Science Education Reform

Pipelines, Partnerships and Pathways

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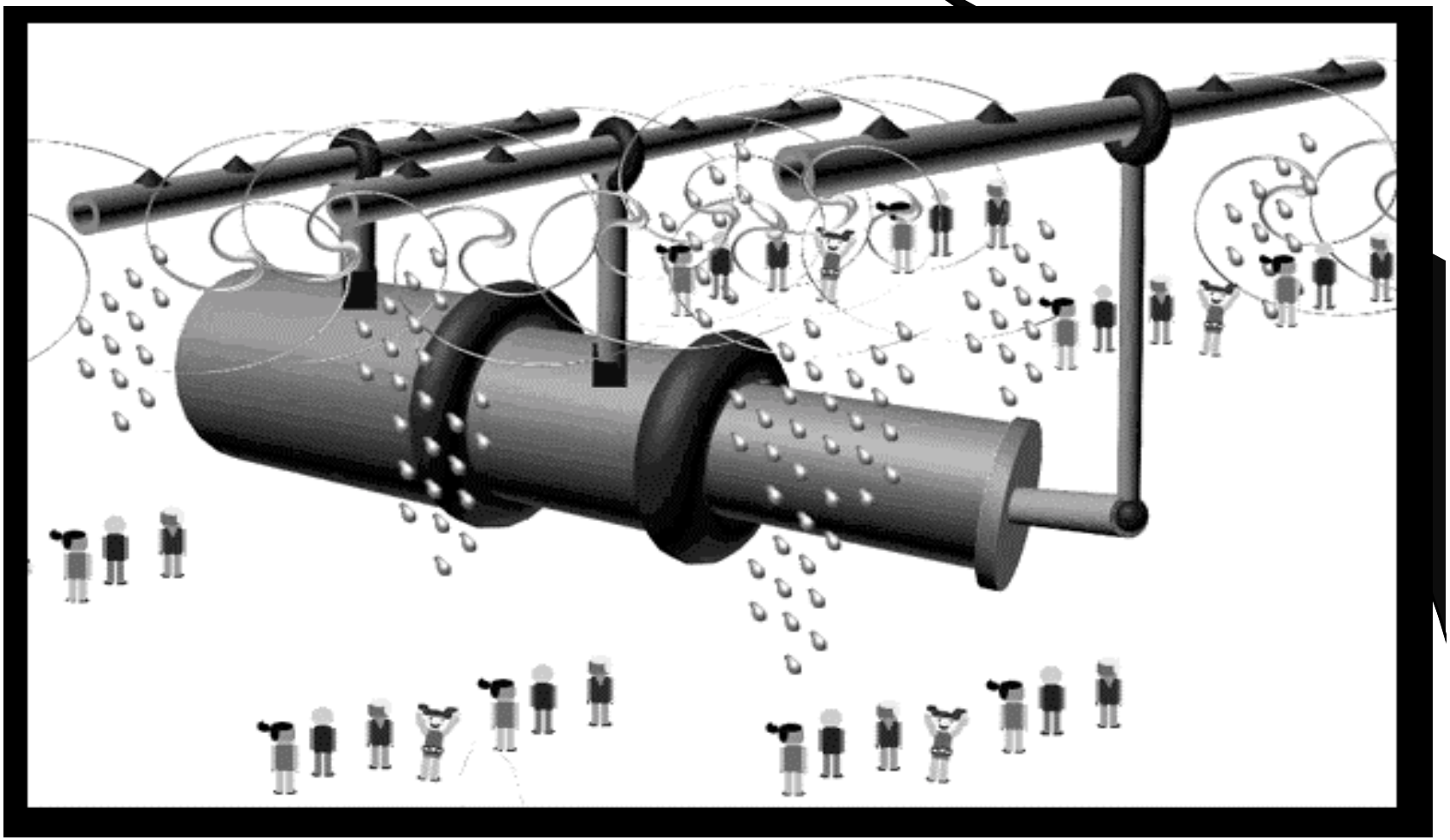
Draw a scientist

what is the scientist is doing

how the scientist looks

describe the scientists values

Science Education Pipeline to Pathways



All students should experience the joy and wonder of science

No Excellence without Equity

	US (%)	B.S. (%)	M.S. (%)	Ph.D. (%)
African-American	12.1	5.7	4.8	3.5
Asian-American	2.9	3.3	2.9	3.5
Hispanic-American	9.0	2.7	2.4	2.6
Native American	0.8	0.4	0.4	0.4

Bill of Rights

from Reinventing Undergraduate Education

- Learn by Inquiry
- Training in oral and written communication
- Appreciation of arts, humanities, sciences and social sciences
- Comprehensive preparation for real world and grad school

- opportunity to work with research mentors
- Access to first class research facilities
- Many options for study
- Interactions with diversity of peoples

Science and Math Depts..

