

# **Building Collaborations and Preparing the Next Generations of Scientists & Engineers**

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**Center for Adaptive Optics**

**University of California, Santa Cruz**

**University of Hawaii Institute for Astronomy**

**NAOC, Beijing, China**

**June 5, 2013**

# Overview of Presentation

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- **How we started**
- **“Workforce Development”**
- **Professional Development Program**
- **Future directions: International Collaborations**

# How our program began

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## Center for Adaptive Optics

National Science Foundation  
Science and Technology Center (STC)  
funded 1999-2009

Directors: Jerry Nelson; Claire Max

Adaptive Optics Summer School: August

All NSF centers develop their own, innovative  
programs for “education and workforce  
development”

Deciding a focus...



# STEM Workforce

STEM workforce  
related to our  
center:

Adaptive optics science  
technology, and *related  
fields*.

For example:  
engineering,  
technology related  
to telescopes

## Challenges (local to Hawaii and U.S.):

- Not adequately prepared for workforce
- Large segments of population not engaged (women, some minority groups)

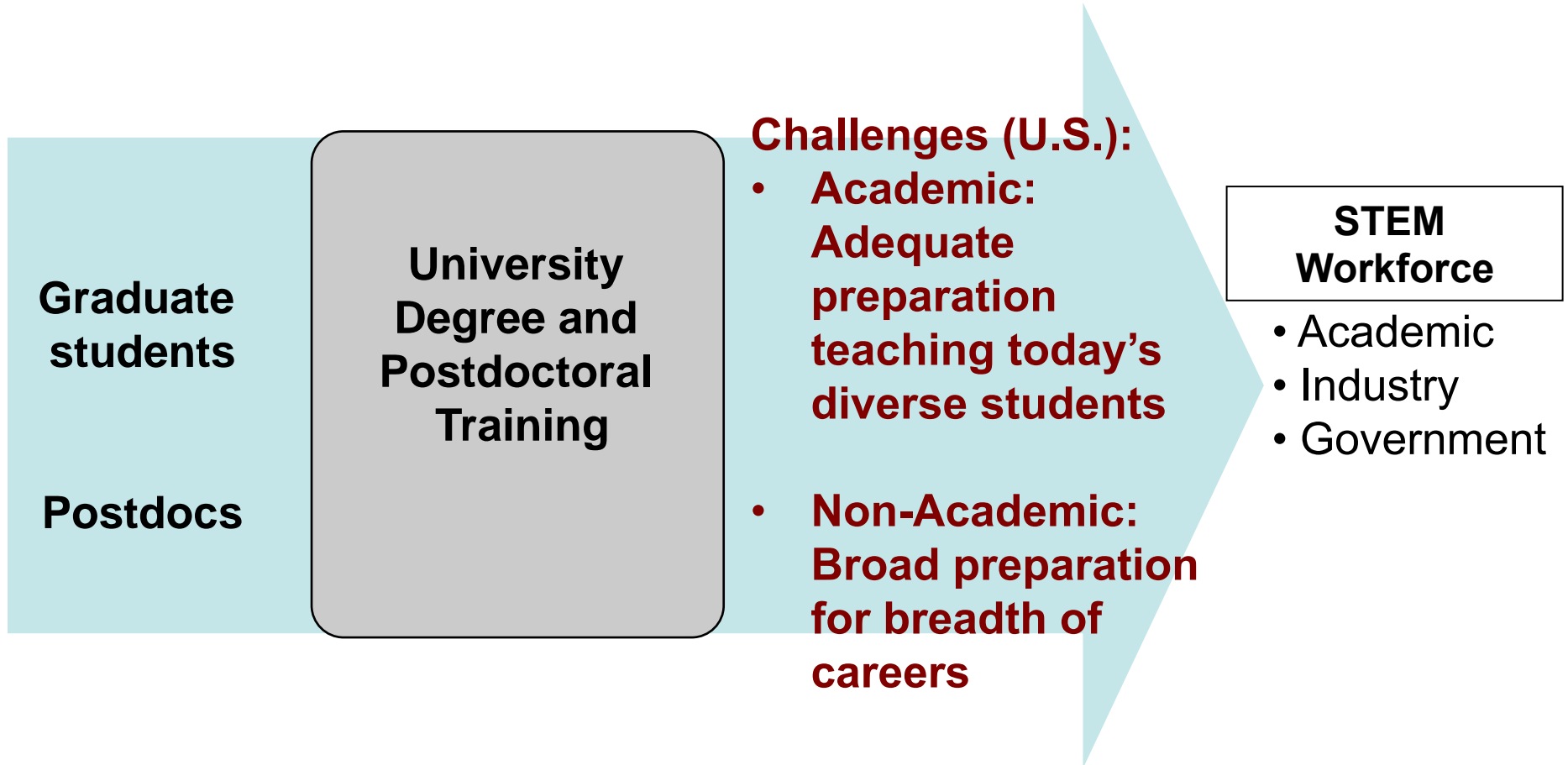
**Undergraduate Degree  
Programs  
(2-year and 4-year)**

**Students**

**College, university  
Undergraduates**

STEM=science, technology,  
engineering, math

STEM workforce  
includes those with  
advanced degrees



Questions we (CfAO) asked ourselves 13  
years ago:

Are we preparing grads and postdocs  
with the skills they need for their  
careers?

(Given our preparation focused on  
academic research careers)

Where are the jobs in U.S. academia?

4688 institutions of higher education

How many are primarily teaching institutions?

# Summary of U.S. Academic Institutions

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<b>Associate' s</b>	<b>1920</b>	<b>41%</b>
<b>Baccalaureate</b>	<b>808</b>	<b>17%</b>
<b>Master' s</b>	<b>727</b>	<b>16%</b>
<b>Doctoral*</b>	<b>296</b>	<b>6%</b>

\* Of these 108 (2%) are “research/very high”

(20% are “special focus”)



# Are we training grads and postdoc to be qualified for today's academic positions?

## From job listings:

“Describe how will you engage a diverse student population in your teaching and research”

“Excellence in teaching and facilitating the learning process for students...applying diverse instructional strategies in response to learner demographics and learning styles”

## Teaching statement, teaching philosophy:

Do our graduates know what to include? Do they have experience to back it?

