Curriculum Design Exercise

The following lists were transcribed from an exercise conducted at the June, 2009 Building Strong Geoscience Departments workshop on Strengthening Your Geoscience Department. One group did the exercise (on building curriculum from skills, goals, content, experience and values) on the morning of June 3 and another group did it that afternoon. In each case, participants were asked to list three important geoscience-specific skills, three important general skills, three important experiences, three central concepts or critical content, three goals and three values that are or should be stressed in their undergraduate geosciences programs. The lists were compiled and organized by the workshop participants.

This document contains the lists from the morning group.

Morning – Critical content and threshold concepts
This chart has 11 clusters (Basic science, Earth materials, Tectonics, water, people, time, basic geology, spatial, interconnections, dynamics, climate) with a few post-its between two clusters

Basic science
- Rigor of scientific methodology
- Thinking in a scientific manner

Earth materials
- Earth materials
- Petrology (igneous, sed, metamorphic)

Tectonics
- Internal processes and plate tectonics
- Plate tectonics and the rock cycle
- Plate tectonics
- Plate tectonics/rock cycle
- Plate tectonic activitiy

Water, hydrology
- Oceans and hydrologic cycle
- Water/climate/environment basics
- External processes – surface and groundwater

People, relationship to society
- Fit into society (economics, natural disasters, environment)
- Surficial processes as relevant to humans
- Understanding relevance of geology to humans
- Social implications
- Economic application (petroleum, mining, etc.)
- Natural resources and human use/management

Time, temporal scales
- Deep time
- Relationship of human and geologic time scales
- Rocks as a record of geohistory
- Deep time
- Time
- Geologic time/uniformitarianism
- Role of timescales (seconds to millennia)
- Interpretation of past and future environments +/- climate

Connecting time and spatial:
Understanding concepts of spatial and temporal scales

Connecting time to dynamics:

Evolution/fossil record

Basic geology

- The importance of the rock cycle
- Solid earth basics
- Introductory geology
- Geomorphology/landform
- Earth – origin, structure, composition

Spatial

- Spatial scales (variability on)
- GIS
- Spatial analysis

Interconnections

- Understand role/importance of four spheres (atom, hydro, litho, bio)
- Interaction among Earth spheres
- Provide understanding of earth system
- Inter-connectivity of earth processes
- Links between different geological realms
- Inter-connectedness of earth systems

Dynamics

- Basic understanding of earth processes
- Darth is dynamic
- Dynamic earth/evoloving earth
- Understanding fluxes, rates of processes and feebacks

Climate, meteorology, climate change

- Climate change
- Physical meteorology
- Dynamic meteorology
- Synoptic meteorology
- Climate change causes and impacts
- Climate change
- To understand basic meteorological principles, such as continuity, vorticity, vertical motion, etc.

Morning – Geoscience-specific skills
Five clusters, labeled Time, Lab skills (divided into data and observation), Field & Maps, Thinking/doing scientist and understanding/executing science and Human Connection

Time
- Be able to determine (at least in theory) absolute agest of materials and processes
- Interpret rock record

Lab skills (divided into data and observation)
- **Data:**
  - Calculate the thermodynamic parameters and evaluate atmospheric stability using a thermo diagram
  - Using computational tools such as forecast models, Bufkit, IDV, etc.
  - Laboratory technology
  - Ability to take (environmental) samples
  - Specific the typical values and units of standard atmospheric parameters
  - Apply standard techniques for interpretation and plotting of meteorological data
  - Basic XRD operation for identification
- **Observation:**
  - Identify basic rocks, minerals and fossils
  - Sample evaluation
  - Basic mineral and rock identification – hand samples and microscope
  - Ability to ID rocks, minerals and fossils
  - Describing observations and separating them from interpretations
  - Know what to do at/with outcrop/rock/thin section (a little)
  - Natural features related to geology (observation)

Field & Maps
- Mapping
- Read a geologic map
- Competence in the field
- Use of topographic and geologic maps
- Field tools and methods
- Make a geologic map/measure sedimentary section
- The ability to read current maps and data to make sense of the atmosphere
- Map interpretation
- Practical GIS capabilities

Thinking/doing scientist and understanding/executing science
- Independent research experience
- Teach students to interpret facts, make decisions without <u>all</u> info
- Integration of geologic concepts/knowledge when making interpretation
- Application of a range of disciplines to a geologic problem
- Application of the scientific method
- Apply scientific process to geosciences problems (skill)
- Immediately question why natural features exist – how did it happen?

Human Connection

- Understand present role of geosciences in society
- Articulation of human-environment connection
- Understand the importance of geology
- Learn about planet that he/she lives on
- Interrelationship of man with environment
- Experience in public outreach

Morning – general skills
There are seven clusters: Oral/Presentation skills, Quantitative/Analytical skills, Research experience/skills, Critical thinking/Problem solving, observational skills, independence, Technical Writing and one odd post-it (internet geological activity).

