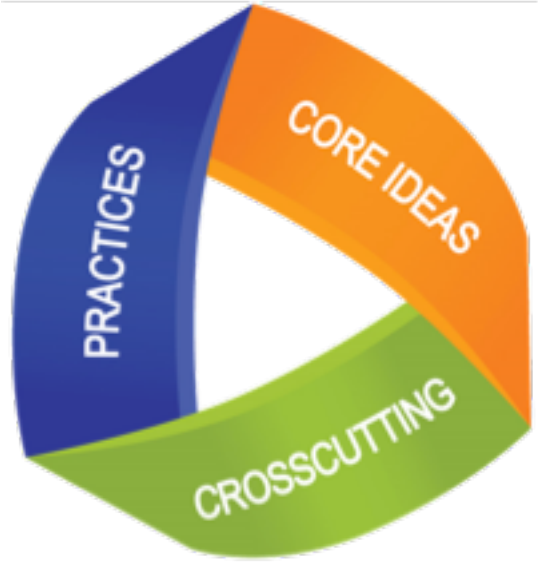
Engagement **in Practices**

Argumentation

Modeling

Ask Questions

…



Engagement as a **Goal**

"Despite the many hours students spend studying math and science, only a few relate to these subjects in a manner that could be described as **advancing their education in a larger sense**—one in which students make a connection to the **subject matter** in such a way that it turns into **a source of inspiration** and **occupies a formative position in the student's life**"

Kozoll and Osborne, 2003

Mark this morning, "Engagement is the goal of teaching."

I was driving home from a friend's house tonight through some low fog to get my neighborhood, and I remembered our discussion about how fog or water vapor can intensify a beam. The fog seemed very thick because my headlights were shining directly on the areas covered with fog, so I turned them off. It wasn't the best idea while driving, but I was surprised to observe the fog itself really wasn’t visible. Then I noticed the moonlight shining on low-lying fog in a nearby field. I thought, "Would the fog appear as thick and defined if the moonlight weren't reflecting off of it?" I got home and decided to use a flashlight outside to see if I could see a beam. To my surprise, I couldn't.

When I was at Walgreen's the other day, I saw some reading glasses and decided to investigate... Right now, our group is working on the idea of how glasses and contacts change the shape of your cornea to balance out a person's misshapen cornea. We thought we could explain it by explaining that people with near-sighted vision need glasses with thicker glass on the sides and that people with far-sighted vision need glasses with thicker glass in the center. However, we only knew what nearsighted glasses looked like. We didn't know what far-sighted glasses (e.g., reading glasses) looked like... And sure enough, the glasses were thicker in the center and as the intensity of the prescription increased, so did the thickness of the center.

Transformative Experiences (TE)

"Students actively using science concepts to see and experience their everyday world in new, meaningful ways." (Pugh, 2004)

- Settings outside of school (free-choice)
- Connections to classroom learning
- Acts of perception / noticing
- Acting on the world because of one's ideas
- Some resolution brought about

An Overview

1. Look at data on student engagement

2. Look at data about who engages out of school

3. Peak inside classrooms that reliably create new interest in science and transfer that engagement outside of school.

Context for Research: College Science

1,000+ students in interactive engagement physics

- Collaborative problem-solving done on whiteboards
- Whole-class discussion around “clicker” questions
- Laboratories focused on data analysis / theory confirm

200+ students in inquiry-based physical science*

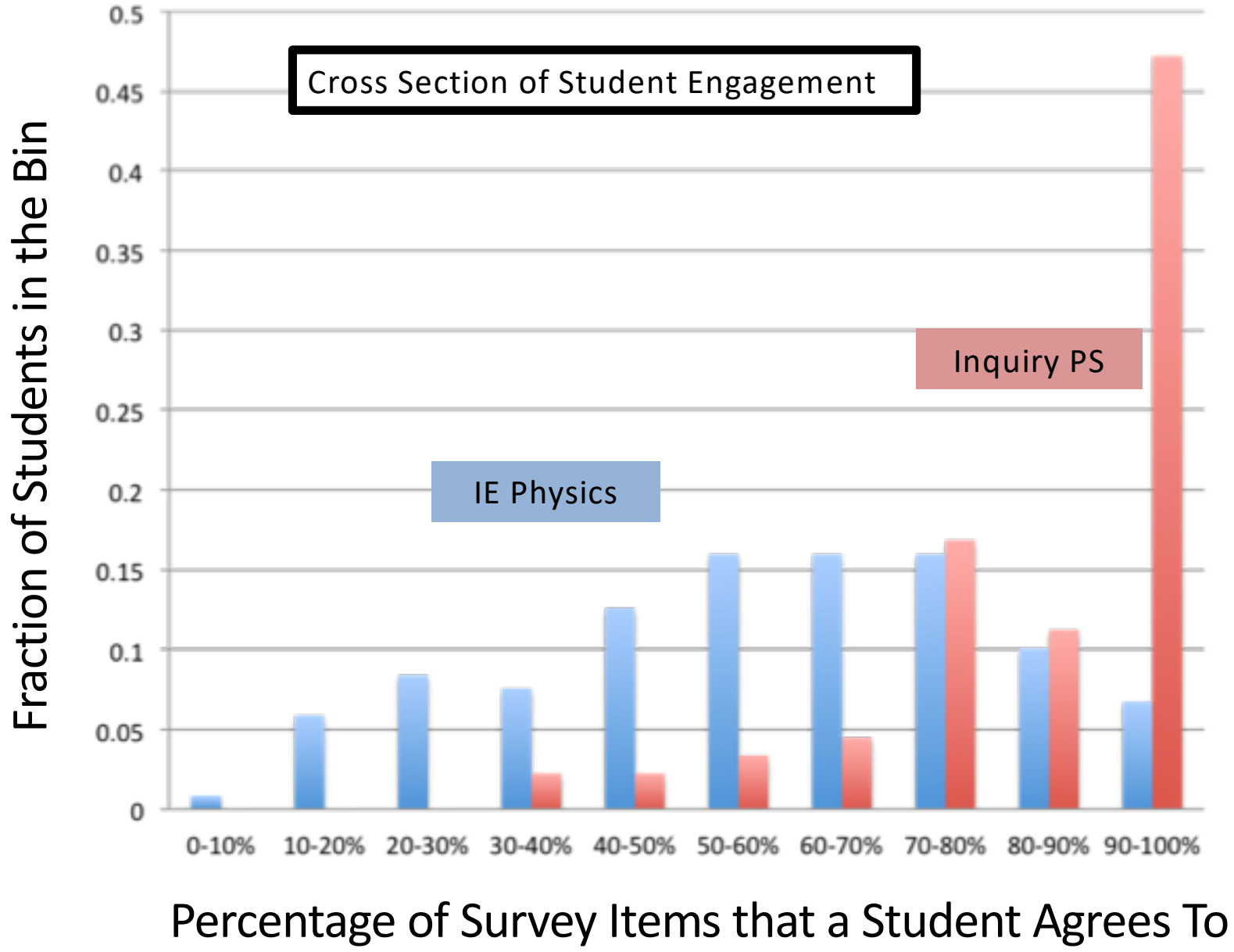
- Broader variety of small-group collaborative activities
- Whole-class discussions more student driven.
- Variety of empirical investigations (nature / purpose)

