Developing Modeling Skills and Science Identity in Physics Freshmen

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THE COMPASS PROJECT

Overview of Compass

The Compass Project is an **APS award-winning, student-founded** and **student-run** organization in the physical sciences at UC Berkeley.

Our goals are to **improve undergraduate physics education,** provide our participants with **professional development opportunities**, and increase **retention** of students, especially those typically underrepresented in the physical sciences. We achieve this by creating an environment that blends teaching, learning, mentoring, leading, and community building.

Among Compass undergrads, 45% are **women**, 30% are **URM**, and 20% are **first-generation** college students. 90% have graduated with or declared a **STEM major**.

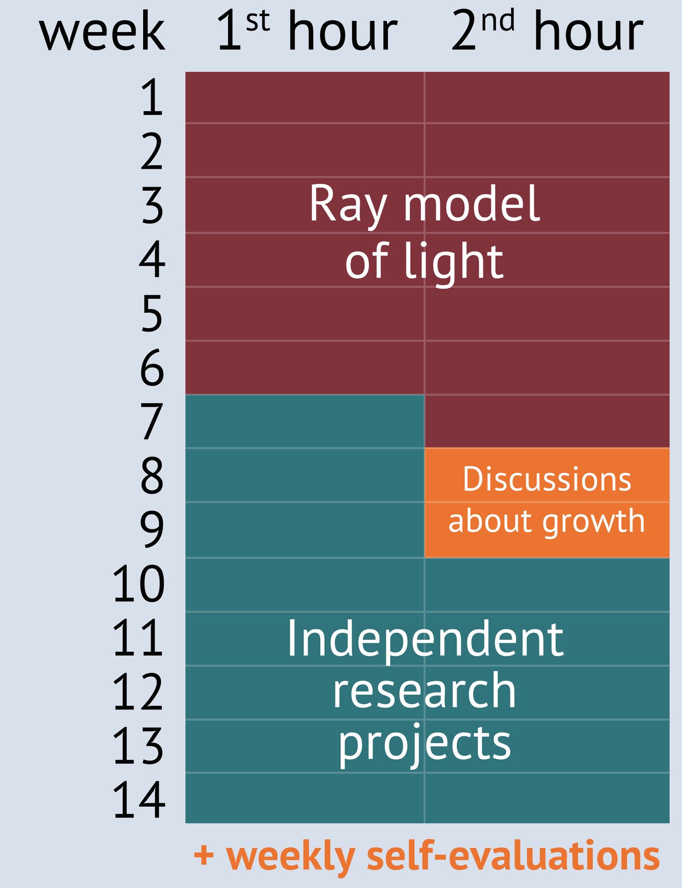
Compass Courses & Programs

- Freshman course sequence:
  - Summer Program
  - **Intro to Modeling** (Fall)
  - Intro to Measurement (Spring)
- Transitioning to Physical Science
- Frontiers of Physics
- Mentoring Program
- Research Lecture Series
- Office Hours
- Organizational Leadership

Overview of "Introduction to Modeling"

Course Structure

- One 2-hour class per week for 14 weeks
- 16-20 freshmen
- 2 graduate student instructors
- Worth 2 units of credit
- First run in Fall 2009



Course Goals

Remove barriers to persisting in STEM & build research skills by developing:

- an understanding of the **nature of science**
- a **science identity** as a member of a community of practice
- a **growth mindset**

Nature of Science

Ray Model of Light

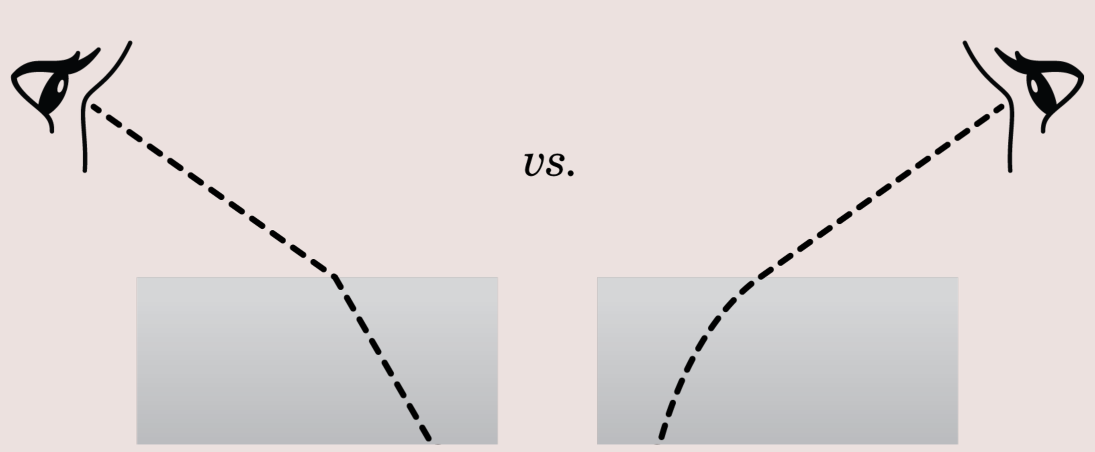
- Students engage in the process of constructing a model for the propagation of light in various circumstances via small-group discussion and experimentation and class-wide consensus-building.
- Students reformulate their own ideas about the "scientific method" by generating new representations of this process based on their experiences studying light.

Outcome

Students deepen their understanding of the nature of science by creating their own representation of the scientific method and engaging in the process of scientific modeling.