# The Professional Development Program



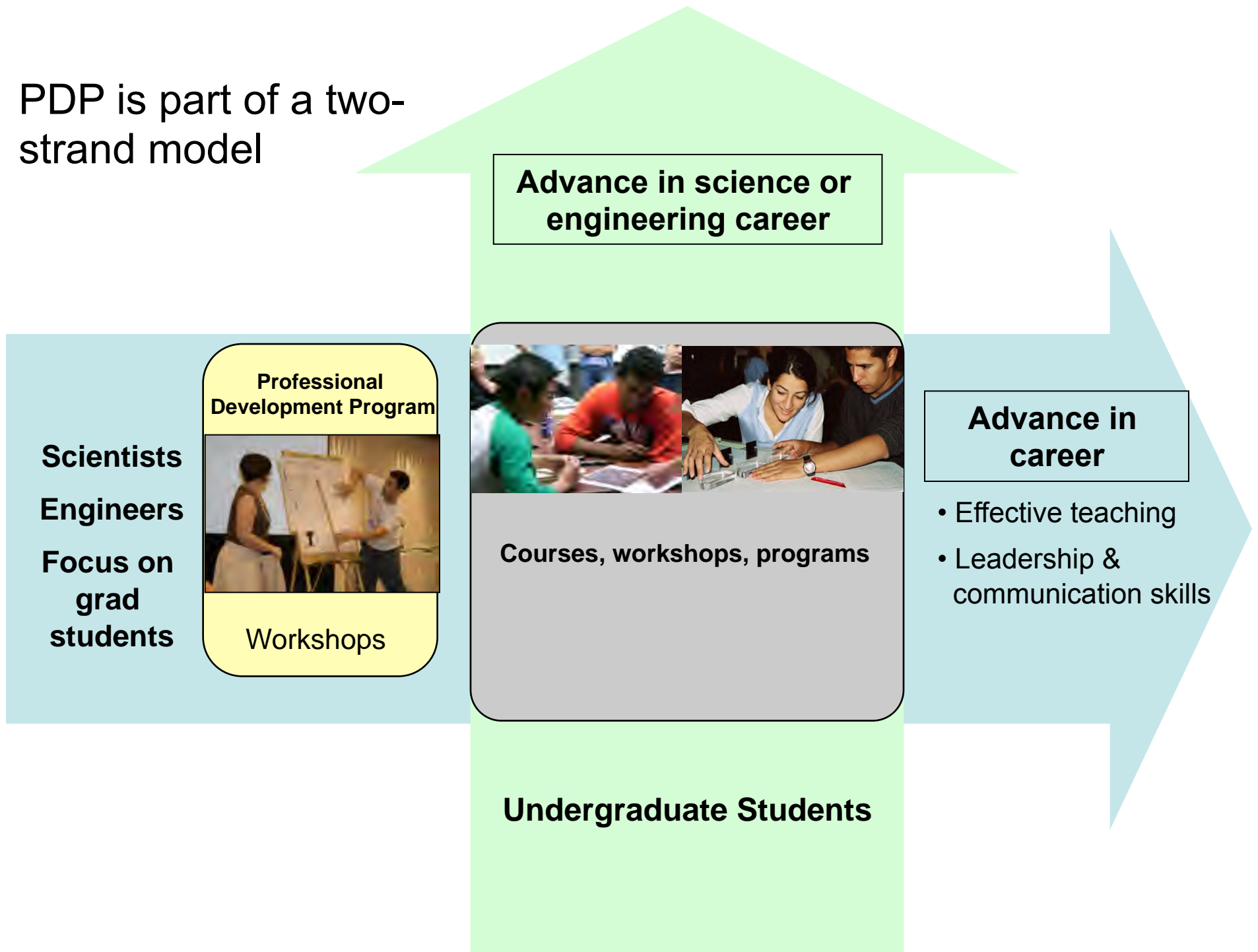
Institute for Scientist & Engineer Educators  
University of California, Santa Cruz

# What is the PDP?

- Bolsters early-career scientist and engineers' preparation for careers with education training and practice
- ~60 grad students, postdocs, professionals, & college faculty
- Workshops & practical teaching experience
- Participants gain teaching and professional skills



PDP is part of a two-strand model



# What PDP participants experience

- Training workshops
- Design laboratory activity (or “module”) with teaching team
- Teach activity with team
- Reflect
- Return to the PDP & lead



# PDP Teaching Focus

- Wide range of science and engineering topics
- Focus areas
  - **Inquiry:** teaching scientific concepts and *STEM practices*
  - **Diversity and Equity:** creating an equitable learning environment
  - **Assessment:** how do you know what your students have learned?

