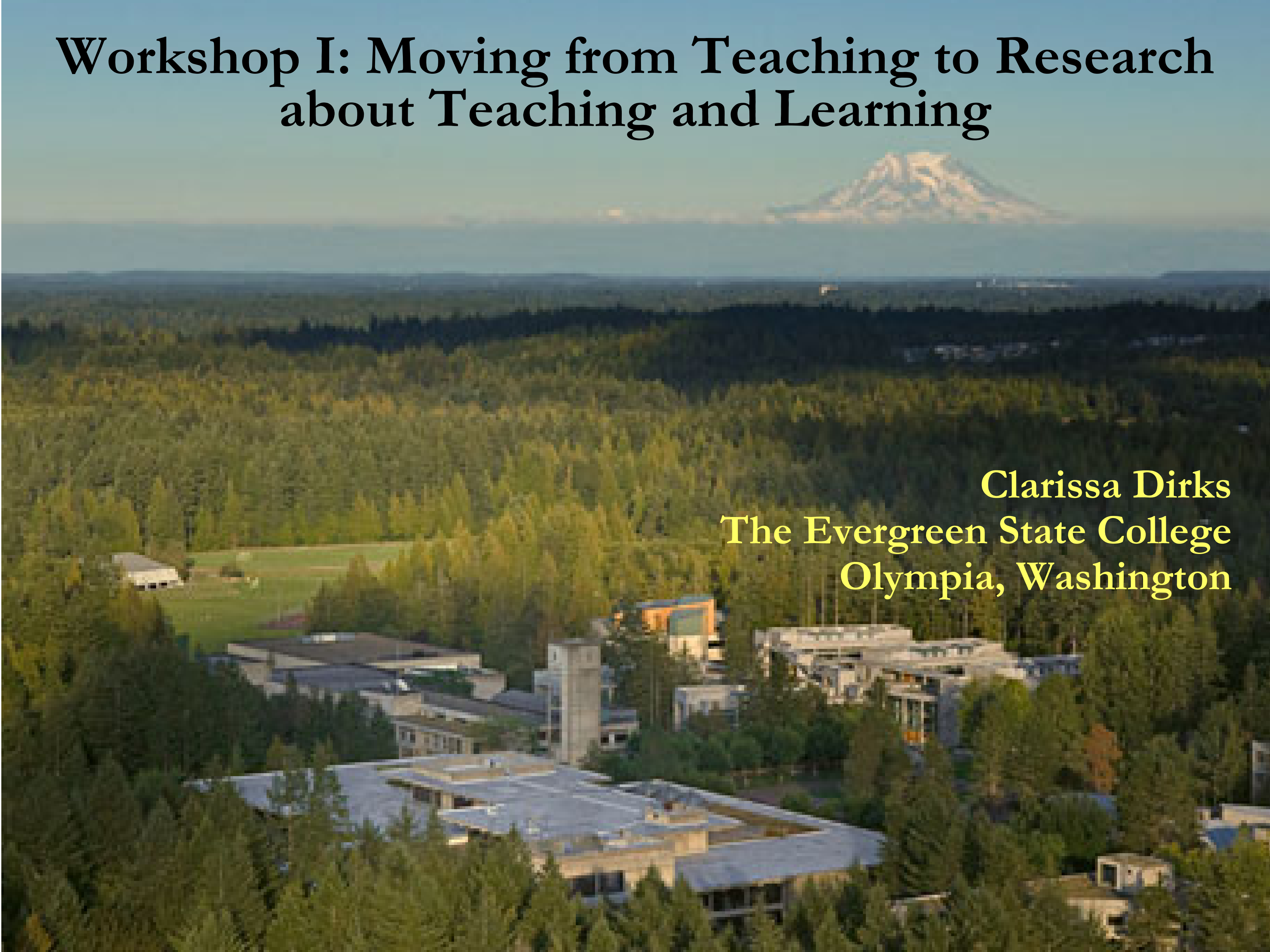
Workshop I: Moving from Teaching to Research about Teaching and Learning



Clarissa Dirks
The Evergreen State College
Olympia, Washington

Discipline-Based Education Research (DBER)

- Workshop I: Moving from Teaching to Research about Teaching and Learning
- Workshop II: Conducting Discipline Based Education Research (12:30 – 2:30 PM)
- Workshop III: Instrument Design (3:00 – 4:00 PM)

Calls for Change in Science Education

- AAAS "Science for All Americans"
- NRC "How People Learn"
- NAS "From Analysis to Action"
- NRC "Bio2010"
- President Obama "Win the Future"
- AAAS "Vision and Change In Undergraduate Biology Education"

Reasons For Change

Talk to your neighbor and determine if and why science education must change.