Example Activity

"Consider two different models for the interaction of light and a piece of plastic: one where the light bends all at once at the interface and one where it bends continuously in the plastic. Using plastic of different, but known, thicknesses, devise and conduct an experiment to determine which model is correct."



Identity as a Scientist

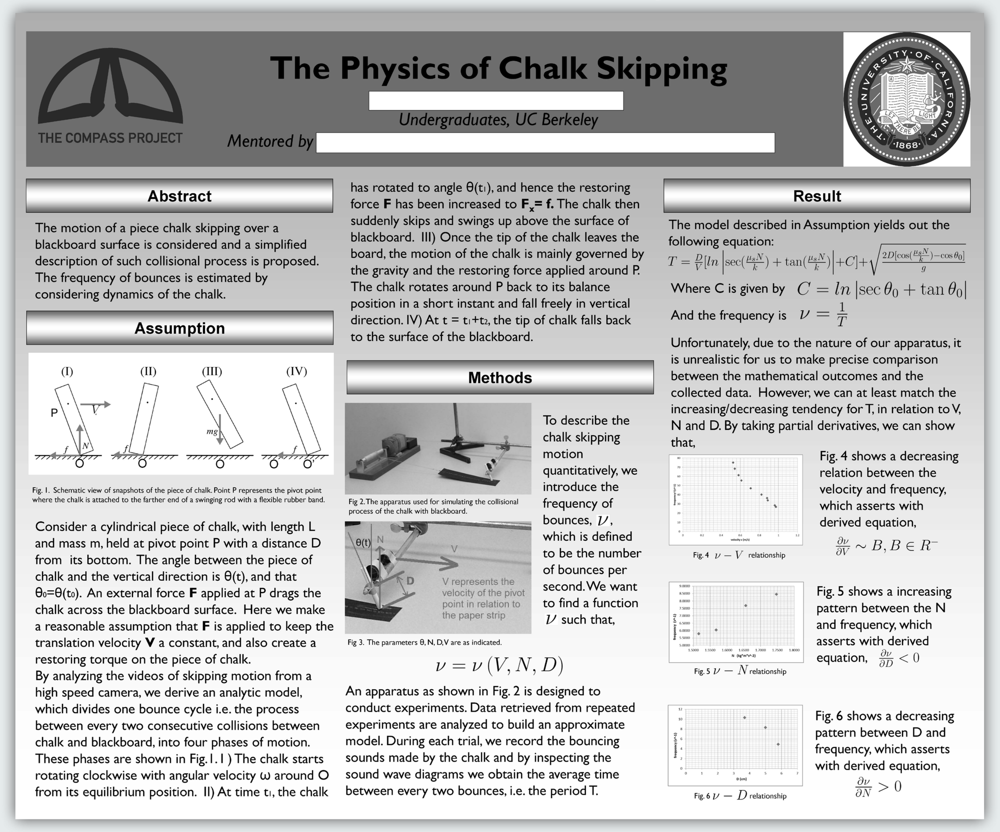
Independent Research Project

- Teams of 2-3 students choose a question about a physical phenomenon of interest.
- To answer the question, the team develops models by talking with peers, consulting the literature, and conducting experiments. Graduate student research advisors help guide this process.
- Teams present their work through papers and a poster presentation.

Outcome

Students gain experience practicing the methods that professional scientists use to conduct and communicate their work, which helps them to identify with the scientific community.

Example Project



Growth Mindset

Self-evaluations and Discussions of Growth

- Through readings, reflections, and class discussions, students learn about the nature of intelligence and how our reactions to both failure and success can impact how we grow as learners.
- Students conduct weekly, written self-evaluations of their performance in a STEM class of their choice based on a rubric of skills. The course instructors provide weekly, personalized feedback.

Outcome

Students develop a growth mindset—the belief that abilities can be developed through hard work and dedication—by evaluating their own progress and critically discussing growth with their peers.

Example Rubric

Primary Skills

Skill	Questions to ask yourself	Beginning	Developing	Succeeding
Persistence	• What do you do when you're frustrated? • Do you independently pursue understanding?	I tend to try one or two things. I give up more easily than I should.	I try to stick with things, but I sometimes feel unsuccessful. Sometimes I seek new approaches to help.	I look for new ways to think about the problem. I find a way to persist when appropriate.
Organization	• Do you keep accurate, thorough, and consistent records of work? • Do you submit materials in a timely manner? • Do you refer to your records to support conclusions?	There are significant gaps in my records, and/or I consistently forget to complete assignments on time.	I don't complete all assignments on time or I have no record of some of my work/activities. When I neglect to do something, I forget about it because it's too late.	I am timely and thorough with work and record-keeping. When I've neglected something, I correct my oversight quickly. My records are a valuable resource.
Connections	• Do you try to make connections with new people who might be able to help you in the future? • Do you make use of your connections when you need help?	I tend to go it alone.	I sometimes get help from other people, but only when I really need it. My network of supporters could be better developed.	I have a strong network of people who I go to regularly for help and support.
Self-compassion	• When you're having difficulty with something, how do you feel about yourself? • Do you make productive use of failure?	I have trouble with feeling like a failure, and these feelings often make me feel like giving up. I'm my own worst critic.	I am sometimes overly critical of myself. I tend to ignore feelings of failure rather than using them to improve.	I acknowledge my difficulty, but I don't let it define how I feel about myself. I act kindly towards myself and view failure as an opportunity for self-improvement.