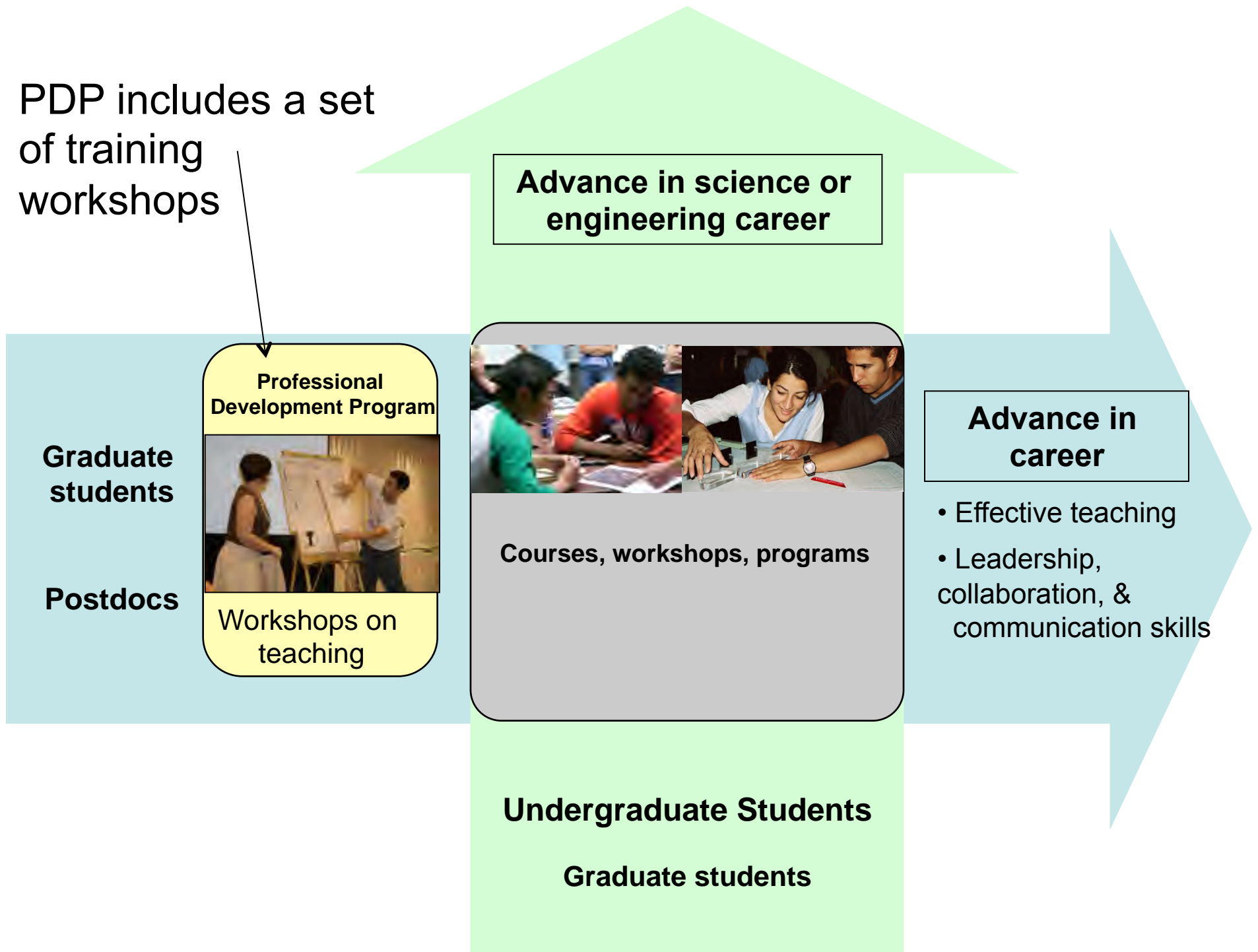


# “Inquiry”: Teaching concepts and practices that are transferrable

- Generating questions
- Designing studies
- Making observations
- Explaining results
- Developing theories
- Clarifying problem
- Identifying requirements
- Proposing solutions
- Testing solutions
- Evaluating tradeoffs

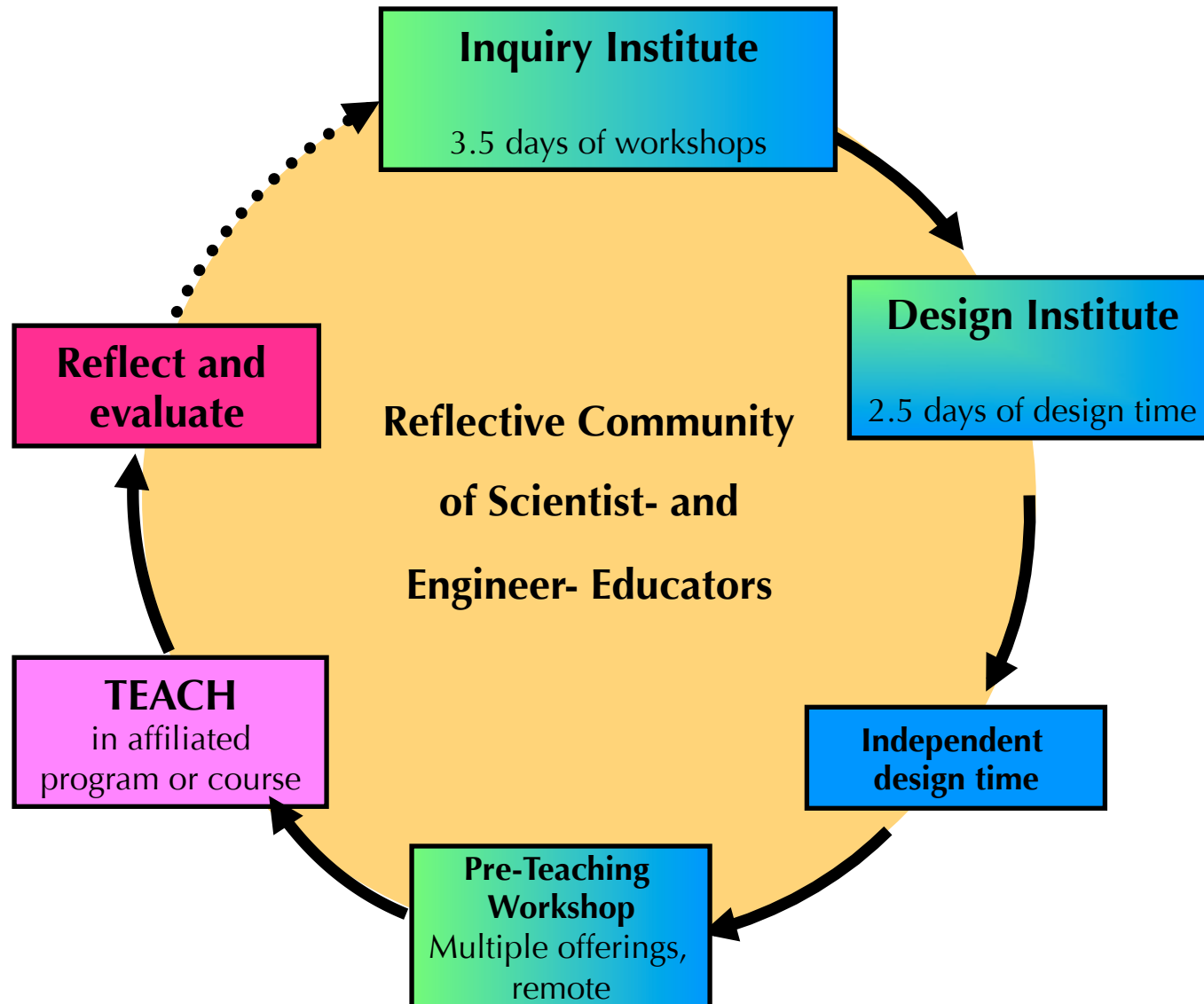
participants design an activity that gets at the subtle, challenging aspects of a skill

