Universal Skills needed for Undergraduate Student Success in Diverse Geoscience Professions

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Summit on the Future of Undergraduate Geoscience Education

- National conversation on shape and content of future Bachelors-level geoscience curriculum & programs (supported by NSF-Geosciences)
  - Three meetings:
    - Summit: 1/14 - 180 educators (2YC to R1); ~20 employers
    - Geoscience Employers Workshop: 5/15 - 46 participants – Geology & Geophysics
    - Heads and Chairs Summit: 1/16; 109 Dept. leaders
  - Nationwide survey of geoscience faculty and professionals - 360 academics; 105 employers; 85% non-Summit participants

- Objectives:
  - identify consensus on essential skills & concepts
  - facilitate curricular transformation in geoscience programs nationwide

- Summit discussions and findings regularly crossed into issues of graduate preparation, especially with geoscience employers
  - http://www.jsg.utexas.edu/events/future-of-geoscience-undergraduate-education/ (for reports and more information)
Summit Outcomes/Survey Results: Science Skills

- Critical thinking/problem solving skills
- Communicate effectively to scientists & non-scientists
- Ability to access and integrate information from different sources and to continue to learn
- Understand and use scientific research methods
- Have strong quantitative skills and ability to apply
- Work in interdisciplinary teams and across cultures
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2. Critical thinking/problem solving skills
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5. Work in interdisciplinary teams and across cultures
6. Be technologically versatile (i.e. Google Earth, tablets, smartphones, apps)
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Have strong computational skills and the ability to manage and analyze large datasets

Have strong field skills and a working knowledge of GIS

Integrate data from different disciplines and apply systems thinking

Work with uncertainty, non-uniqueness, incompleteness, ambiguity and indirect observations

Readily solve problems, especially those requiring spatial and temporal (i.e. 3D and 4D) interpretations

Make inferences about Earth system from observations of natural world combined with experimentation and modeling
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Employers
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<thead>
<tr>
<th>Skill List (A-awareness (had in class); P-proficiency (had to use/apply); M-mastery (project, etc. requiring demonstration of ability); E-expert (MS or PHD)</th>
<th>Level of Mastery</th>
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<tbody>
<tr>
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Geoscience Employers Workshop – skills for undergraduates relevant for graduate students

• Systems Thinking
  • Earth as an open and dynamic system
    • interacting parts, linkages/feedbacks

• Understand Processes
  • Coupling, interactions

• Solve problems in 3D & 4D
  • Space, geologic & real time & scale

• Geologic reasoning & synthesis

• Be intellectually flexible - applying skills in new scenarios
Preparation for “real world” professional projects and/or future research

Critical thinking & problem solving

• Problem Solving with real data, non-unique answers
  • Understand context of problem
  • Identify appropriate questions to ask, data to collect, methods to use
  • Be able to collect data, analyze quality, interpret and apply
  • Make predictions with limited data
  • Understand & manage uncertainties
  • Visualize and solve problems in 3- & 4-D
  • Work on problems with no clear answers, high ambiguity

• Work by analogy, inference and the limits of certainty
High level quantitative skills increases employability & resiliency

- Higher level math & computer programming skills
  - Differential equations/linear algebra
  - Probability, statistics, uncertainty analysis & risk assessment
  - Computer programming, modeling
Data Analysis Skills

• **BIG DATA**
  • Integrate multiple large datasets
    • Different types - disciplines
    • Model, statistical analysis
    • Use visual models, modeling tools (Stella, Modflow, Matlab, etc.), simulations
    • Integrate technical, quantitative skills, programming, application development

• Technological diversity
• Communication skills
  • Written & verbal scientific communication
    • Tailored to several different audiences
      • Scientists, educated non-scientists, potential funders, management & general public
  • Listening skills
Cross-disciplinary Teamwork on Interdisciplinary Projects

• Project management in team settings
  • Working in teams with different backgrounds, specialties, experience, personalities
    • Being a leader & follower; listening, sharing
  • Goal setting
    • Solution-oriented approaches
  • Time management
  • Conflict resolution
    • Managing problems on the front end

Fieldwork builds these skills
Non-technical Skills

• Ethics
  • Codes of conduct
  • Awareness of implicit biases

• Interpersonal skills - ability to work with different...
  • Personalities, emotional makeup, viewpoints
  • Specialties, educational backgrounds, abilities

• Professionalism
  • Business acumen
  • Risk management
  • Leadership

• Global perspective
  • Different cultures

• Understanding societal relevance & implications
Most PhD & M.S. students will not go to academia!

So, in addition to their specialty, what do they need to learn in graduate school?