One Method: Survey of TEs

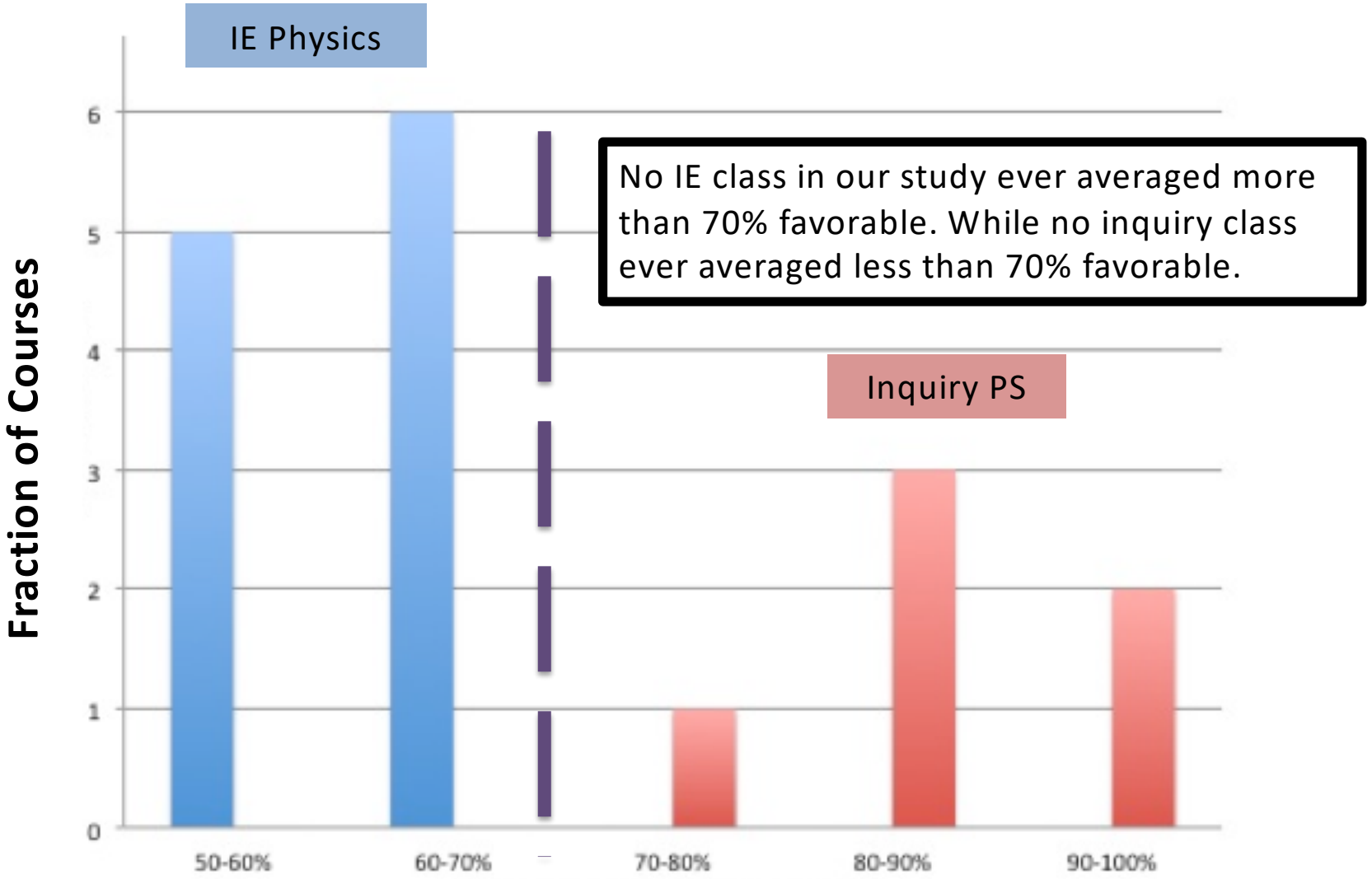
31 items that probe student engagement:

- in-class ("I talk about energy during class".)
- out-of-class ("I talk about energy outside of class.")
- interest ("I think energy is an interesting topic")

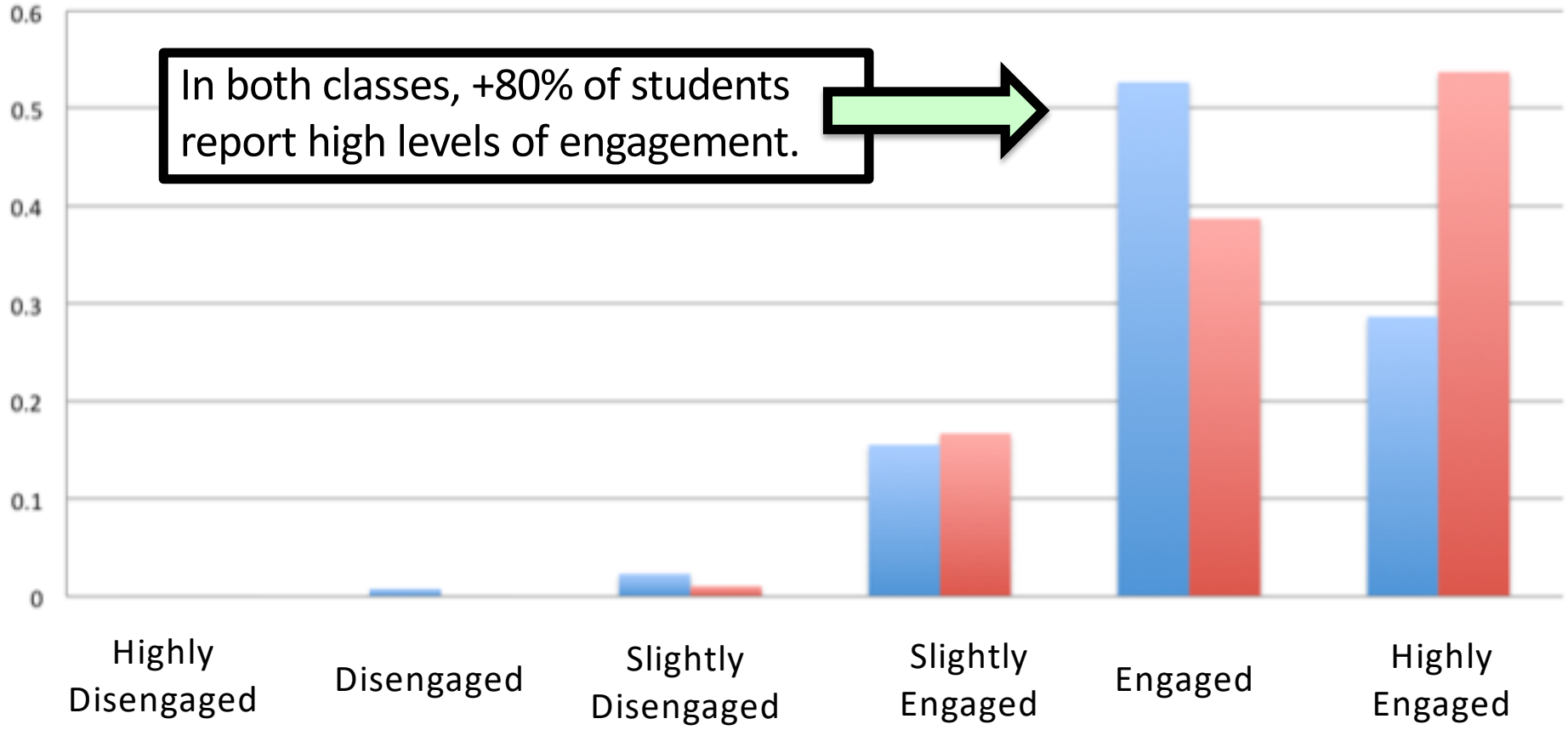
Strongly Disagree	Disagree	Agree	Strongly Agree


Cross Section of Student Engagement
Inquiry PS
IE Physics
Fraction of Students in the Bin
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0-10%
10-20%
20-30%
30-40%
40-50%
50-60%
60-70%
70-80%
80-90%
90-100%
Percentage of Survey Items that a Student Agrees To