PDP includes a set of training workshops

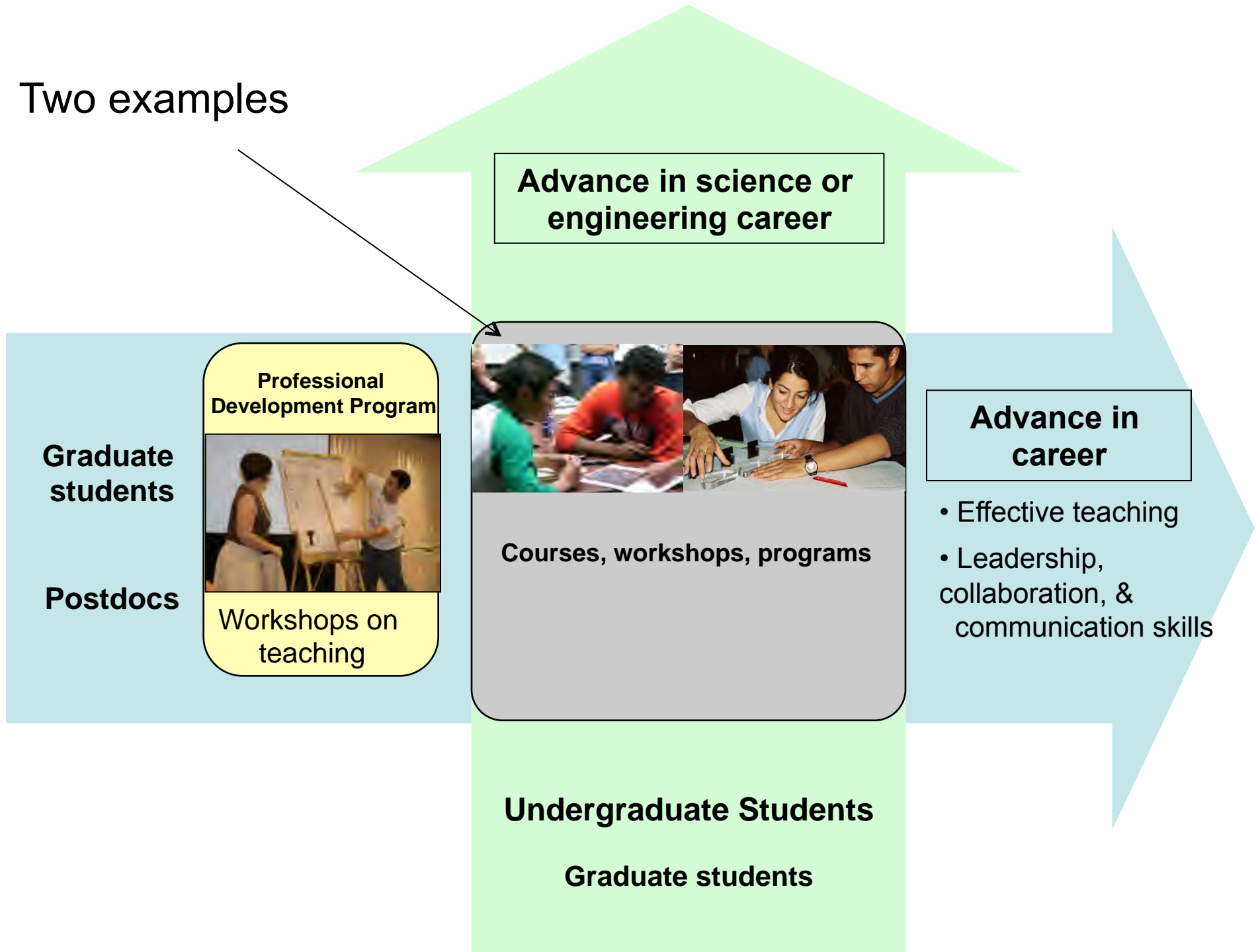




# PDP Cycle of Activities



# Two examples



# Where PPD participants teach



**Short courses, workshops, programs**

**For example:**

**Workshops to prepare undergraduates for  
research or internships**

# Preparing Undergraduates for Astrophysics Research Experience



**WHAT WOULD HELP UNDERGRADUATE RESEARCHERS BE MORE EFFECTIVE?**

Etsuko Mieda (grad student), Tuan Do (postdoc), and Jeffrey Fung (grad student) discuss their ideas.

Dunlap Institute, April 2013

Their module (or “activity”): A 2-day workshop for undergraduates before their research experience

Students chose between 3 astronomical investigations.  
Asked to design an investigation that minimized the number of measurements to make a scientific conclusion.

Learning goals:

Gaussian errors

Relationship between measurement errors and number of observations

Explaining using evidence

# Akamai: Preparing Undergraduates for Summer Internships at Observatories and companies



**What do college students need to be successful to do a project in an observatory or related industry internship?**

Heather Kaluna (astronomy grad student), Ehsan Yevari (electrical engineering grad student), and Brooks Thomas (physics postdoc) report on their unit.