Reasons Often Cited For Change

- Inability of science students to engage in conceptual and analytical thinking
- Poor retention (10-20% lecture content)
- Exit of students from college science
  (biology majors ~60%)
- Greater loss of certain ethnic minorities
- Long term lack of persistence of women in academic science

What Is Discipline-Based Education Research (DBER)?

"DBER is grounded in the science and engineering disciplines and addresses questions of teaching and learning within those disciplines."

"DBER can be defined both by the focus of the research and by the researchers who conduct it"

National Research Council. *Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering.* 2012

DBER practitioners publish to advance their field. (C. Dirks)

What is the Relationship of DBER to Other Areas of Research?

Scholarship of Teaching and Learning

"SoTL has focused on engaging faculty across disciplinary boundaries, including the humanities, social sciences, and natural sciences with their wide-ranging epistemologies and standards of evidence."

"While DBER scholars gravitate to discipline-specific journals, SoTL researchers mostly publish in broad journals on teaching and learning such as the Journal of College Student Development or through the International Journal for the Scholarship of Teaching and Learning (IJSoTL)."

National Research Council. ***Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering.*** **2012**

What is the Relationship of DBER to Other Areas of Research?

Some other important education research areas that differ from DBER:

Educational Psychology Research

Cognitive Science Research

Education Evaluation

And there are others!

National Research Council. ***Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering.*** **2012**

Some More Terminology: Scientific Teaching (ST) and Action Research (AR)

"The same scientific approaches that are applied in the laboratory and in the field can also be applied to the classroom. In the practice of "**scientific teaching**" (Handelsman et al., 2007), faculty bring the art of research into their classrooms by reflecting on and improving their teaching after collecting and analyzing evidence about student learning. Rather than making assumptions about their students' learning, they use **action research (AR)** to collect evidence to support or reveal inadequacies in their pedagogical practices and thereby strive to improve student learning outcomes. Scientific teaching assumes that faculty are methodical in their approach, employing best practices established by cognitive research on teaching and learning. Not only do faculty apply science to teaching, but they bring the discovery process of science into student learning with the hope that students will be excited by both the content and process of science."

Dirks, C., Wenderoth, M., and Withers, M. *Assessment in the College Science Classroom.* **2013**

So to summarize . . .

Scientific Teaching (ST) is when a scientist brings the process of science (for many purposes) into their classrooms.

Action Research (AR) is when an instructor gathers some data about student learning or their teaching in order to improve both of these endeavors.

Introductions – 5 Minutes

Turn to your neighbors, introduce yourself and identify the area(s) of research/activities you have practiced:

Science (chemistry, physics, engineering etc . . .)
DBER
SoTL
Educational Psychology Research
Cognitive Science Research
Education Evaluation
Scientific Teaching
Action Research
Other (describe)

Transitioning from Teaching to DBER

Questions about student learning that led to action research

Connection to others conducting DBER or education researchers

Program or grant requirements for assessing student learning outcomes

Other

What Was My Own Transition Into DBER?

The first thing you should know is that I am a biologist.

Arizona State University; B.S. in Microbiology

Microbiology; First teaching experience as a teaching assistant

University of Washington; Ph.D. in Molecular and Cellular Biology

Virology; Graduate student teaching experience for biology labs

Fred Hutchinson Cancer Research Center

Virology and Cancer Biology; Science Education Partnership; K-12 Teachers

University of Washington; Department of Biology

Howard Hughes Medical Institute Programs for Undergraduate Education; Ecology and Bioinformatics

The Evergreen State College

DBER, Professional Development Programs; MIT Students; Virology, Malacology (snails), and Tardigradology (water bears)

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Virology and Cancer Biology; Science Education Partnership; K-12 Teachers