- In collaboration with other departments and with prospective employers, set departmental goals for undergraduate learning.

- Provide a curriculum that engages and motivates the broadest spectrum of students, enabling every student to learn

Shaping the Future, NSF 1996

Faculty

- Build into every course inquiry, a knowledge of what STEM practitioners do, and the excitement of cutting-edge research.
- Devise and use pedagogy that develops skills for communication, teamwork, critical thinking, and lifelong learning in each student.

Science Literacy for all

- all citizen must be able to make intelligent decisions about how and when to apply science and technology
- Scientific “habits of the mind” teach us to:
  - think critically
  - become thoughtful compassionate citizens
  - promote a just society
- Economic vitality depends upon a technologically and scientifically literate citizenry

Science Literacy for all

- Essential for solving real problems
  - population
  - climate change
  - health and disease
  - environment
  - preventing war and violence

What should we do?

Real Reform

Participatory

Inclusive

Collaborative

Visionary

Strategic

Hard

Slow

Saber-Tooth Curriculum??

Three fundamentals taught in community schools, created by the great innovator, New-Fist: fish grabbing with bare hands, horse clubbing and saber tooth tiger scaring with fire.

When a glacier caused fishes, horses and tigers to disappear, schools nevertheless went on teaching the old fundamentals for the eternal verities they contained---until a few radicals called for revisions in the Saber Tooth Curriculum.

Pediwell, 1939

Most Science curricula are overstuffed

but undernourished

Great Science Education

Hands-on, Minds on

Inquiry-based

Emphasizes exploration

Builds skills

Less is more

Encourages collaboration

Addresses Equity Issues

Sets high standards

Encourages excellence

Convey Values and Attitudes of Scientific Worldview

- Verifiable data
- Testable Hypotheses
- Prediction
- Integrity
- Diligence
- Fairness
- Curiosity
- Imagination
- Open to New Ideas
- Skeptical

Develops skills

- Critical analysis
- Observation
- Computation
- Communication
- Logic

In other words...

- Engage
- Explore
- Explain
- Elaborate
- Evaluate

replaces

- Tell them what you'll tell them
- Tell them
- Tell them what you told them

Effective Learning and Teaching

- Quality, not Quantity
- Connects New Knowledge to old
- Constuctive, restructures old frameworks based on new
- Concrete to Abstract

- Student Development
- Laboratory and Course Development
- Collaborative minors & majors
- Faculty Development

We have met the enemy and he is us

Faculty Development

- Investigative Cases, PBL
  - http://www.sciencenet.emory.edu/coll_curr/faculty_projects/recent.html
- Integrating Neuroscience into Psychology
- Bioinformatics
  - http://www.bioquest.org
- Course and Laboratory Development
- Venture grants

Reform requires change

- texts and materials
- tests and assessments
- culture
- priorities

Pathways-student development

- Options and alternatives
- Know the requirements at each level
- Internships (industry, education, journalism, policy)
- Theory and practice
- Finding vocations
  - What you like doing
  - What you are good at
  - What needs doing

Center Education Goals

- Create a cadre of interdisciplinary investigators in behavioral neuroscience
- Expand career pathways for undergraduate and graduate students
- Increase the participation of women, underrepresented minority students and people with disabilities in behavioral neuroscience research and education
- Enhance science content and pedagogy in metro Atlanta K-12 school systems

Increasing Women and Minorities in Behavioral Neuroscience

- Effective outreach programs
- Early exposure for undergraduates
- Collaborative graduate training
- Access to alternate careers

Integrating Research and Education

- Students as Vectors
- Venture grants
  - Infusing Neuroscience into Psychology
  - Web based Behavior modules
- Released time and research support for AUC faculty
- Research Faculty involved in BRAIN, SURE, Outreach, Teacher Research Program