Hawaii Design Institute, April 2013

Their module (or “activity”): A 2-day workshop for undergraduates before their research experience

100,00 km

Students chose an image, a “feature of interest,” and justify a minimum sampling rate

Learning goals:

- Sampling rates
- Defining performance requirements to meet a science goal

# Summary of what PDP participants gain

- Teaching and mentoring skills
- Experience designing and teaching
- Publications
- Teaching certificate
- Intellectual community
- Collaboration of diverse teams
- “the PDP kept me in grad school”

→ *Career qualifications, JOBS*





# CERTIFICATE OF COMPLETION

in

*Teaching Innovative Laboratory Experiences*

*Presented to*

*Mark Pitts*

*For successfully designing and teaching a laboratory experience through the ISEE Professional Development Program.*

*March 22, 2010*



*Lisa Hunter*

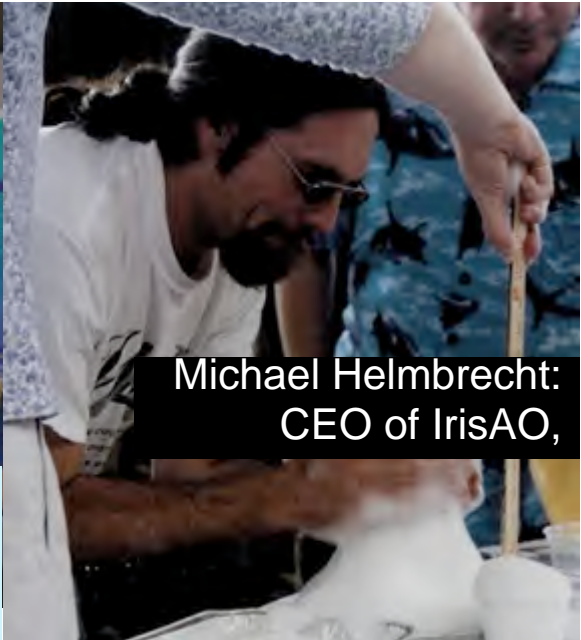
*Director, Institute for Scientist & Engineer Educators*



Emily Rice:  
Faculty, CUNY-CSI



Jason Porter:  
Faculty, U Houston



Michael Helmbrecht:  
CEO of IrisAO,

Shelley Wright:  
Faculty, U Toronto

PDP participants advance in their careers:

- Postdoc fellowships
- Faculty positions
- Industry positions
- Education professionals
- Obtaining grants



Sally Robinson:  
Faculty, U Texas



Mike Fitzgerald:  
Faculty, UCLA



Andy Sheinis:  
Head of Instrumentation,  
Australian Astronomical Observaotry

# Recent Advancements of PDP Alumni

## New Assistant Professors:

- Kathy Cooksey, University of Hawaii, Hilo
- Jessica Lu, University of Hawaii, Institute for Astronomy
- Calla Schmidt, University of San Francisco

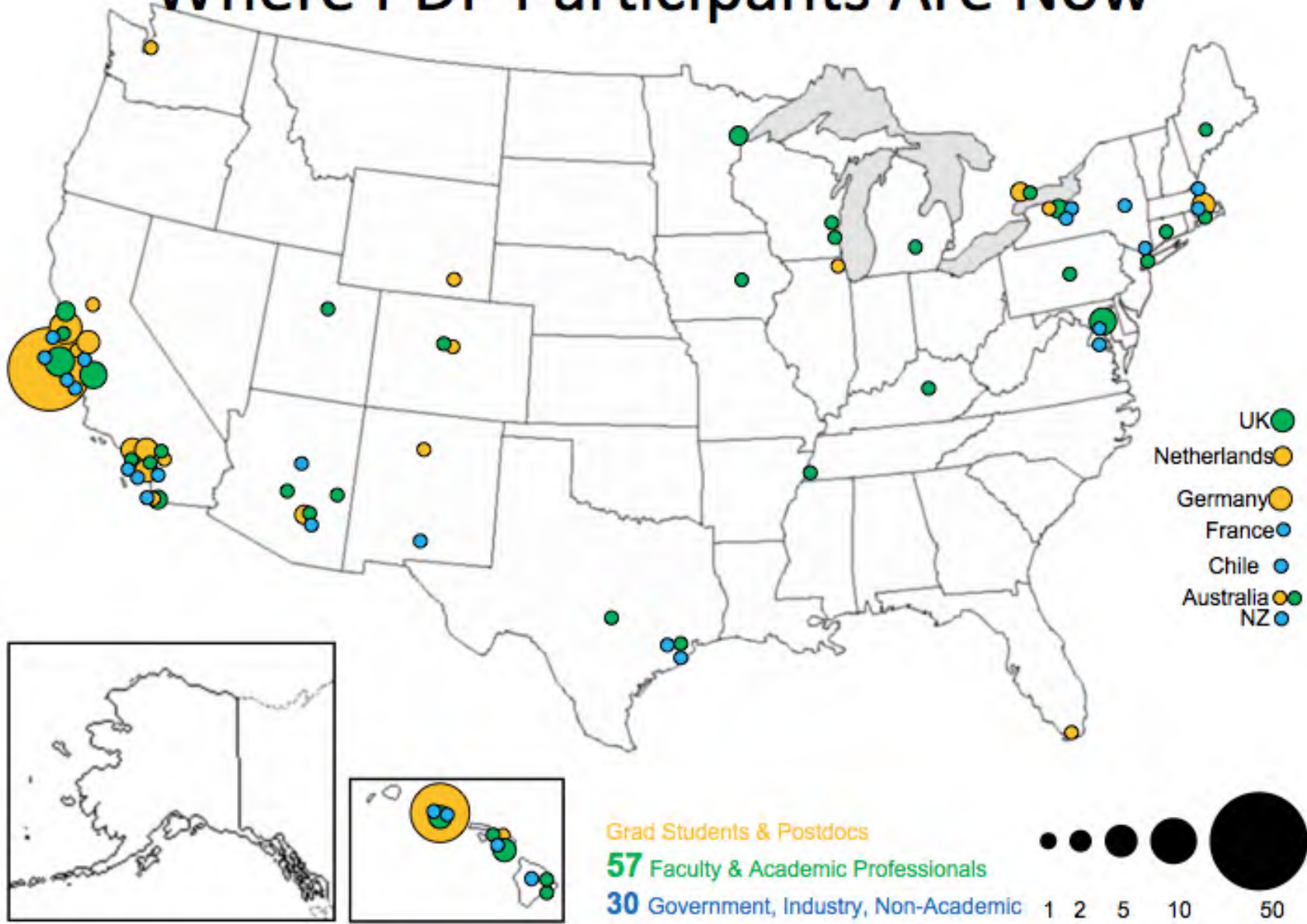
*“During my interview I had to give a teaching demonstration and discuss inquiry and learner-centered models of education. I felt confident doing this as a direct result of the PDP”*

## Promotions:

- Andrew Sheinis, Head of Instrumentation, Australian Astronomical Observatory
- Phillip Choi, Associate Professor

*“I just passed my tenure review ... and based on the feedback I received about my teaching and mentoring, there is no question in my mind that I would not have been half as successful without my experiences with the PDP”*

# Where PDP Participants Are Now



Questions we (CfAO) asked ourselves 13  
years ago:

Are we preparing grads and postdocs  
with the skills they need for their  
careers?

