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Refocusing the Revolution: A New Research Agenda for Geoscience Education.

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Blueprint for Change: Revolution in Earth and Space Science Education (Barstow & Geary, 2001)

www.EarthScienceEdRevolution.org

- 2001 national conference
- Vision for improving the state of geoscience education
- Major, long-term, recommendations
- Pointed to a need for research in geoscience education

Geoscience Education: Stuck in Low Gear or Poised for a Breakthrough?

We must act quickly & broaden approaches to four problems

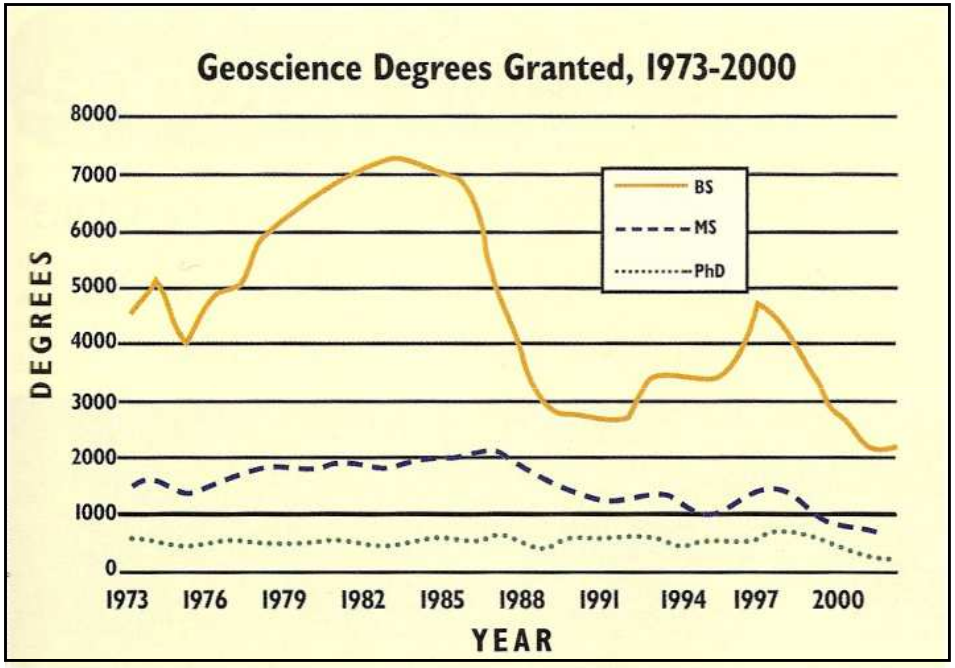
- Falling geoscience undergraduate enrollments
- Lagging diversity in the geosciences
- Insufficient secondary Earth & space science teacher supply
- Low (7%) high school ESS course offerings and enrollment

Leverage existing educational research literature & theory

- Curriculum stability and change
- Culture, gender, and science education
- Socio-cultural models of science and theories of learning

Develop a new research agenda to spark the *Revolution*

Problem # 1: Higher Ed Geoscience Majors



Source: AGI data in Ridky, 2002.

- Compared to the early 1980s geology departments are producing 65% fewer undergraduate geoscience majors; 50% less now than in mid-1990s (AGI, 2002)
- Difficulty in attracting and retaining underrepresented groups of undergraduates (6.3%) as majors (Huntoon & Lane, 2007)

Problem # 2: Secondary Education Earth & Space Science Teachers

- Historically, there have never been enough qualified ESS teachers…
  - In **1966**: ~ **6,000** to **7,000** Earth science teachers
  - In 1966 the Earth Science Curriculum Project staff predicted a need for **20,000** teachers by **1970** (Romey, 1966)
  - In **2001: ~ 14,050** Earth science teachers (CCSSO, 2001)

Forty years later, we still haven't reached the numbers of teachers that were needed in 1970.

- By **2010** (due to 30% est. teacher retirements in 2001):

  14,050 - 4,215 = 9,835 + X (New ESS Teachers)

Biology Education: An Example of Success

- Over the last 100 years biology has achieved a strong foothold in high school science
- Biology has the highest number of certified teachers: **51,048**
- **88%** of students take high school biology
- Large numbers of students majoring in the biological sciences
- Women are more attracted to biological than the physical sciences
- More women **(39,913 = 62%)** than men **(23,979 = 38%)** majoring in biology (NSF, 2007).

In the geosciences, we have 95% fewer majors, and men (1,812 = 57%) still outnumber women (1,358 = 43%).