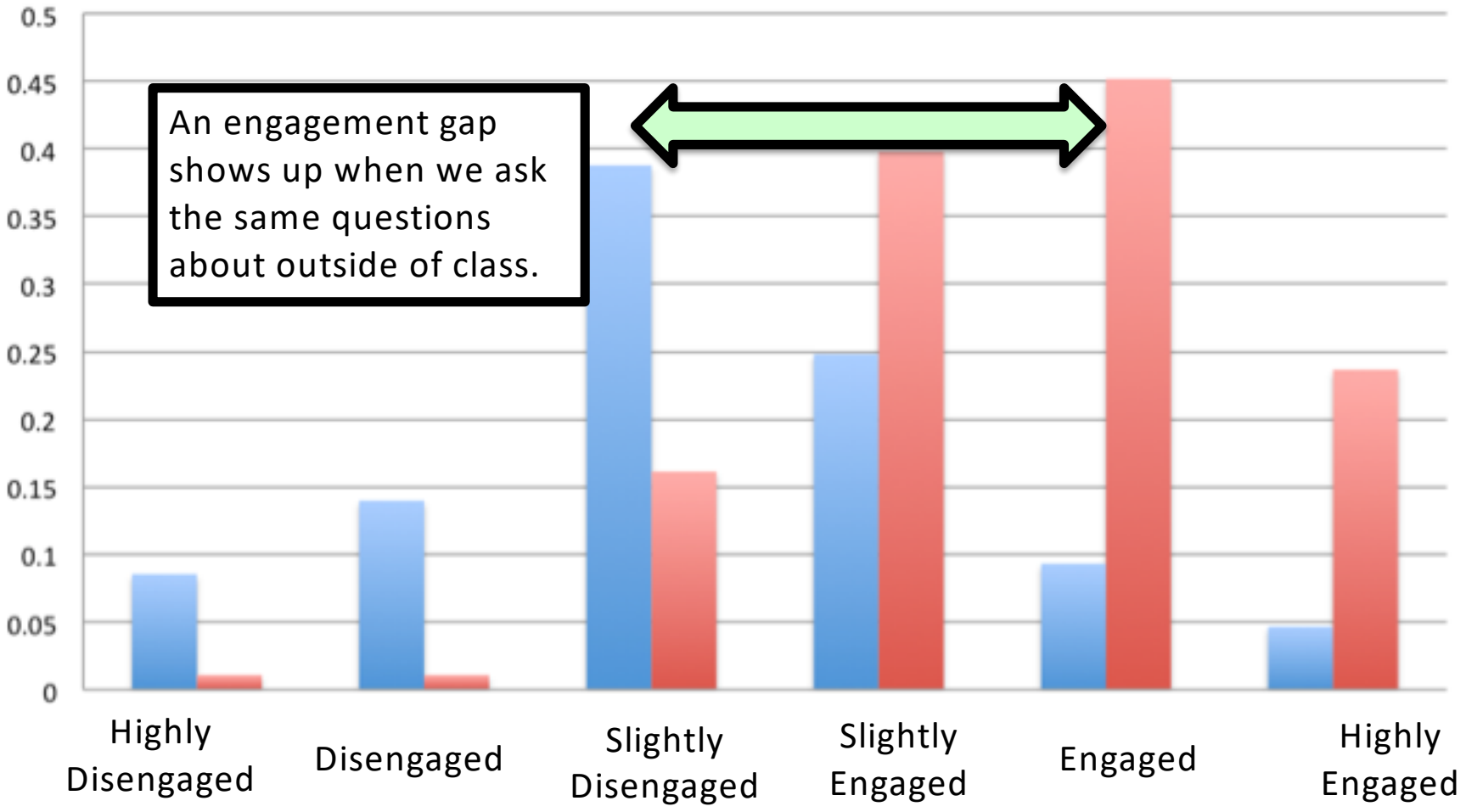
At course-level: Threshold in our Survey Results



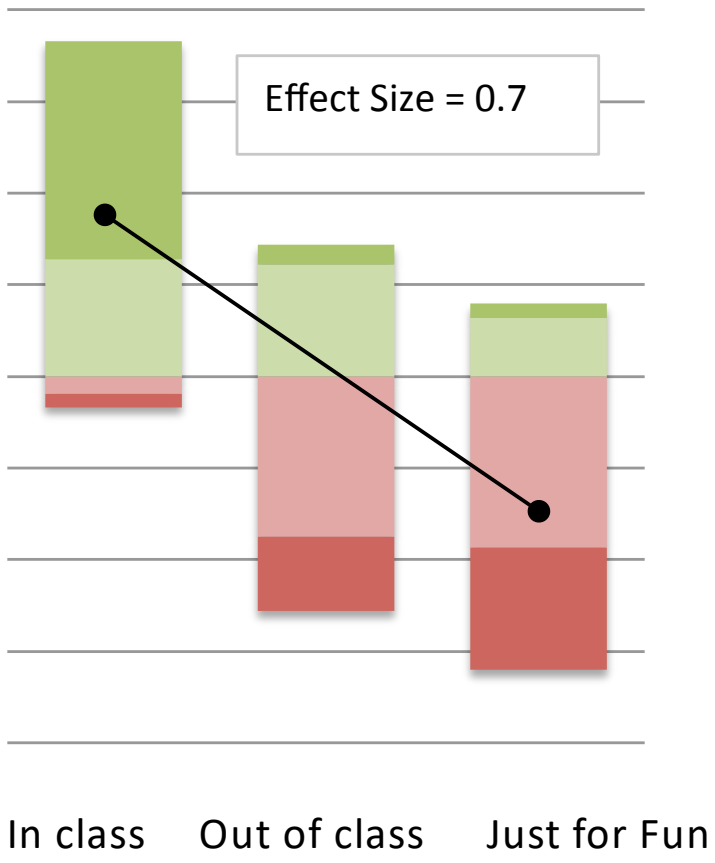
Breaking it Down: In-class Engagement Only