Given supply and demand, less than half will  
get academic jobs

# Outcomes of from the PDP

**Advance in STEM Career**

**Professional  
Development Program**



**Workshops**

**Scientists  
Engineers  
Many grad  
students**



**Courses, workshops, programs**

**Advance in  
STEM career**

- Effective teaching
- Leadership, collaboration, & communication skills

**College/Univ Students**

# Professional Skills

- Teaching and mentoring
- Collaboration, teamwork
  - Interdisciplinary, diverse teams
- Communication
- Leadership
- Time and project management



# Volume on the PDP

Published by Astronomical Society of the Pacific:

[http://www.aspbks.org/a/volumes/table\\_of\\_contents/?book\\_id=484](http://www.aspbks.org/a/volumes/table_of_contents/?book_id=484)

## 45 Papers on

- Professional development curriculum
- Participant developed curriculum

### *The Adaptive Optics Summer School Laboratory Activities*

S. M. Ammons, S. Severson, J. D. Armstrong, I. Crossfield, **T. Do**, M. Fitzgerald, D. Harrington, A. Hickenbotham, J. Hunter, J. Johnson, L. Johnson, K. Li, J. Lu, H. Maness, K. Morzinski, A. Norton, N. Putnam, A. Roorda, E. Rossi, and S. Yelda