Current Situation: The Engine is Idling

Contributing historical factors:

- Entrenched precedent for 9th grade general or physical science courses despite the NSSE's condemnation of the practice in the 1930s
- Secondary Earth science was never considered to be a viable course until the 1960s with the advent of plate tectonic theory (Lewis, in press)
- Geology's historical low status among the other "Nobel" sciences (Dodick & Orion, 2003)

ESS is not central to the high school curriculum despite equal emphasis in the national standards as part of a national vision of scientific literacy (NRC, 1996).

Challenge of Affecting Institutional Changes

- Historical research reveals the overall stability of American curriculum in response to external and internal factors. (Cuban, 1992)
- **ESS external factors:** 1960s and 1970s successful promotion of Earth science curricula and teacher professional development through highly funded, well-coordinated efforts by AGI and NSF.

Despite these efforts, the status of ESS is not equal to that of biology, chemistry, or physics.

Suggests the majority of the control lies with internal factors.

- We lack empirical data on **internal** factors, e.g., teachers, parents, students, and administrators, guidance counselors' perceptions of geoscience).
- We need to move beyond anecdotal speculation about causes and sources of resistance to geoscience education.

Geoscience Education Discourse & Research

- Geoscience education reform has focused nearly exclusively on developing more engaging lessons
- Majority of scholarly articles in geoscience education research concentrate on:
  - identifying students' misconceptions
  - developing lessons to affect conceptual change
- While this is important and necessary work, it does not address:
  - failure to enact high school ESS standards
  - the lack of well-educated secondary ESS teachers
  - undergraduate geoscience recruitment problems

Geoscience Education Stereotypes

- Anecdotal evidence points to a lack of awareness of the intrinsic value of ESS by internal factors
- Stereotypical view of ESS courses = less rigorous than biology, chemistry, and physics (e.g., "rocks for jocks")

It's time to broaden our research agenda to find out more about systemic internal factors.

- Are lower-performing students more likely to be enrolled in ESS to satisfy their graduation requirements?
- Does this phenomenon further support the stereotype and reinforce misconceptions about the geosciences?

Shifting Gears:
Leveraging Other Research Lenses

- We know what the big problems are, but to understand why they exist, researchers must dig deeper.
- Currently the geoscience community has largely adopted a cognitive/conceptual change model of learning as its paradigm
- Limits our understanding of social-cultural actions and events
- Time to employ complementary social science theories and perspectives including:
  - interactive communities of practice
  - situated learning contexts with other people and their environment
  - emphasis on the local construction of meaning (Wenger, 1998)

Once we understand the landscape for the journey we can better configure plans of action.

Socio-Cultural Aspects of Learning Science

- Science education is a cultural enterprise (Maddock, 1981)
- Cobern & Aikenhead (1998)
  - Sociological view: "socializing students into a community of practitioners [scientists]."
  - Anthropological view: "enculturation via a rite of passage into behaving according to [scientific] cultural norms and conventions."
- Science as a social language (Lemke, 1990)
- Western modern science is its own culture and discourse, one that is foreign and confronting to many students
- Science often asks students to adopt scientific identities without valuing their existing identities (Gee, 2005)

Gender & Science Education Research (Baker & Leary, 1995)

- School-aged girls think that women can and should do science, regardless of topic or area
- Parents can negatively affect girls' desire to pursue science as a career if they hold traditional gender stereotypes
- Girls prefer learning science in interactive and social contexts rather than through isolating activities, such as note-taking and lectures

If we broaden ESS teaching practices with more peer interaction are we more likely to meet the needs of female learners and increase geoscience enrollments?

Fuel for Thought: New Angles on Research

Problem #1: How to increase geoscience majors

Geoscience enrollment issues may have more to do with:

- A student's identity
  - Do geoscience practitioners' ways of making meaning in science and communicating appeal to students' cultural values, norms, and practices?
- Preferred ways of meaning-making & learning
  - How do students perceive their learning environments?
- Status of women and minorities in geoscience
  - Are they encouraged and mentored with equity by faculty?
  - Are their (cultural) differences respected in departmental communities?

Further Fuel for Thought

Problem #2: Increase numbers of ESS teachers

- Systemic structures to support teacher education programs
- Attitudes of geoscience faculty
  - What attitudes toward K-12 education do faculty hold?
  - What attitudes do faculty express regarding students' whose career goals involve teaching?
  - And how do community attitudes affect the recruitment of ESS teachers?
  - Do students' embrace/reject teaching as a career due to others' attitudes toward education?

Next Steps: Re-Fueling the Revolution

- Bridge the gap between students' culture and identities and the culture, community, and discourse of geoscience.
- Talk with college of education faculty to help evaluate geoscience instructional practices and/or seek out professional development to broaden teaching skills.
- Interview faculty in the biology department about their success in attracting, and retaining, students and educating teachers.

Multi-method approaches and multiple, **complementary theoretical lenses** hold the promise of empowering geoscience education research and firing up the ***Revolution.***

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