*How engaged are students **out of class**?*



Talking in class, out of class, and just for fun

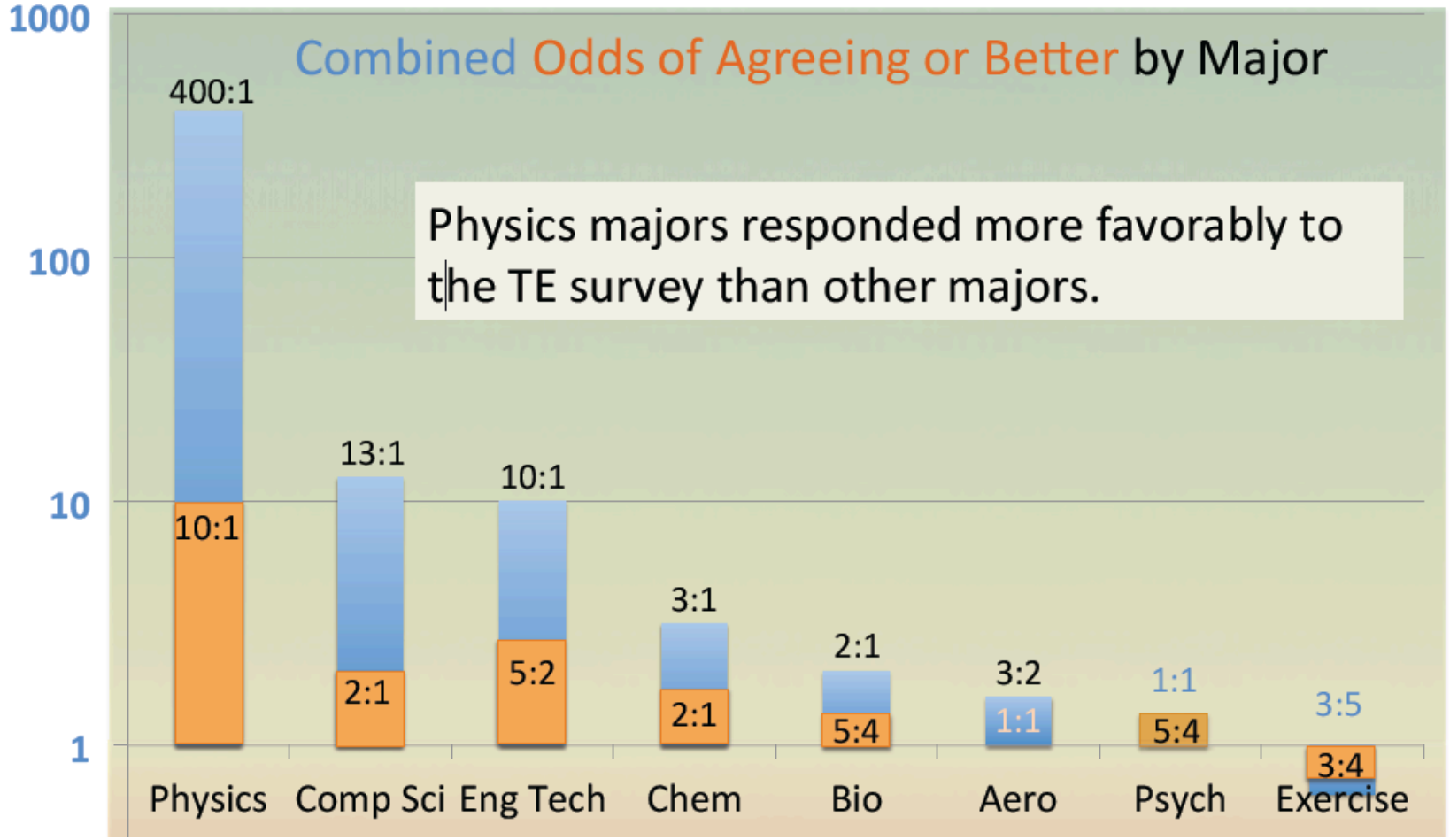


Things I hope your curious about

Who the students are that engage this way.

What kinds of instruction support this engagement

IE Physics: Broken down by Major



Examples: Robert and Harrison

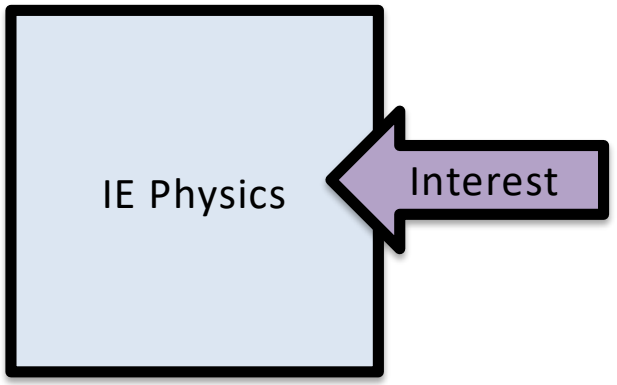
Robert: Double Major in Physics and Chemistry

"Yeah, but not just optics, physics in general, and chemistry for that matter, and mathematics. Any science really. I just love learning about the world… I intentionally surround myself with people like that –people who really want to understand things–and I want to surround myself with people with common goals so we can all discuss.""

Harrison: Biochemistry Major

"**Since I was a kid, you know, I had all these questions**. Well how come if you walk in front of this mirror and you look like your face is this wide, and you walk in front of another one and you're ten feet tall. So, now that I have learned about optics and think about why that is."

Transfer of Interest: In



Students bring various interests into class.

Engagement in class (can) enrich those interests.

Mark this morning talked about three distinct groups of students

1. “Engaged and Eager”
2. “Compliant and Willing”
3. “Disengaged”

Inquiry Physical Science

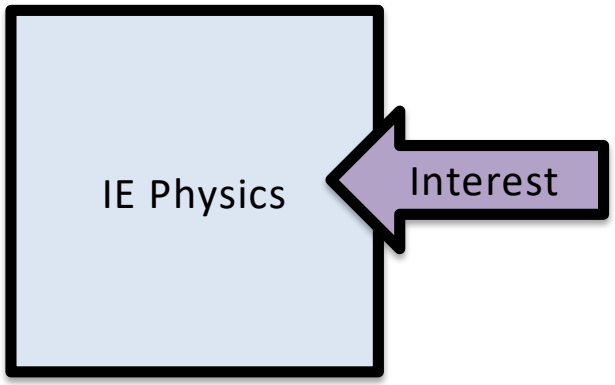
Madison: Elementary education major

"**Not as much as I am now**. I don't know if interested would be the word. **It would be more like I wasn't intrigued,** is that a better word? Now when I see something, I question it. Before, you know, you may just kind of question it a little bit, or why it's working and just walk away. **But now, I have to know,** why those colors are there, or I'll look at the moon and go okay tomorrow it's going to be here."