Undergraduate Goals

- To attract students to careers in behavioral neuroscience and to other fields in which understanding of behavioral neuroscience would enrich science literacy for the public,
  - science journalism
  - K-12 and college teaching
  - public policy

- To increase the number of women and minorities entering PhD programs in Behavior and Neuroscience

Highlights

- Faculty workshops
  - Morris Brown: Integrating Neuroscience into Psychology
  - Investigative Cases
- BRAIN expansion
  - 34 in ForeBRAIN; 24 in midBRAIN; 27 in HindBRAIN
- 36 of 86 Summer Research in CBN (SURE)
- Grants for BRAIN and a postbaccalaureate research opportunity program

The Triune BRAIN

- ForeBRAIN
  - Evening seminars- 5 faculty, 1 postdoc, 3 graduate students
  - 34 participants- 85% URM
  - 97% “increased interest in neuroscience”
  - 94% “increased interest in doctoral study”
  - 71% continued to research internship
- MidBRAIN
  - 11 week internship in Spring for 24 students
  - 91% URM; 75% interested in research career
  - 58% continued to summer research

The Triune BRAIN

- HindBRAIN
  - Funded by new NSF REU for freshmen and sophomores
  - Research, mini-neuroscience course, journal club, SWORD
  - 27 participants; national and CBN institutions
  - 81% from HBCU; 50% AUC

BRAIN

- Robot Project
  - Innovative way to learn scientific method and behavioral neuroscience
  - Design experiment to determine animal robot most closely mimicked
  - Train robot to respond differently to aversive stimuli
  - Propose a model of the brain and map the cerebral cortex

Student Research

Research experiences often attract students -- including women and members of underrepresented minority groups --

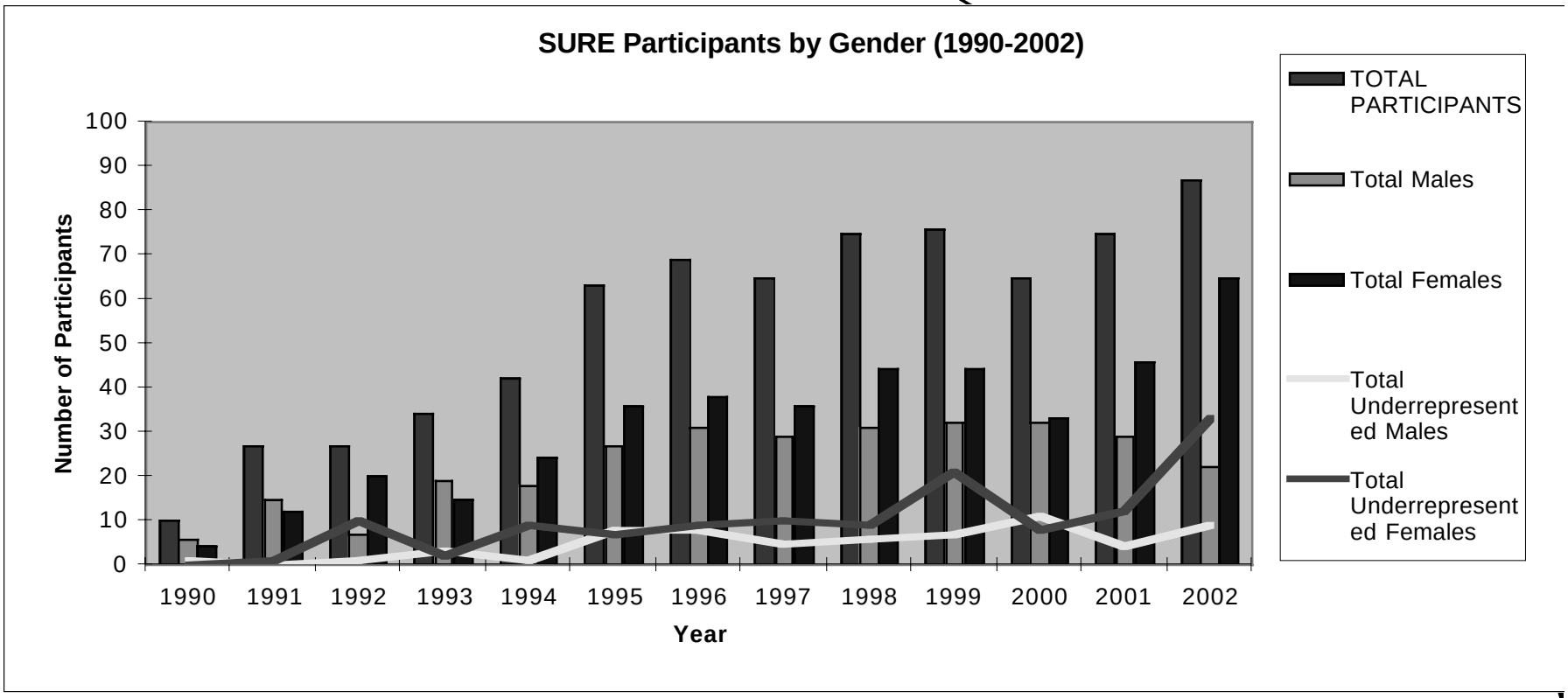
to science, and stimulate their interest in science as a major and a career.