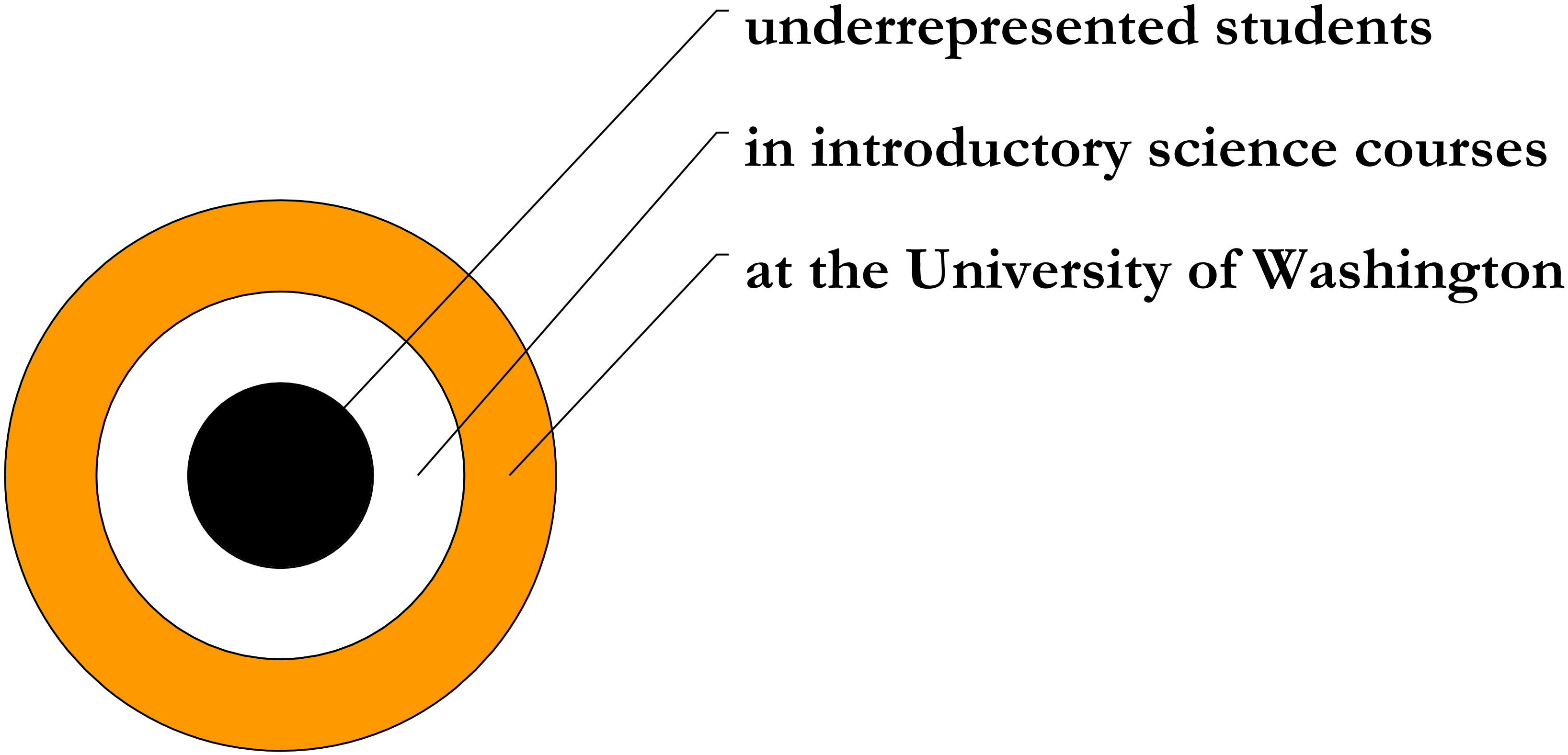
University of Washington; Department of Biology

Howard Hughes Medical Institute Programs for Undergraduate Education; Ecology and Bioinformatics

The Evergreen State College

DBER, Professional Development Programs; MIT Students; Virology, Malacology (snails), and Tardigradology (water bears)

One of my small assignments connected to the HHMI grant was to improve the success of . . .



Where Did I Start?

1. Read the literature
2. Talked with others on campus
3. Tried to identify the problems. What were the barriers to success in Introductory Biology?
4. Formulated a plan for an intervention

Where Did I Start?

1. Read the literature
2. Talked with others on campus
3. **Tried to identify the problem. (What were the barriers to success in Introductory Biology?)**
4. Formulated a plan for an intervention

- ✓ **Learned about the three part Introductory Biology series**
- ✓ **Interviewed faculty who taught the courses**
- ✓ **Interviewed students to identify how they were challenged**
- ✓ **Reviewed student success (or not) in the series**
- ✓ **Reviewed course assessments/exams**

What I found . . .