Lauren: Elementary education Major

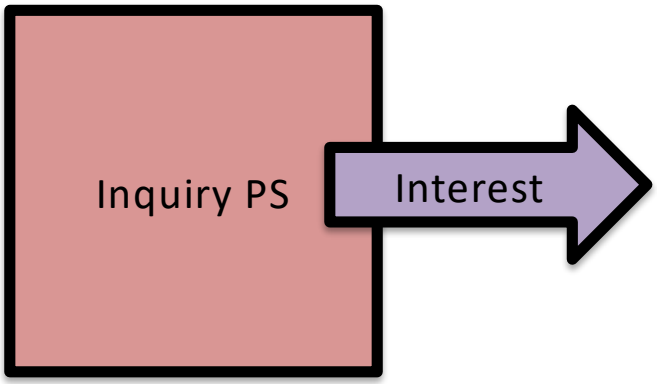
No, definitely, definitely not. Never in a thousand years would I thought that I would actually like science. Our class always felt like a breath of fresh air. Yes we would be learning a lot but it wasn't, I don't know, it didn't feel like school. I just felt like actual learning. **I never liked science before**. I didn't realize that I actually could relate to it. Like the moon, I didn't realize I could actually care about that…

Transfer of Interest: In vs. Out



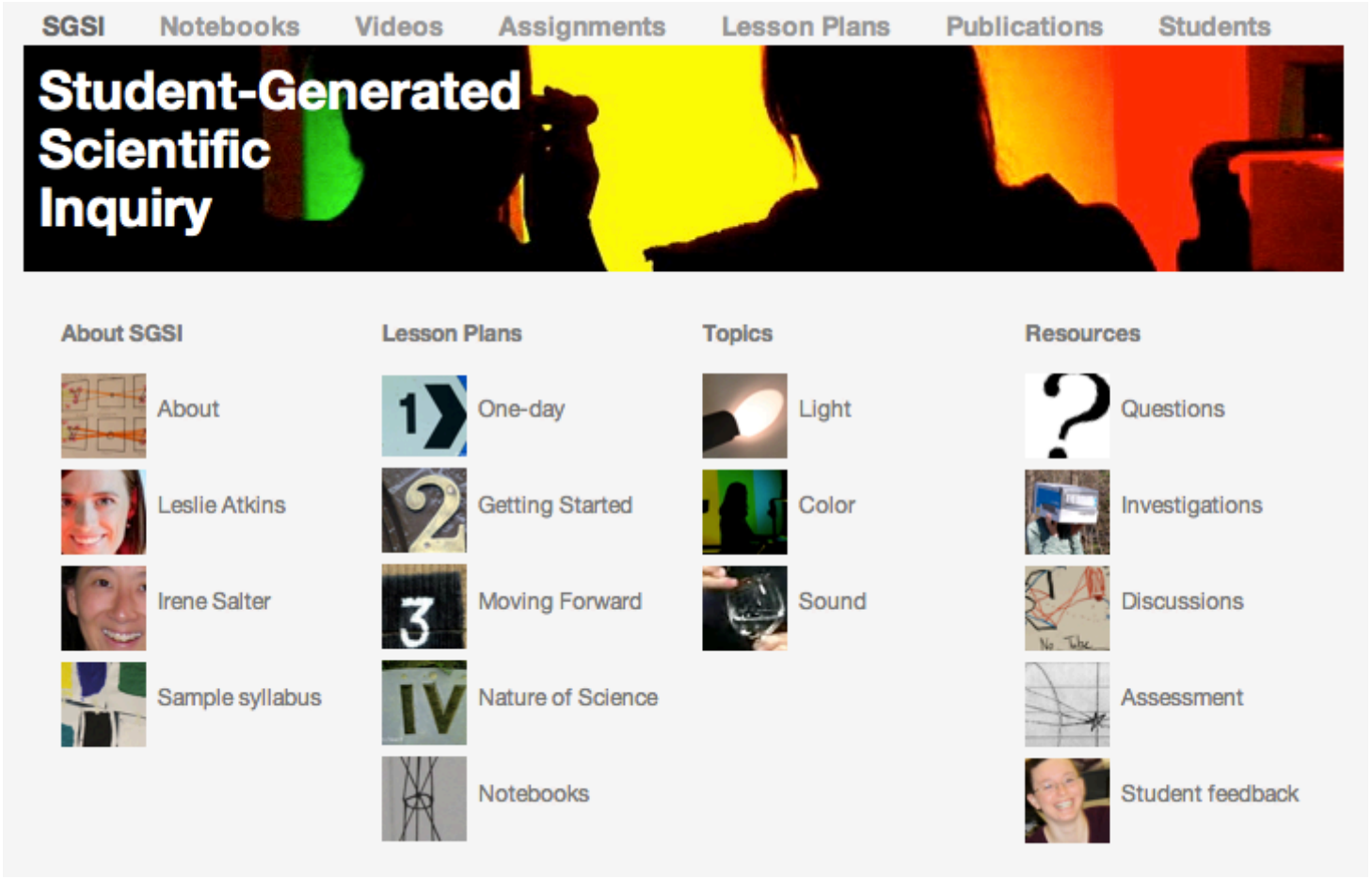
Students bring interest **into class**.

Engagement in class enriches **existing interests**.



Engagement in class builds **new interest**.

