Some Reflections on Curriculum Design and Program Assessment:

David Mogk
Dept. Earth Sciences

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http://serc.carleton.edu/107251
We do a pretty good job presenting scientific content to students:

- Taxonomies
- Methods
- Problem sets and worked examples....
But, are we doing a good job producing good Scientists?

- What are the attributes required of being a good geoscientist?
- Where in your curriculum professional development as a scientist explicitly addressed?
- What other extracurricular training is needed?
- Who has responsibility?
Whole Student Approach

- Define programmatic **student learning goals**
- Embed **assessments** throughout the program to demonstrate mastery
- **Align** course sequences to reinforce and anticipate essential concepts and skills
- Prepare students to be **life-long learners**
- Assign **responsibilities** to ensure these goals have been met.
The Product

❖ Students who can

❖ Understand geologic context, apply concepts and skills
❖ Ask the next question
❖ Know where to look for information
❖ Formulate a plan to address the problem
❖ Become critical producers and consumers of data
❖ Integrate multiple lines of evidence
❖ Communicate results;
  ❖ write a report, make a map, develop a GIS….
❖ Be life-long learners
“Backward Design”

What is the profile of the student leaving your department?
- What should they know, be able to do?

Preparation for the workforce
- Traditional “geo” employment or grad school: exploration, environmental, regulatory agencies…
- Non-traditional: policy planning, environmental law, K-12 teaching, business (e.g. insurance…)

“If it ain’t broke don’t fix it”
- But it was broke
- Need for more efficient utilization of faculty, TAs, course credits and resources;
- New courses needed, some courses terminated or merged.
Learning Sequences

Based on Bloom’s Taxonomy

- Observation of Earth (remembering)
- Description of Earth materials and land forms (understanding)
- Interpretation of Earth processes (application)
- Integration of multiple lines of evidence to address geologic (and societal) problems of consequence (analysis, synthesis, evaluation)

Base curricular decisions on sound Discipline-Based Education Research!
See: http://serc.carleton.edu/NAGTWorkshops/DBER.html
Rule of 3’s (or 4’s)

- If something is worth learning, students need multiple exposures and opportunities

- Exposure
- Familiarization
- Competency
- Mastery

Photo Credit: Jeff Ryan
- Review course sequences
- Scaffolded and articulated?
- Can students see a clear path towards graduation?
The “Matrix Approach”

Defining and assigning student learning outcomes
Recurring Themes

**History and Evolution of the Earth System**
- Biological and tectonic evolution
- Historical Geology, Vert and Invert Paleo, Tectonics

**Composition and Architecture of Earth**
- Earth Materials, Mineralogy, Petrology, Sed/Strat, Structural Geology

**Surface of Earth and the “Critical Zone”**
- Weather and Climate, Geomorphology, Hydrology

**Human Dimensions**
- Human, Regional, Resource, Economic Geography
- GIS and planning
- Hazards and Earth Resources; units in numerous courses
Geoscience Habits of Mind

- Earth System: heterogeneous, dynamic, complex, open system;
- Incomplete geologic record;
- Processes not directly observable on human scales (temporal or spatial);
- Ambiguity, uncertainty, inference.

Students need practice early and often!
Provide Students Opportunities to DO Science

- **Research Opportunities**
  - Intro course (PCAST)
  - Embedded in courses
  - Independent study projects
  - REU sites

http://serc.carleton.edu/NAGTWorkshops/undergraduate_research/index.html
Quantitative Skills

- Take as much math as can be fit into degree program!
- Calc I and II
- Statistics
- Linear Algebra, Diff Eq

http://serc.carleton.edu/mathyouneed/index.html
Collaborative, Interpersonal Skills

- Trust
- Respect
- Responsibility
- Willingness to share ideas
- Common sense of purpose
- Equal ≠ Equitable
Develop Extracurricular Departmental Activities—The “Co-Curriculum”

- Social events
- Journal clubs
- Department seminars and colloquia
- Field trips
- Internships
Expectations for the Workforce

- Quantitative skills
- Communication skills (verbal, written, graphical)
- Collaborative work (interpersonal skills)
- Systems thinking
  - Integration of multiple lines of evidence
- Problem-solving
- Research and research-like experiences,
  - Acquisition and use of data, modeling
- Applications to societal issues