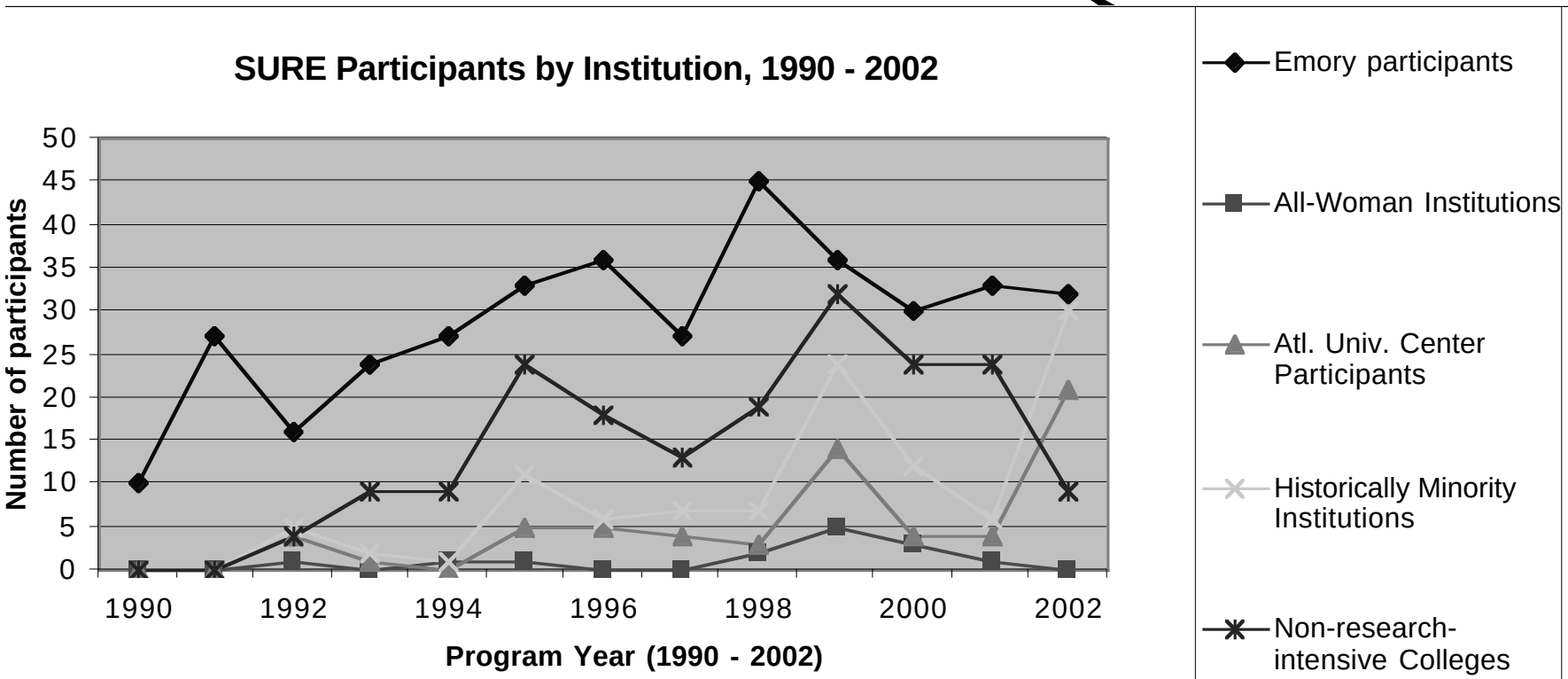
Research Programs

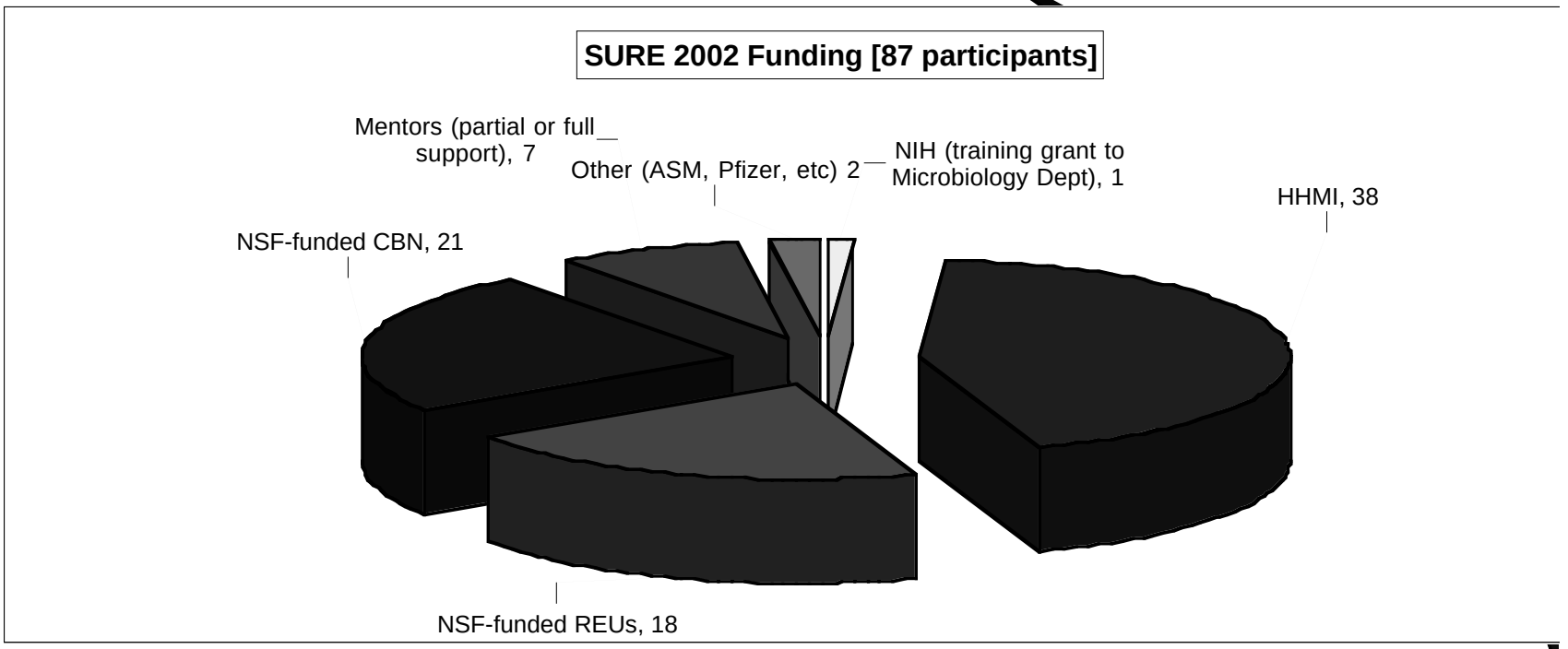
- Summer Research Program
- Research for Credit
- Resource Files