Oral/Presentation skills
- Create and present a small poster
- Good presentation skills
- Ability to communicate (oral and written)
- Oral communication
- The ability to communicate scientiric data and analysis in oral and written form
- Excellent communicators
- Verbal communication skills
- Give a clear, professional oral presentation
- Presentation skills (verbal, written): audience-specific
- Strong written and oral communication
- Present and organize data (for potential interpretations/conclusions)
- Give a short talk
- Communication with other scientists
- Give an oral presentation in front of a large audience

Quantitative/Analytical skills
- Students will develop an adequate skill set in math and physics that allows them to quantitatively solve meteorological problems
- Perform quantitative assessment
- Use excel to solve quantitative problems
- Analytical experience – careful collection of scientific data
- Ability to apply mathematical descriptions to geologic concepts or phenomena

Research experience/skills
- Literacy – understanding databases and how to read primary literature and navigating on-line data sets
- Research
- Ability to perform research
- Review primary literature
- Ability to do research with primary sources
- Research skills: finding, obtaining, using valuable resources
- Read and understand scientific/professional literature (and news)
- An appreciation for the role research plays in the science of meteorology

Critical thinking/Problem solving
- Problem-solving skills
- Critical thinking
- Develop hypotheses, design experiments/programs to test them
- Ability to test hypotheses
- Deductive reasoning

- Ability to recognize critics flaws/strengths if scientific arguments
- Ability to articulate well-developed and thoughtful answers
- Understand a scientific report or paper and evaluate it

Observational skills

- Observation
- Observation

Independence

- Look after themselves in the field

Technical Writing

- Visual/written interpretation
- Write a technical report
- Persuasive and clear writing and oral communication skills
- Write a clear, well-documented report or scientific paper
- Writing
- Ability to write well

Morning – Goals
There are eight clusters: Communication, Field Experience, Program Improvement, Students and Research, Careers, Geoscience and Society, Encourage Geoscience Identity, Program Expansion

Communication
- Write effectively
- Present effectively
- Excellent communicator
- All students practice and improve communication of geologic ideas

Field Experience
- Take regular field trips
- All students have a significant field experience
- Include students in field work
- Encourage more co-curricular activities

Program Improvement
- Strong department
- All faculty teach undergrad majors
- Improve capstone experience
- Use a variety of techniques to address earth issues

Students and Research
- More lab experiments
- Involve undergrads in research
- Faculty research productivity and success
- All students collect data and interpret results within context of literature

Careers
- Employable
- Adequate preparation for graduate study or professional employment
- Completion of major leads to employment or graduate school

Geoscience and Society
- Common goal to improve visibility of science across campus
- Students behave in a professional manner
- Develop a sense of societal relevance
- Generate logical and thoughtful citizens/scientists
- Demonstrate department role re: campus and regional sustainability efforts
- Articulate (to students/parents) the student development goals
- Training students to be stewards of and advocates for the Earth

Encourage Geoscience Identity
- Build a strong foundation for those wanting to pursue a geology major
- Well-rounded geoscientist

- Broad/interconnected knowledge of geosciences
- Interrelationship of Earth's spheres
- Identify similarities/differences between Geology and Geography
- Train students to recognize and address problems associated with the earth

Program Expansion

- Create more enticing entry courses
- Recruit more majors
- Increase enrollment
- Expanding program
- More full-time faculty

Morning – Experiences

3 overlapping fields, with intersection in middle (with a group work post-it in center), labeled Field, Research/Communication/Professional Community and Lab/Analytical/Computer

Field:

- Being in the field
- Field trip to study water hands-on
- Field school
- Collect data in field and analyze it, represent it graphically
- Field trip to study rocks/soils hands on
- Field data collection/sampling
- Field experience tied to geologic interpretation
- Field work (in general)
- Field investigation
- Extended field trip experiences
- Field course (multiple field trips)
- Undertake fieldtrip somewhere exotic
- Go on field trips
- Mega field trip out west
- Local field trips to illustrate/document concepts/principles
- Local geology of their area
- Find a fossil
- Field trip
- Construct topographic profiles and geologic cross-sections

Research/Communication/Professional Community

- Public presentation of research
- Geoscience research
- Applying knowledge to novel problems
- Network, exposure to geosciences community
- Summarize and present results to peers
- Chance to investigate a relevant topic of his/her choice
- Research project start to finish
- Formulating and executing a project
- Create, justify and verify campus weather forecasts
- Conduct a meteorological case study and present the results in oral and written form
- Writing a substantive paper that incorporates scientific literature
- Give an oral presentation in front of a large audience
- Complete/solve geologic project/problem
- Pursuit of a geologic project/question through data collection and interpretation
- Speaking about science to peers and/or public
- Understanding and appreciating the messiness/uncertainty of the world
- Forming and testing hypotheses (both successfully and with some failure)

Lab/Analytical/Computer

- Lab analyses (GIS or chemical)
- Lab skills using binoc and petrographic microscopes
- Working with data and analysis tools
- Use a microscope
- Using forecast models in real time
- Ability to run a numerical model and plot and interpret its results
- Use/see a modern instrument/lab
- Analyzing current atmospheric states
- Google earth
- Analysis and interpretation of “real” original data

Morning – Values
Four clusters, labeled collegiality and collaboration, sustainability and environmental awareness, communication, and student development. One post-it is in the center: Ethical and responsible. Eight other post-its are strung across the bottom

Collegiality and collaboration
- Collegial/fun
- Collegiality
- Collegiality
- Great team work
- Collegial atmosphere among faculty and with our majors
- Collaboration
- Collaborative and cooperative work environment

Sustainability and environmental awareness
- Sustainability
- Stewardship
- Promoting sustainability
- Environmental concern
- Respect environment incorporated in all we do
- Foster love of science and appreciation for the natural world by example and effort

Communication
- Communication among faculty
- Respectful of (community, college, faculty, student)
- Open communication/transparency
- Constructive/encouraging and enthusiastic
- Honesty in communicating with undergrads

Student development
- Provide a multitude of student development opportunities for students willing to work for them
- Student-centered
- Great relationship with students
- Student-centered
- Committed to student development
- Effort by instructors
- Foster and encourage independent thinking in our students

Miscellaneous
- A culture of success that depends upon our high expectations of our students
- Integrating our research into our teaching
- Pursue an active research program
- Goal-oriented (hopefully with the same goals)
- Desire to be leaders in college and disciplilne
- Field work important to illustrate concepts/acquire skills

- Balance practical knowledge over theoretical
- Value undergraduate education over graduate (this one sparked a lot of discussion)