

Changing Undergraduate STEM Education:

Addressing Disciplinary and Institutional Culture

Cathy Manduca

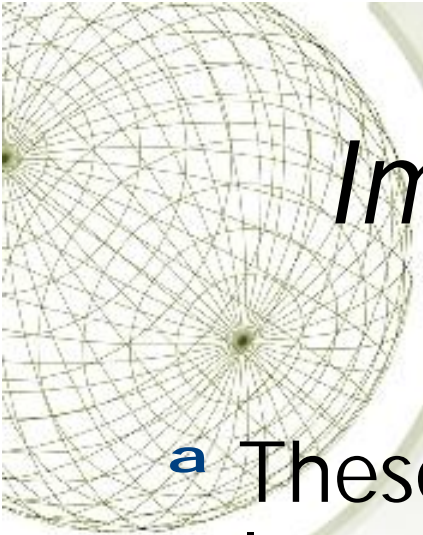
Science Education Resource Center

Carleton College



My reference frame: Geoscience

- a On the Cutting Edge - Workshops and websites for geoscience faculty
 - a 6 years, 1200 participants, 80% change teaching, 70% change attitude, 10,000 intensive website users
- a Building Strong Geoscience Departments
- a AGU Committee on Education and Human Resources - 8 years of service
- a NAGT President 2004, Executive Director , 2007-

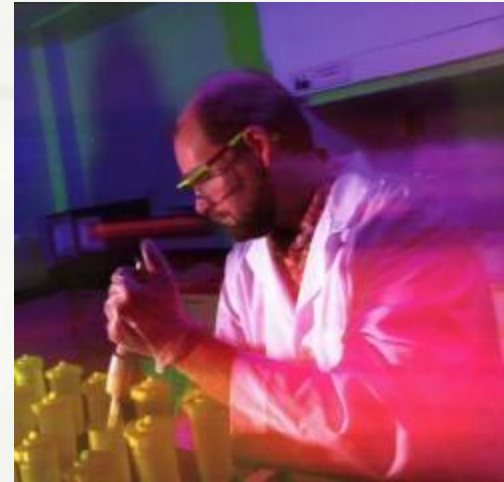


Improving STEM Education: Focus on Faculty

- a These programs work - faculty come, learn and change
- a We are frustrated because
 - a Things don't change as fast as we'd like
 - a The reach is not as broad as we'd like
- a Can we accelerate change by looking at the cultures

Faculty Live in Two Cultures

- a Learning Communities
(colleague interaction, primary source of information)
- a Values and Expectations *(is my teaching important? How good is good enough?)*
- a Reward and Recognition
(respect, tenure and promotion)
- a Resources *(grants, teaching spaces, time)*





Geoscience Professional Society Approach

a Nurture Leaders

a Educate Masses

Uninformed Faculty

Informed Faculty
Make Use of Research, Observe Impact

Disciplinary Ed Researchers, Curriculum Testers

People

Information



Meeting Sessions: GSA 2008

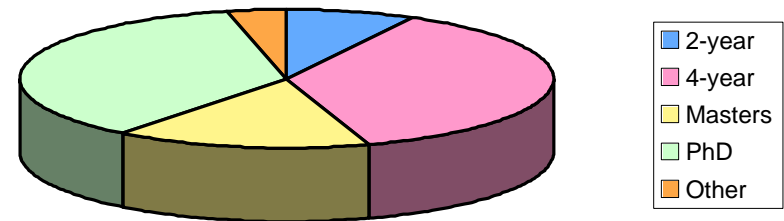
21 sessions including:

- a Research on Geoscience Teaching and Learning in Experiential Environments
- a Geocognition: Researching Student Learning in the Geosciences
- a Global Warming Science: Implications for Geoscientists, Educators, and Policy Makers
- a What Should Students be Learning in Our Geology Classrooms?
- a Geoscience Diversity 2008: Status, Strategies, and Successful Models
- a Teaching with New Tools: Visualizations, Models, Online Data, Games, and More
- a Teaching Petrology and Structural Geology in the 21st Century

Cutting Edge—Scale Matters

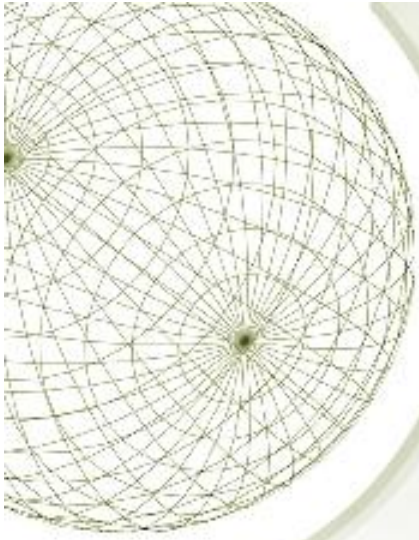
- a 20% of geoscience faculty have participated in workshops
- a 46% know about the program

Departments - Faculty Participants



a Impact:

- a Legitimizing teaching as a topic of discussion
- a Repurposing research networks for educational discussion
- a A culture of sharing: 10,000 returning website users; 727 activities



Data Help

Macdonald et al., 2005, JGE v 53 p237-252 2200 responses 39%



Building Strong Geoscience Departments


Departments are important:

- a** Changes in course structure made by individual faculty can be institutionalized (Tobias)
- a** Changes in curriculum beyond a single class are possible (Savina)
- a** Student experiences in a major include factors beyond an individual faculty members teaching (Hilborn and Howes)
- a** The department is most proximal source of support or discouragement for changes in teaching methods (Macdonald et al)




Building Strong Geoscience Departments

Build Leadership Group
Verify Need



Understand Current Practice
Develop Resource Base



Disseminate Lessons
Learned

Evaluate Impact



Geoscience Departments: Developing Pathways to Strong Programs for the Future

Supporting individual departments Strengthening the geosciences as a whole

- Promoting communication and discussion
- Sharing information and resources
- Enabling collective action



Building Strong Geoscience Departments

Build Leadership Group
Verify Need

- a Sharing Resources is Valuable
- a Challenges
 - a Recruiting Students
 - a Preparing Workforce
 - a Rapidly Evolving Field
 - a Institutional Dynamics
 - a Curriculum Design/Program Assessment
- a Characteristics of Thriving Departments

a Impact:

- a *Leadership Group Established Including Reps from AGI, AGU*
- a *Increased Discussion in Geoscience Community*



Building Strong Geoscience Departments

Build Leadership Group
Verify Need



Understand Current Practice
Develop Resource Base

Evaluate Impact

Understanding Current Practice: Workshops and Website

- a The Role of Geoscience Departments in Preparing Students for Professional Careers: *January 2007, 26 departments*
- a Connecting Geoscience Departments to the Future of Science: New Structures for Research and Curriculum: *May 2007, 24 departments*
- a Strategies for Successful Recruitment of Geoscience Majors: Conceptual Framework and Practical Suggestions, *October, 2007, 37 departments*
- a Assessing Geoscience Programs: Theory and Practice - *February 22-24, 2009*

Building Strong Geoscience Departments

Defining Strong Departments

Many researchers have studied what makes a department "strong." Read about their findings.

National Context

Given the ongoing changes in how we do science, how colleges and universities operate, and in the realm of education, how can your department anticipate and prepare for the future?

Department Activities

Find resources and references about student recruitment, program development (including curriculum, internships, student research, advising, mentoring, and more), and professional preparation for students as they prepare for the next stage of their development, whether that's entry into a career or further education.

Heads and Chairs

Department Heads and Chairs are expected to lead their departments through strategic planning processes, recruit and retain top-notch faculty, and advocate for their departments in a world of finite resources. Learn successful strategies for doing all of that.

Workshops and Sessions

Find out about workshops and conference sessions focusing on strengthening geoscience departments and ensuring the future of quality geoscience education at colleges and universities.



Photo of [Olin Hall](#) at the University of Minnesota

serc.carleton.edu/departments



Building Strong Geoscience Departments

Understand Current Practice
Develop Resource Base

Impacts:

- a* Changes in participants programs - *short T, complex system*
- a* Website supports change for participants and beyond -900 repeat visitors
- a* Possible to describe state of recruiting, curriculum, workforce preparation in at least a limited sample - *impacts disciplinary culture for change*
- a* Mechanism for collecting opinion, integrated view - *accreditation*
- a* Increased value for departmental actions - *at least for the leadership group*

Building Strong Geoscience Departments

Build Leadership Group
Verify Need

Understand Current Practice
Develop Resource Base

Evaluate Impact

Disseminate Lessons
Learned

Outstanding Questions:
Does this improve climate for faculty?
Strengthen departments?



In Sum

- a **Disciplinary culture**

- a accepts interest in education - how much was us? NSF? the times? next generation?
- a improvements in teaching, use of research are happening - still room to grow, spontaneous sharing
- a has pace or reach increased?

- a **Departmental culture**

- a Workshops lead to changes at participating institutions - Harder because of institution/department/faculty interaction
- a Increased importance in disciplinary culture
- a Discipline/Institution interaction - how can these efforts be aligned?



Acknowledgements

- a* This presentation reflects the integrated effort of my colleagues both within and beyond the geosciences.
- a* My work within the professional societies is informed from my years on the AGU Committee on Education and Human Resources where I served under Chairs Randy Richardson and Roberta Johnson, and with Education Directors Frank Ireton, Jill Karsten and Ines Cifuentes, as well as by my years as an NAGT officer serving with presidents Jill Whitman, Ed Geary, Geoff Feiss, and Karen Havholm and Executive Directors Bob Christman and Ian MacGregor.
- a* The On the Cutting Edge project is lead by Heather Macdonald, Barb Tewksbury, Dave Mogk, and myself; sponsored by NAGT and funded through grants from the Division of Undergraduate Education at the National Science Foundation (#0127310, #0127141, #0127257, #0127018, #0618482, #0618725 and #0618533).
- a* The Building Strong Geoscience Departments project is led by Geoff Feiss, Heather Macdonald, Randy Richardson and myself; sponsored by NAGT, AGU,GSA and AGI, and funded through grants from the Division of Earth Sciences and the Division of Undergraduate Education (#0331930, #0331933, #0614926, #0614570, #0614393, #0817353, #0817265).
- a* The Teach the Earth site includes work from NSF projects funded through the NSDL program, the CCLI program, the scientific research directorates and others.