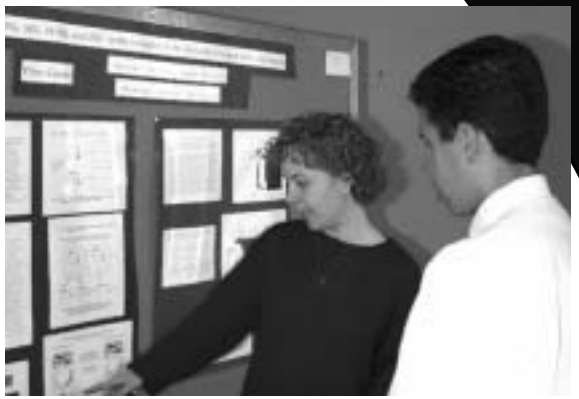
SURE

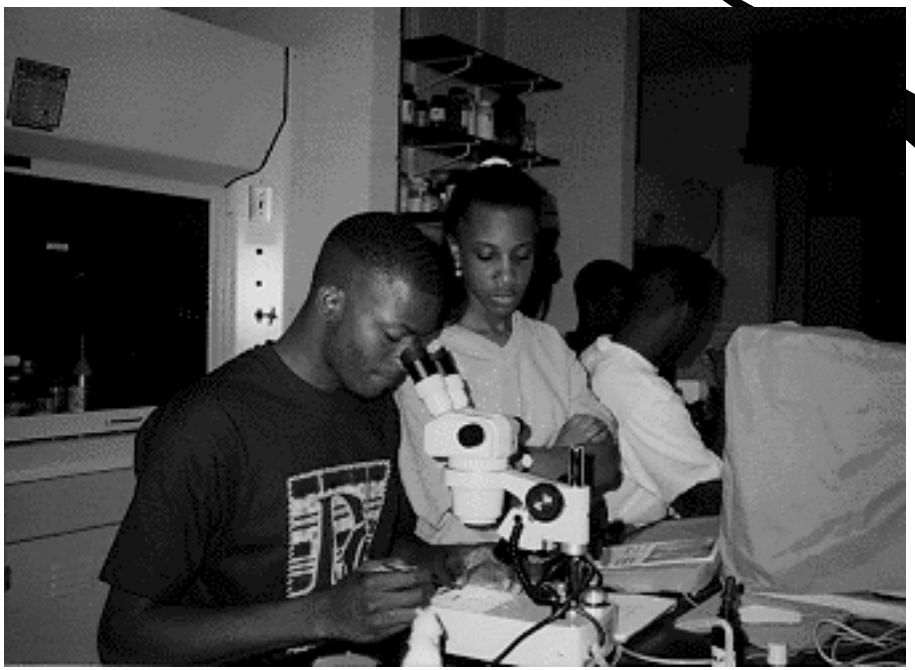
- promote the development of skills that will help students enter and remain in the field of science
- explore ethical issues pertaining to research
- enhance students' abilities in questioning, problem-solving, analysis, and oral and written communication
- provide information about careers in research and encourage students to enter careers in research, and
- recruit students for Emory's graduate programs.


SURE Participants by Gender (1990-2002)
Number of Participants
100
90
80
70
60
50
40
30
20
10
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
Year
TOTAL PARTICIPANTS
Total Males
Total Females
Total Underrepresented Males
Total Underrepresented Females


SURE Participants by Institution, 1990 - 2002
Number of participants
50
45
40
35
30
25
20
15
10
5
0
1990
1992
1994
1996
1998
2000
2002
Program Year (1990 - 2002)
Emory participants
All-Woman Institutions
Atl. Univ. Center Participants
Historically Minority Institutions
Non-research-intensive Colleges


SURE 2002 Funding [87 participants]
Mentors (partial or full support), 7
Other (ASM, Pfizer, etc) 2
NIH (training grant to Microbiology Dept), 1
HHMI, 38
NSF-funded CBN, 21
NSF-funded REUs, 18





"We are convinced that science and mathematics education works wherever it takes place within an active community of learners,... and where faculty are deeply committed to teaching, devoted to student success, and convinced that all students can learn. It works where learning is active, hands-on, investigative, and experiential, and where the curriculum is rich in laboratory experiences, steeped in the methods of scientific research as it is practiced by professional scientists . This approach works for women, minorities, for all students."

Project Kaleidoscope Report

Questions

- How can your center assist faculty with interactive pedagogy?
- How can your center develop curricular materials for majors, prospective teachers?
- How can your center build early research and internship opportunities?

Challenge

- Identify list of Best Practices that might work for your centers
- Challenges and Constraints to implementation