See AGI Workforce Reports:  [http://www.americangeosciences.org/workforce](http://www.americangeosciences.org/workforce)
2015 Geoscience Employers Workshop
[http://www.jsg.utexas.edu/events/files/Employers_Workshop_outcomes.pdf](http://www.jsg.utexas.edu/events/files/Employers_Workshop_outcomes.pdf)
Workforce Expectations—Personal Traits

- Critical-thinking
- Problem-solving
- Curiosity
- Persistence
- Resilience
- Initiative
- .....
Ethics and Values

- Ethics and Self
- Ethics and Profession
- Ethics and Society
- Ethics and Stewardship of Earth

Teaching GeoEthics Across the Geoscience Curriculum

David Mogk, Department of Earth Sciences, Montana State University and Monica Bruckner, SERC, Carleton College

Jump down to: What do we mean by GeoEthics | Why Teach GeoEthics | How to Teach GeoEthics | Multiple Facets of GeoEthics: Self, Profession, Society, and Earth | Teaching Resources | 2014 Workshop | Get Involved/Contribute

http://serc.carleton.edu/geoethics/index.html
Essential Steps

- Align with institutional Mission Statement and Departmental Role and Scope Documents
- Know your students.
- Identify the “Ideal Student” who graduates from your dept.
- Address new realities
  - Changing nature of Geoscience, Workforce, Emerging Research....
- Identify essential: Concepts, knowledge, geo-skills, professional skills, “Habits of Mind”, experiences, values....
- Create your matrix: Skills/content v. course sequence
  - Faculty input...
### Curricular Claims:
- Earth System Approach
- Multiple exposures to key concepts
- Reinforcement of skills
- Workforce expectations
  - GIS
  - Communication
  - Problem-solving
- “Habits of Mind”
- Articulation of curriculum
- Formative assessment
  - Changes in emphasis
  - “Gap” analysis
These are competencies or skills that are not “owned” by any one course, yet are essential for student pre-professional training.

The matrix approach identifies where these are addressed in course work, to what extent, how, and by whom— an important formative assessment for departments!
Support Claims Made About Your Department

- The department contributes to the institutional mission.
- The department is uses an Earth System approach
- The department has an integrated curriculum that is designed with learning sequences that develop higher order thinking skills.
- The department provides authentic research experiences.
- The department prepares students who are prepared a) to go to graduate school, or b) enter the workforce.
- The department serves society by addressing the "grand challenges" of living on Earth.
http://serc.carleton.edu/departments/index.html
Resources

- EER Workshop on Creating “The Matrix”

- A Curriculum by Design (blog on course alignment in curriculum)
  [http://serc.carleton.edu/earthandmind/posts/curriculum_desi.html](http://serc.carleton.edu/earthandmind/posts/curriculum_desi.html)

- A Curriculum by Design 2 (blog on matrix development)
  [http://serc.carleton.edu/earthandmind/posts/curriculum_desi2.html](http://serc.carleton.edu/earthandmind/posts/curriculum_desi2.html)

- Building Strong Departments
  [http://serc.carleton.edu/departments/index.html](http://serc.carleton.edu/departments/index.html)
ADDITIONAL SLIDES
Becoming a Valued Member of Your Institution

Administrators value departments they perceive as making positive contributions to the institution. There are two steps to becoming valued: making positive contributions, and making sure that your administration knows what you’re doing.

Building Strong Departments
Developing Pathways for Strong Programs for the Future

Strategies for Making Your Case

The best time to make a case for your department is all the time, so that your administration never questions your value to the institution. Here are some strategies for making your case, early and often.

Develop a Unifying Vision and Goals for Your Department
We Know “What Works”

- Recruitment and retention
  - Communities of scholars; faculty and peer mentoring; engagement
- How people learn
  - Discipline-Based Education Research
  - Human Cognition, affective domain, metacognition
- Course and curriculum design
  - Student-centered; active learning;
  - High Impact Practices
  - Alignment of learning goals, activities, assessments
We Must Change the Culture

- We don’t tolerate poor scholarship in research
  - Why not insist on excellence in education?

- Faculty professional development
  - Staying current in Science and Pedagogy/Practice

- Value Scholarship of Teaching and Learning
  - Creation of validated instructional activities is a major scholarly contribution.

- Awards, Rewards, Recognition
  - It’s “Us” that set standards, serve on P/T committees