This interest is then brought out of class, and transfers engagement **beyond class**.



http://tinyurl.com/sgsinquiry

NSF-Funded Project: CCLI #837058
Leslie Atkins & Irene Salter

Student-Generated Scientific Inquiry for Elementary Education Undergraduates: Course Development, Outcomes and Implications

Salter & Atkins (2011)

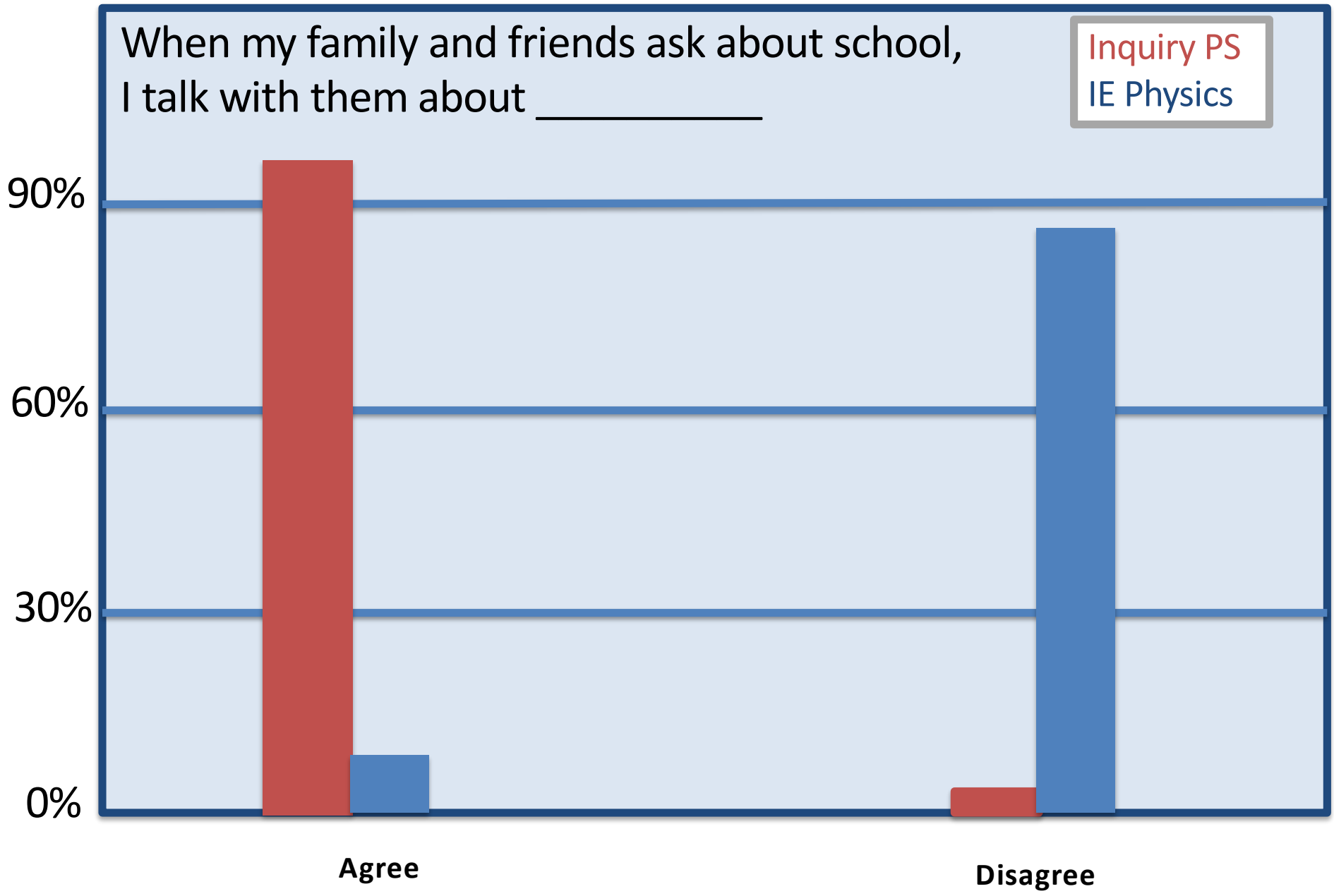
Three Themes that Emerge

(specific to out-of-school engagement)

1. Student share what they are learning when they feel **confident in their ability** and take **pride in their learning**.

2. Students are more like do science outside of class when classroom is a **rehearsal space for "cross-over"** practices.

3. Students are more likely to take ideas out of the classroom when **outside ideas are brought into** the classroom & valued


When my family and friends ask about school, I talk with them about _____
Inquiry PS
IE Physics
90%
60%
30%
0%
Agree
Disagree

Sharing Science Learning at Home

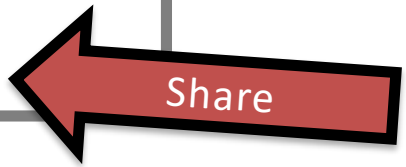
Everyday after class I'd go to have lunch and have a full discussion about what I learned, what we were trying to figure out and then I would try to figure it out with friends

My roommate has said that although the pinhole theater is interesting and how the eye works, she is tired of me bringing it up each time after class.

So my dad and I started talking about why things would get blurry...and I said he should try and draw a diagram too! So this is what he thinks will happen...but he said he's not sure if he's right.