A. There really was a problem (a big one)!

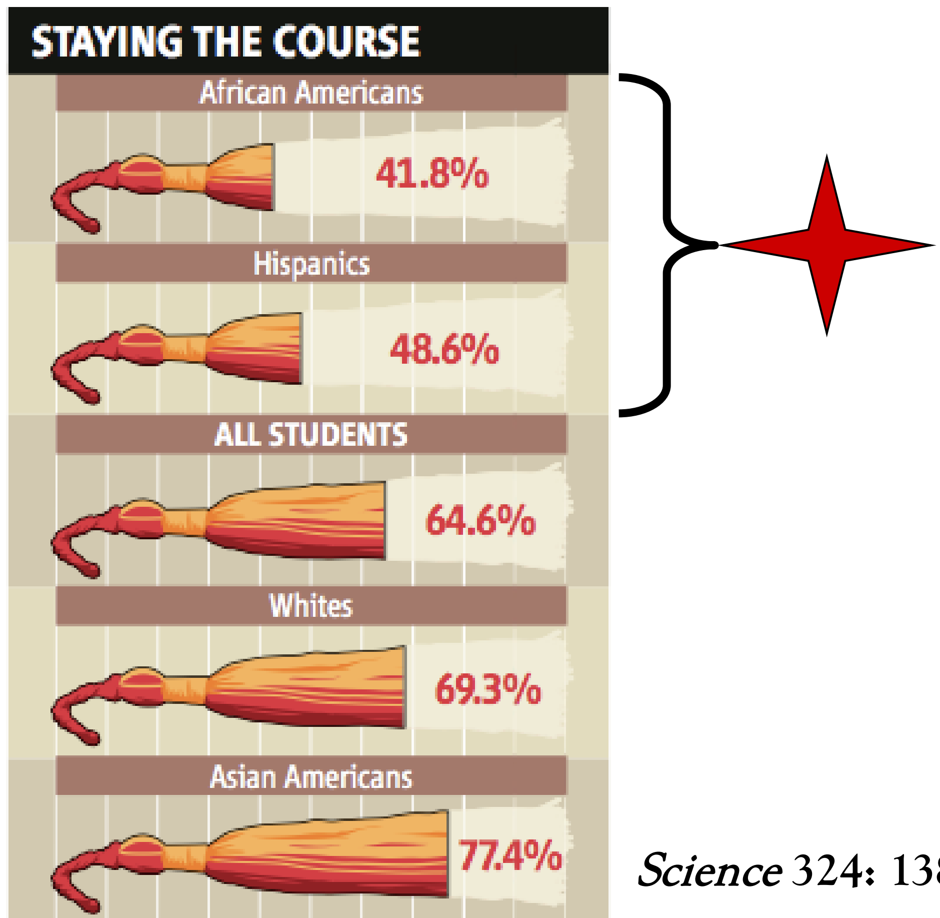
A review of 1581 EOP and 915 URM students during 2001–2003 showed, on average, 38% of URMs and 43% of EOP students entering Biology 180 received a grade below 2.0 or withdrew before completing the course.

B. The Biology 180 course exams required students to use many science process and reasoning skills (graphing, data analysis, experimental design, to name a few).

Given that minority retention rates in science are a sore spot for most universities . . . what would you do at this point?

No, really what would you do?

Talk to your neighbors and pose a "solution" or an intervention based on my case.



Science 324: 1386-1387 2009

The Biology Fellows Program (BFP)

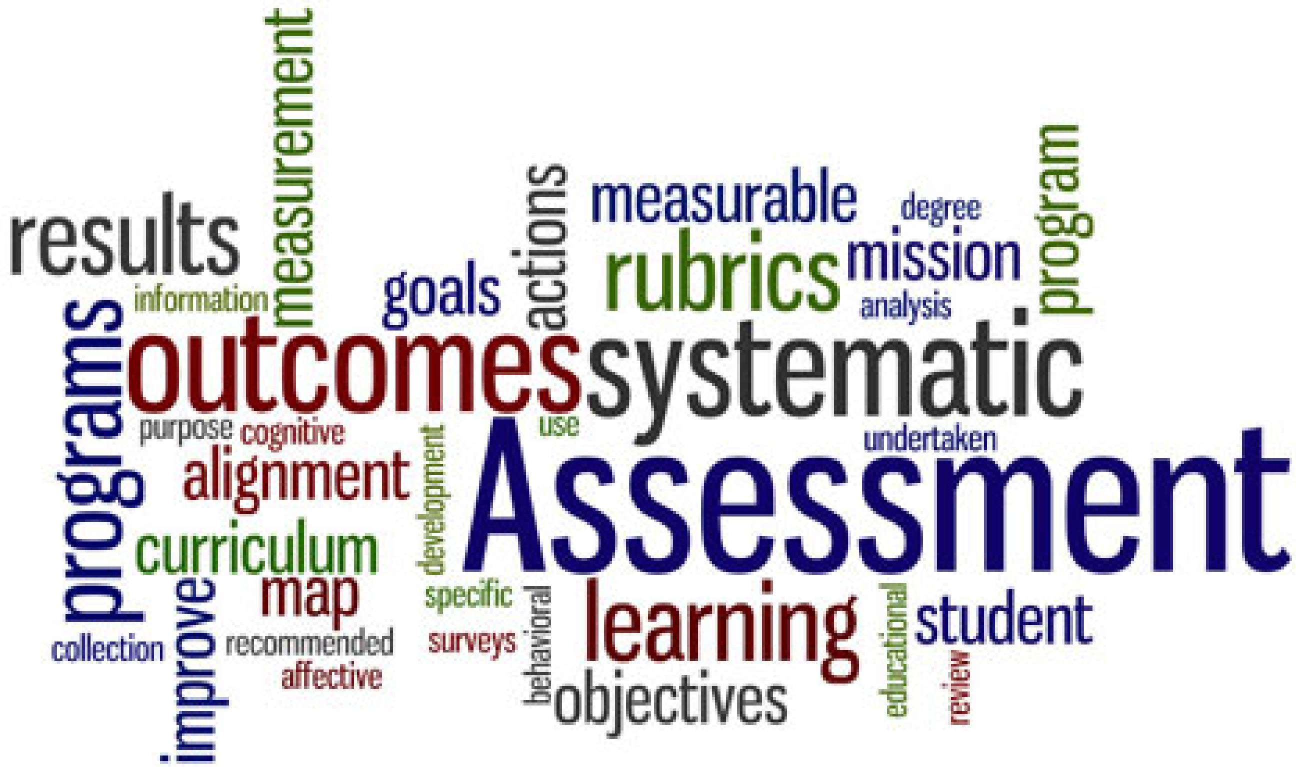
• a two-quarter program that met once a week for 1.5 hrs.