ASTRONOMICAL SOCIETY OF THE PACIFIC  
CONFERENCE SERIES

VOLUME 436

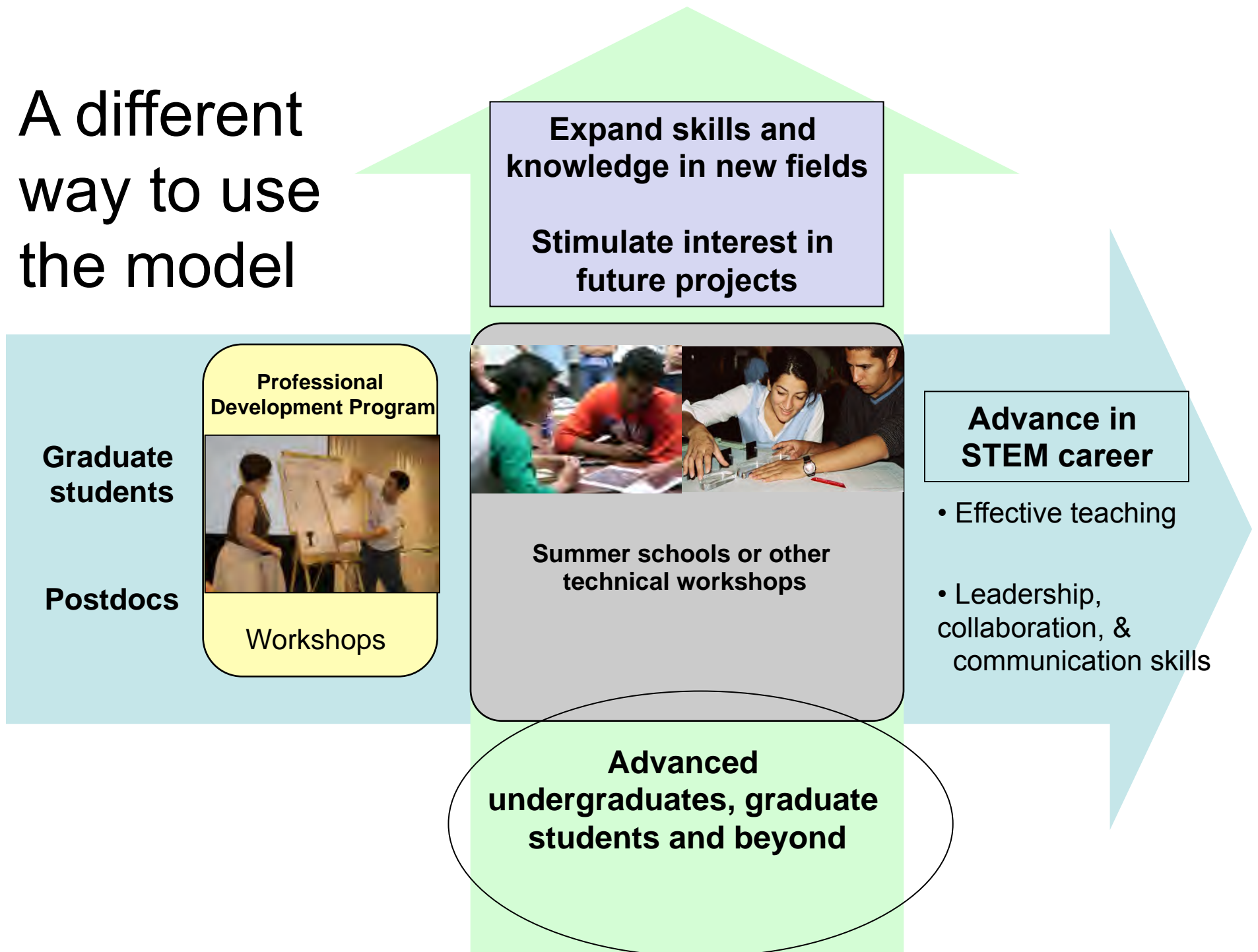
LEARNING FROM INQUIRY IN PRACTICE



Edited by  
Lisa Hunter and Anne J. Metevier



# A different way to use the model



# CfAO Adaptive Optics Summer School

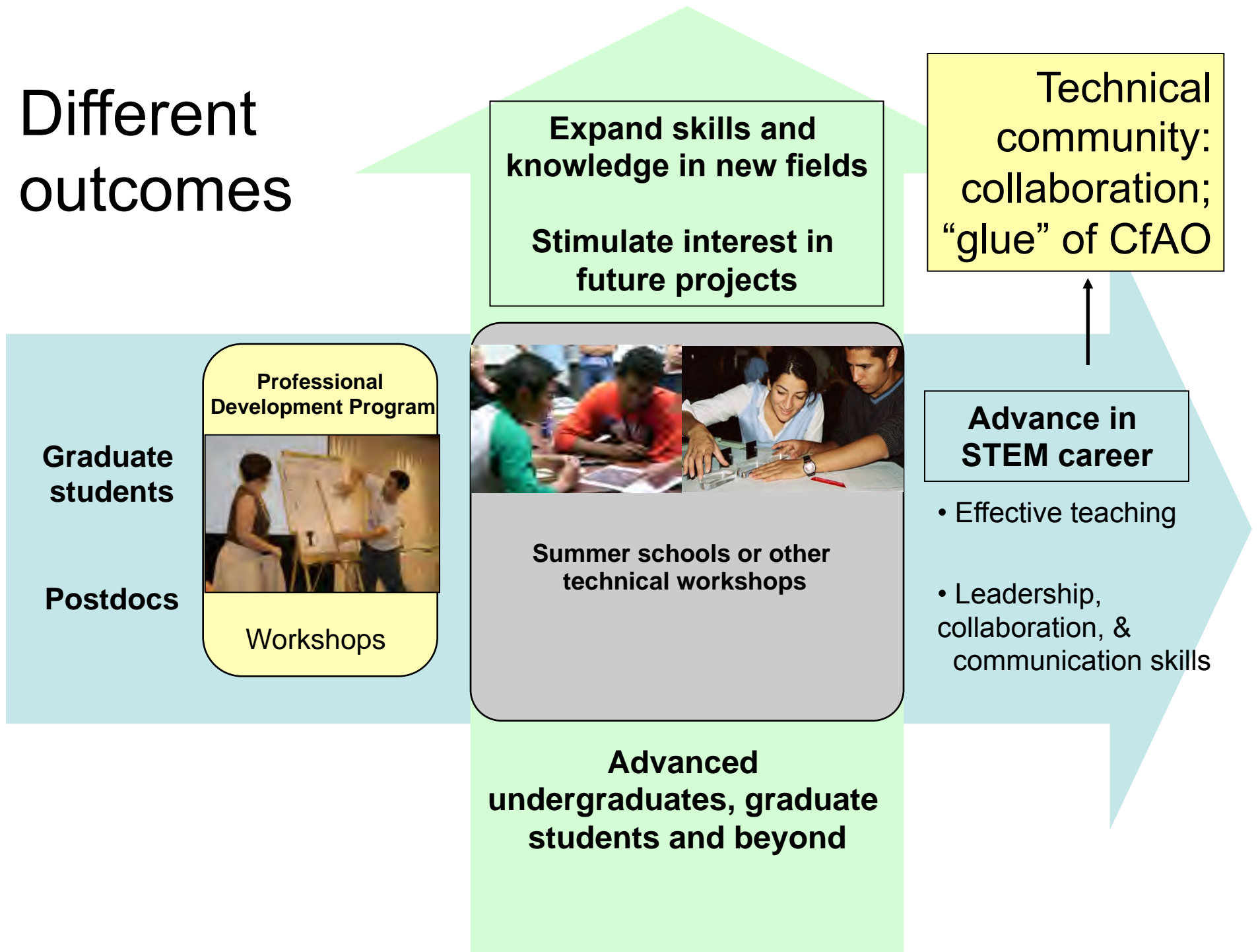
## 1-week technical course for grads and professionals

Transformed from all lecture to include hands-on labs:  
fourier optics, vision science, optical alignment