Self-Efficacy & Pride → Sharing at Home

"I like that **I could successfully talk about the moon to a variety of people and be confident in what I know.** I like knowing that information. Not many people really understand the moon and I now can enlighten them…. I think it's because I was invested in our claims and **I worked hard to come to the claims that we feel are valid**. By doing that, I feel like I am more passionate about what I have learned and **I want to share that.**"



In IE physics, Students Rehearse Problem Solving

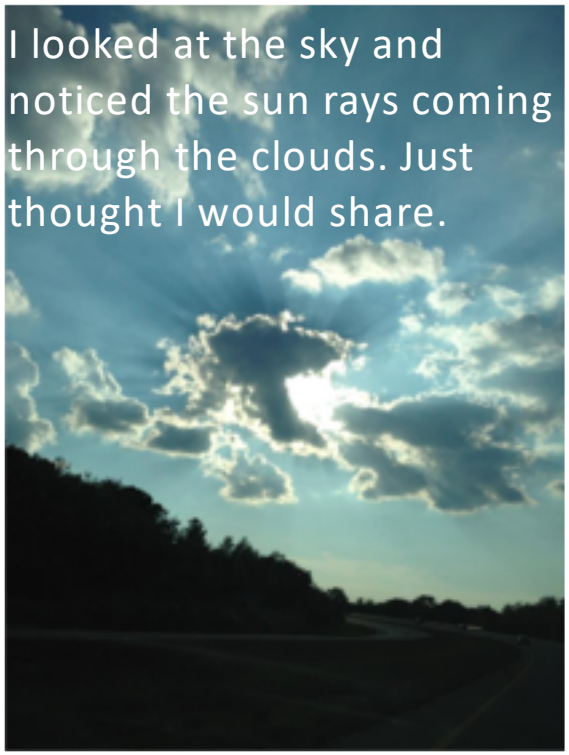
Harrison the physics majors who has peer group of science-interested students

There was one problem I remember …., but what I was thinking about at that time was what the index of refraction …. **It was really bugging me, so I just spent an hour researching** the difference between glass and plastic headlights."

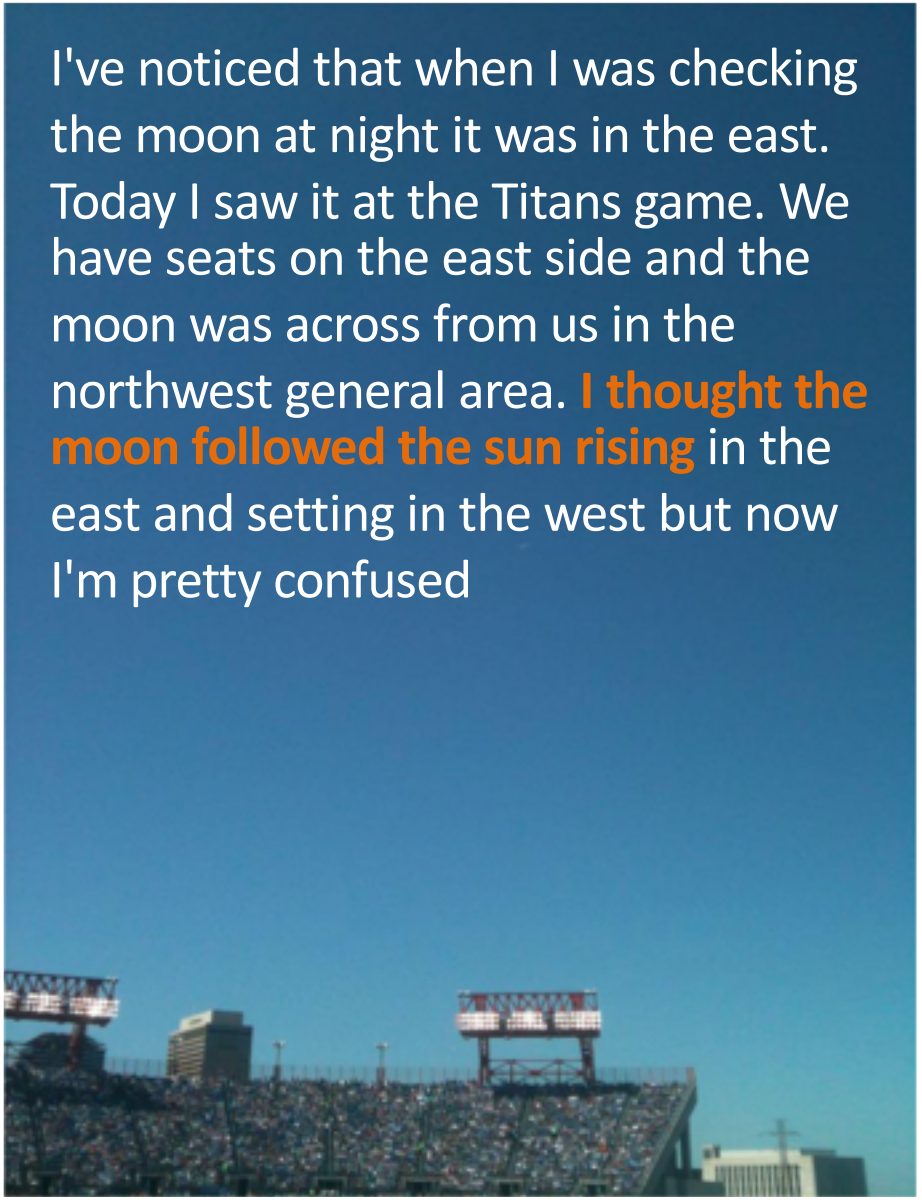
"Yeah, I went home at calculated the coefficient of drag of my beard."

Noticing, Wondering, and Asking Questions

→ are Practices we Rehearse in Inquiry



Looking for how evidence speaks to your ideas.



III. Student Ideas are Valued

"The way this course was taught got me interested in the topic… because **I wanted to be in class** and listen to what everyone else was thinking. … **Others wanted to hear my ideas just as much as I wanted to hear theirs**…"

"In our class **we could use personal experiences** for us to make sense of why that would be happening, so that was pretty cool. We've never been able to draw personal experiences in to learning about science before. **They just never asked**. I mean it's not their fault, but like no one's asked. "

Summary

In school engagement doesn't necessarily transfer to out of school engagement.

It seems easier to enrich existing interest than to develop new interest, but it's not impossible.

We think we know some of the ingredients that support out-of-school engagement