• I taught them science process skills such as graphing, data analysis, experimental design, scientific writing, and science communication

• BFs were also strongly encouraged to participate in supplementary instruction sessions while taking the Introductory Biology courses (approximately half of the BFs took advantage of this opportunity)

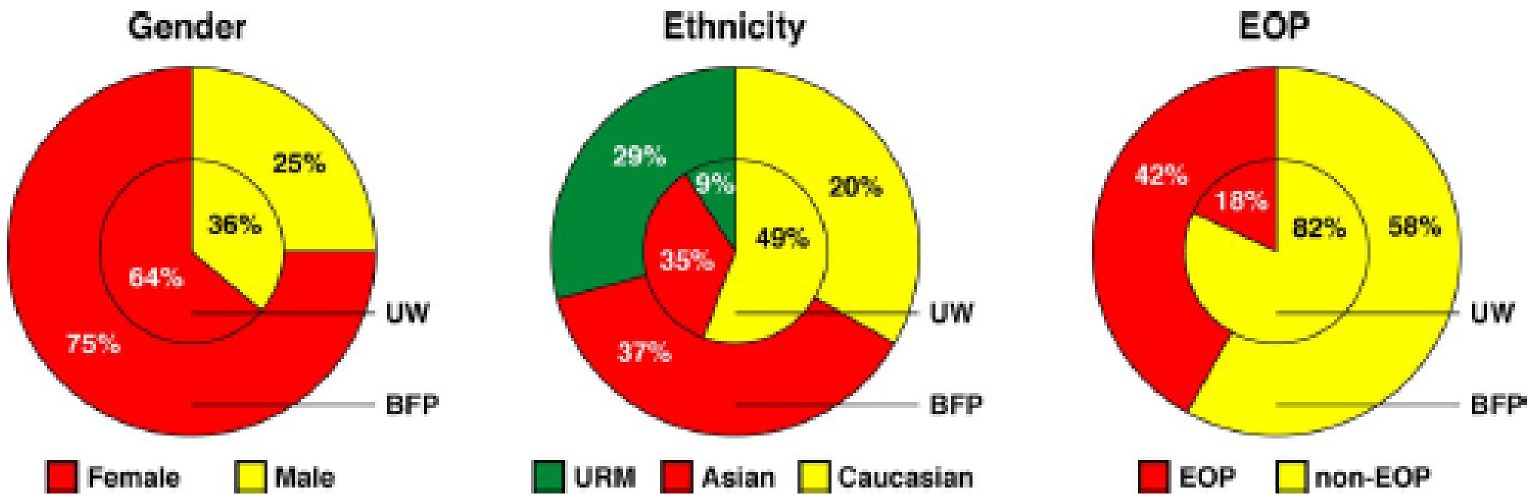
• the majority of Biology Fellows (BFs) waited to start the introductory biology series until after they completed the BFP

Now that I had this program, I had to determine if it was successful.



Some findings from the BFP program . . .