Labs designed  
by advanced  
graduate  
students and  
postdocs in the  
PDP



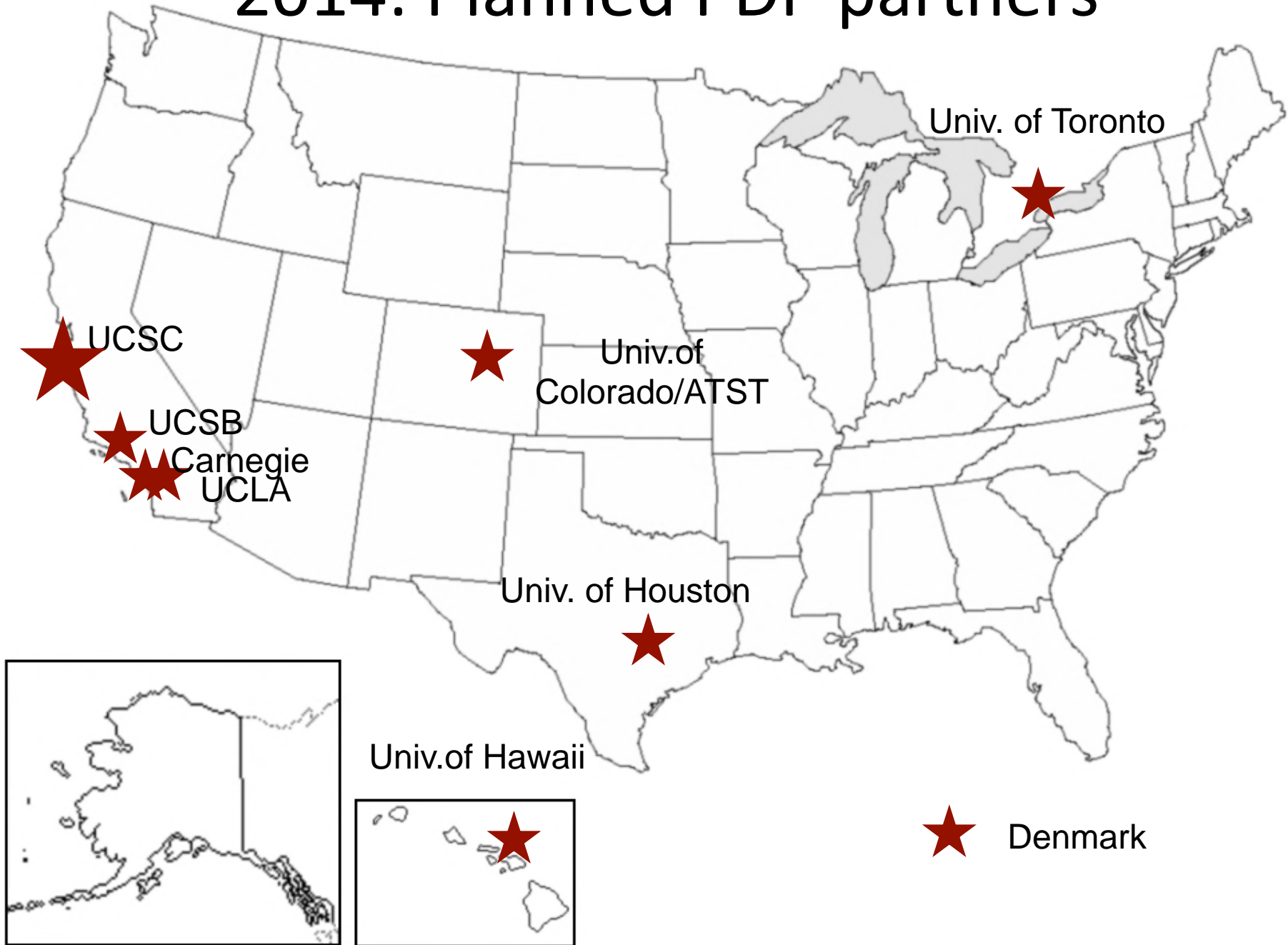
# Different outcomes



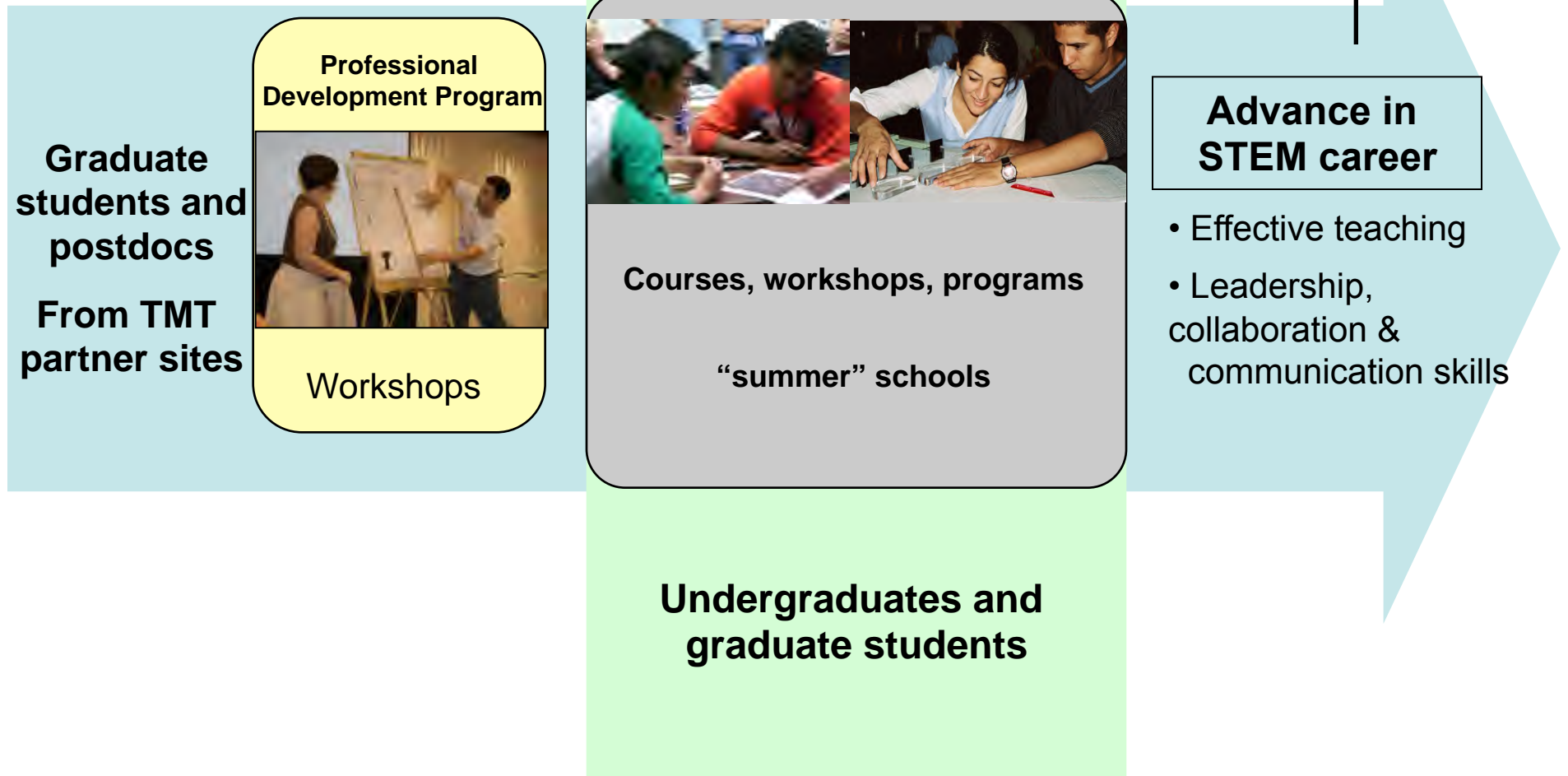
# New International Training Program using our PDP model

- Astronomical facilities (for example, TMT) require international collaboration
- Graduate students need global and cross-cultural competencies
- The PDP integrates research and education, and is the perfect foundation
- Dunlap Institute (Canada) partner since 2012

# 2014: Planned PDP partners



Could the PDP be used to create an international TMT community, and train the next generation?



# Summary

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- **“Workforce development” includes preparing graduate students and postdocs**
- **Graduate students and postdocs need opportunities to develop professional skills**
- **PDP is a refined model and developed and tested over 13 years**
- **Future directions: International Collaborations**
- **TMT partnership could utilize PDP to:**
  - **Enhance international collaboration and cooperation**
  - **Train the next generation of grads and postdocs**

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University of California Santa Cruz

University of Hawaii

Inquiry model: Exploratorium Institute for Inquiry