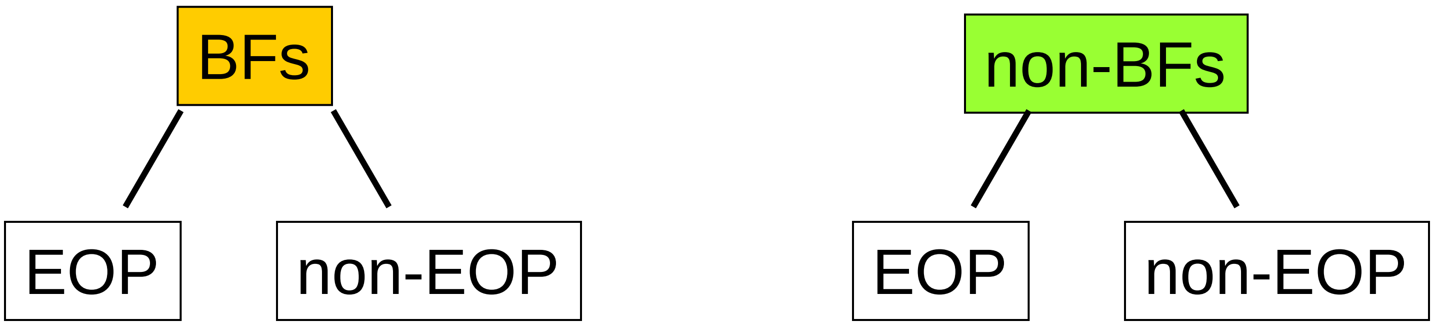
We successfully recruited our target audience.



Dirks, C., and Cunningham, M. *Enhancing Diversity in Science: Is Teaching Science Process Skills the Answer?*
CBE—Life Sciences Education Vol. 5, 218–226, Fall 2006

Who were we studying?

We compared SAT scores and high school GPAs of BFs and non-BFs based on their EOP status. Were these populations different?



BFs had somewhat higher verbal SAT scores than non-BFs, regardless of EOP status.

Did the program do anything for the BFs?

Table 4. A comparison of median and mean grades of BFs and non-BFs in Biology 180

	All students	URMs	EOP	Non-EOP	Women
BFs					
Median	3.3	3.3	2.7	3.4	3.2
Mean ± SD[a]	3.0 ± 0.9 (50)[b]	3.0 ± 0.8 (11)[b]	2.6 ± 1.1 (21)[b]	3.3 ± 0.6 (29)[b]	2.9 ± 1.0 (35)
Non-BFs					
Median	2.7	2.4	2.2	2.9	2.7
Mean ± SD[a]	2.6 ± 1.0 (2887)	2.3 ± 1.0 (163)	2.1 ± 1.0 (523)	2.7 ± 0.9 (2364)	2.6 ± 1.0 (1641)

[a] Sample size is given in parentheses.

[b] Statistically significant compared with non-BFs, $p < 0.05$.

Yes! They were successful in Biology 180 and didn't get "weeded out."

Dirks, C., and Cunningham, M. *Enhancing Diversity in Science: Is Teaching Science Process Skills the Answer?* **2013**CBE—Life Sciences Education Vol. 5, 218–226, Fall 2006

Did the program do anything for the BFs?

Table 5. A comparison of median and mean grades of BFs and non-BFs in the introductory biology series (Biology 180, 200, and 220)

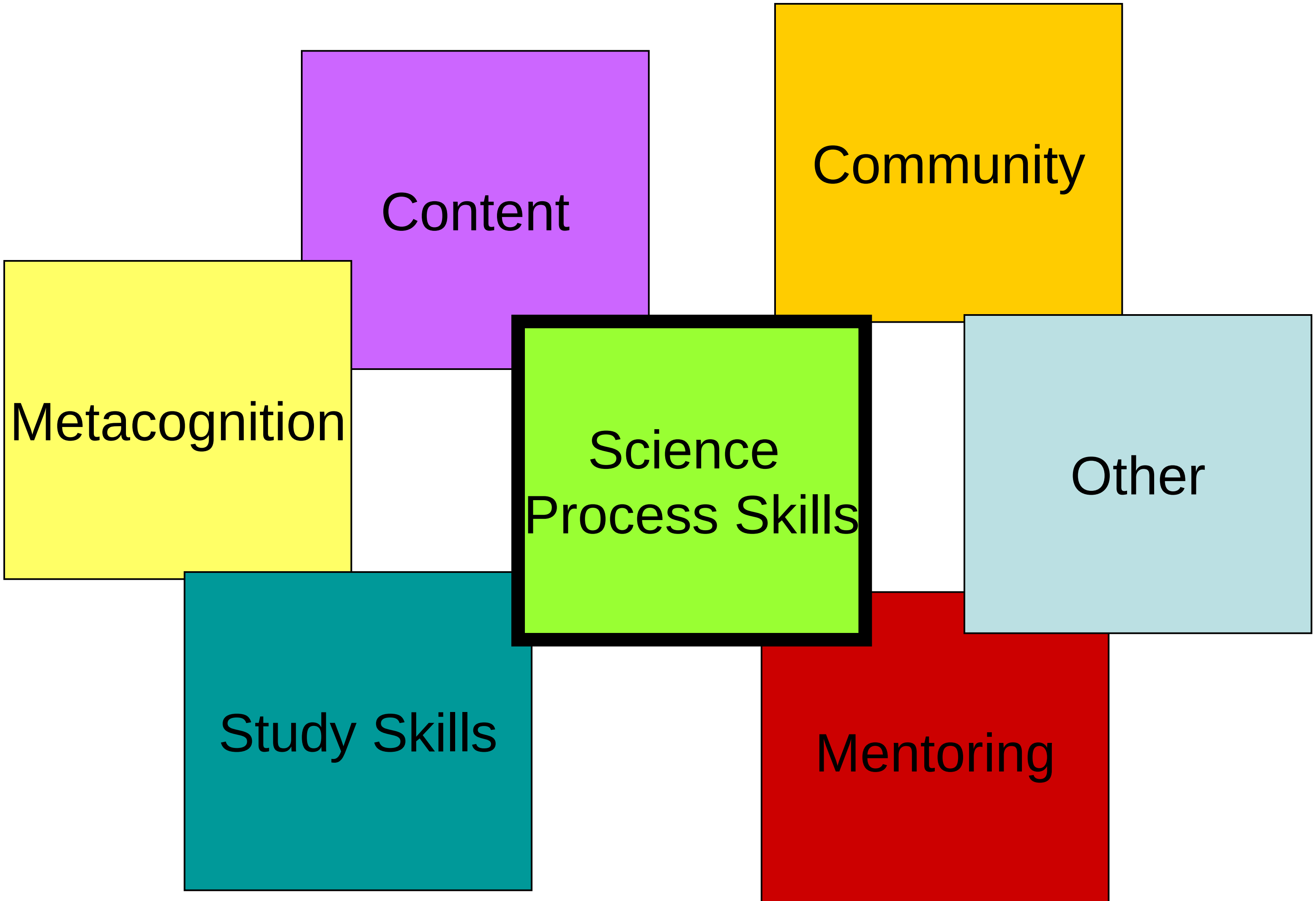
	All Students	URMs	EOP	Non-EOP	Women
BFs					
Median	3.3	3.2	3.0	3.5	3.1
Mean ± SD[a]	3.2 ± 0.58 (33)[b]	3.2 ± 0.43 (7)	3.0 ± 0.72 (14)[b]	3.3 ± 0.45 (19)[b]	3.1 ± 0.6 (25)
Non-BFs					
Median	2.9	2.8	2.6	3.0	2.9
Mean ± SD[a]	2.9 ± 0.61 (1392)	2.7 ± 0.63 (58)	2.6 ± 0.61 (246)	2.9 ± 0.60 (1146)	2.9 ± 0.6 (787)

[a] Sample size is given in parentheses.
[b] Statistically significant compared with non-BFs, $p < 0.05$.

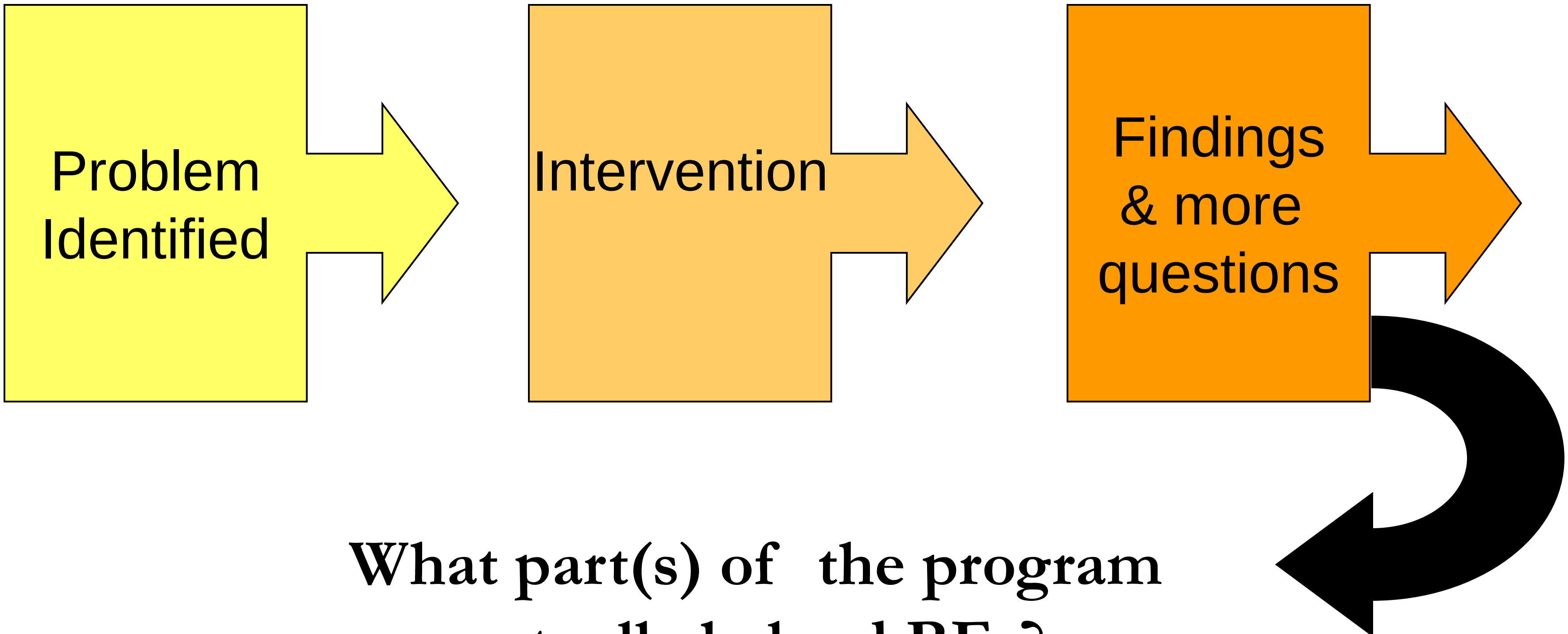
They also preformed well in the entire biology series and persisted in the major. (N = ~250)

Dirks, C., and Cunningham, M. *Enhancing Diversity in Science: Is Teaching Science Process Skills the Answer?* **2013**CBE—Life Sciences Education Vol. 5, 218–226, Fall 2006

What Did the Biology Fellows Program (BFP) Provide for Students?



Now I was on a path to DBER . . .



What part(s) of the program actually helped BFs?

My Pathway Into DBER is a Case Study for Today's Workshops

Part I. My transition from teaching and action research into DBER

Part II. DBER about student's acquisition and mastery of science process and reasoning skills

Part III. Development of the Science Process and Reasoning Skills Test (SPARST)

My Pathway Into DBER is a Case Study for Today's Workshops

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Now I use Action Research to Address Many Questions about Teaching and Learning

Do interdisciplinary quizzes help students learn biology, physics and chemistry in an interdisciplinary manner?

Can students develop metacognitive skills and change study behaviors by taking short quizzes while studying?

How do students best learn how to create and interpret phylogenetic trees?

If small groups of students are assigned figures from a primary literature paper and then jigsaw with other small groups, do they better understand the content in the paper?

AND MANY, MANY MORE!

Group Work (20 minutes)

In small groups:

1. Discuss and list the ways in which you a) have used action research or b) would like to use action research.

2. Identify the common themes within your group.

Examples of action research to assess students' . . .
attitudes about science
learning of science content
learning of science process skills
development of metacognition
interventions for success of a group (gender, URM, etc…)
other

Each Group Report Out

What are the ways in which you a) have used action research and b) would like to use action research.

What were the common themes within your group?

Using Action Research and DBER To Move Beyond Anecdotal Evidence for Learning

Common measures of teaching and learning in the sciences	Use of Action Research and DBER for measuring learning
Student evaluations of faculty	Measurements of student learning gains using validated and reliable instruments
Exam scores	Evaluation of assessment tools
Final grades	Qualitative and quantitative evaluation of student development or ways of knowing

How Can We Move Toward Bring Best Practices for Science Teaching Into the Classroom?

Use of Action Research and DBER for measuring learning

Measurements of student learning gains using validated and reliable instruments

Evaluation of assessment tools

Qualitative and quantitative evaluation of student development or ways of knowing

Spread the Word and Continue the Movement

AIP | American Institute of Physics

per central

FIRST IV

Faculty Institutes for Reforming Science Teaching

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Reflect
Beliefs
Design
Practice
Network

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

HHMI
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The National Academies
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ACS
Chemistry for Life®

AGU
American Geophysical Union

CIRTL

Society for the Advancement of Biology Education Research
SABER

AMERICAN SOCIETY FOR ENGINEERING EDUCATION
ASEE

Make Scientific Teaching Transparent To Help Students To Accept it as the Norm

Why do you give so many quizzes?
Benefits of Testing versus Studying [Roediger & Karpicke (2006)]

Why did you organize the syllabus that way?
Blocking vs Interleaving [Kornell & Bjork (2008)]

Why do I have to do homework before you lecture on the content and then come to class to do problems with others?
Active Learning [There are so many studies that show it works!]

Research supports… “teaching with my mouth shut.”

Active Learning

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DISCUSSION AND REFINEMENT OF RESEARCH IDEAS

QUESTIONS?