Outcomes of 2018 Geoscience Employers Workshop & recent employer updates

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Skills Needed for Success

- **Problem solving & critical thinking**
  - ***Defining problem, solving, applying solution***
- **Written & oral communication / listening skills**
  - ***Expressing technical work effectively to different audiences***
- **Capacity for learning/adaptable**
  - ***Be a life-long learner & apply skills to new situations***
- **Systems thinking & approach**
- **Expertise/depth in core area, strong technical skills**
- **Data management, Data Analytics**
  - ***Working with Big DATA & integrating different types of datasets***
- **High level quantitative skills**
- **Computational skills, programming, modeling**
- **Project management, teamwork, leadership**
- **Ethics & professionalism**
- **Social dynamics - interpersonal skills**
- **Understand societal relevance, global perspective**

PowerPoint slides, webcasts & more information:
http://www.jsg.utexas.edu/events/summit-on-improving-geoscience-graduate-student-preparedness-for-the-future-workforce/
and
http://http://www.jsg.utexas.edu/events/future-of-geoscience-undergraduate-education/

What skills and competencies make PhD and MS graduates successful in the workplace today (and future)? 🙂
And what do they lack? 😔

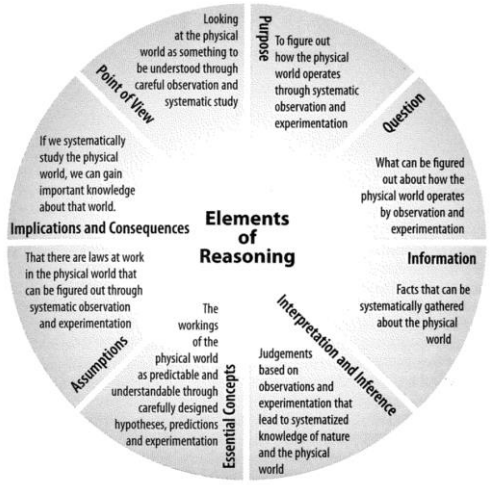
- **Need Expertise/Depth in core area → leads to judgment and confidence**
  - **Core technical skills in relevant area of expertise is absolutely necessary**
  - **Deep understanding of the fundamentals/mechanics of the techniques/methods they are using**
  - **Having foundational skill set – good education in the geosciences**
    - **Breadth in core area, grounding across all sciences**
    - **Course background in their field – even if switched fields from undergrad to grad**
- **Graduates generally are coming with very strong technical skills**
  - **Knowledge in their field of geosciences**
  - **Research skills; field skills**

Most Important Skills – regardless of discipline

- **Problem solving & critical thinking**
  - **Pragmatic critical thinking, logical thinking**
  - **Flexibility, open-mindedness**
  - **Defining problem and applying an appropriate solution**
    - ***Establishing what is a sufficient solution vs. a precise and complete solution***
  - **Translating the problem to the -- so what?**
    - **Articulate importance of outcomes**
    - ***What decisions will be made based on the work you are doing***
  - **Understanding the broader impacts of your research & how to communicate those impacts**

- ***Independence in critical thinking, and problem development, execution and analysis skills***

Many graduates struggle with being able to define a problem and identifying how to apply the solution **(but could solve the problem)**



- **Teamwork, Collaboration *(generally lack)*** 😔
  - **Ability to work with other scientists & other trained individuals towards your goal**
  - **Ability to get others to work together; deal with conflict**
  - **Valuing diversity of thought**
  - **Developing self-awareness & recognizing skills among ourselves & people around us**
  - **Evaluating expertise, knowing your own strengths**
  - **Being coachable, taking directions, leading**

- **Leadership -- in science, education, public policy/politics, business** 😔

- **Communication** (common limiting factor) 😔
  - written, verbal; external and internal

  Expressing technical work effectively to appropriate audiences

  - Technical writing & verbal communication
    - within specialty and other science & engineering fields
    - to non-technical audiences, management, pubic, press
  - Be able to convey complex material in a simple way
  - Express ideas logically
  - Be comfortable speaking with people when English is not their first language
  - *Be able to communicate societal and/or financial impacts*
  - Skill in editing – evaluate critically & accept criticism
    - Evaluate/recognize credible sources
  - Listening Skills
    - High sensitivity to audience – reading the room
    - Pay attention to what others say
    - Answer questions asked & logically

Research Skills

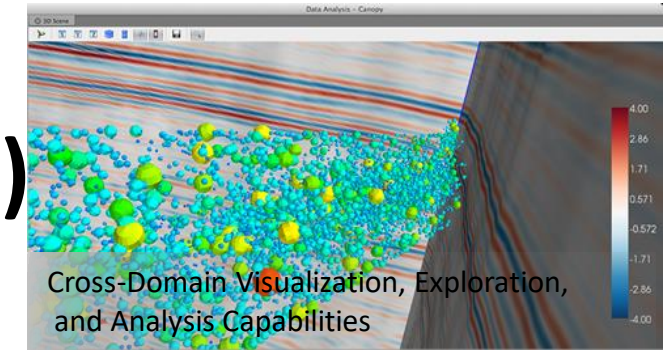
Currently need and increasingly important in the future – across employer spectrum!

➢Data Management & Data Analytics

- Awareness of data analytics, the applications, processes for using data (Answers questions we have not framed yet)
- Dealing with Big Data & Datasets
- Examining datasets to draw conclusions about the information they contain

- **Data Acquisition** --Data collection – different types of data, different data sources – establishing data credibility, familiarity with available tools for access & interpretation
- **Data Management & Analysis**
  - Using data effectively & have proficiency at managing
  - Looking at & synthesizing data from different perspectives (e.g. air, ground, etc.)
  - Using various types of data; Knowing the tools for analysis, how to organize
  - Data Manipulation – adding, deleting & modifying data, retrieving data from dataset
  - Learn/develop new ways for data management & analysis & synthesis

➢Data Management & Data Analytics (cont.)


Cross-Domain Visualization, Exploration, and Analysis Capabilities

- **Data Integration**
  - **Merging information/data to solve problem**
  - **Integrating different types of data; synthesize**
- **Data assimilation – sequential updating of model forecast with new observations**
- **Data quality – understanding, evaluating, using data of different qualities**
- **Visualization & Modeling -- Data simulation, display; ability to model & know limits of modeling; immersive Virtual Reality data exploration**
- **Valuation: how valuable is the data - monetizing**
- **Other data science - e.g., Machine Learning, AI, computer science, robotics – increasing in future**

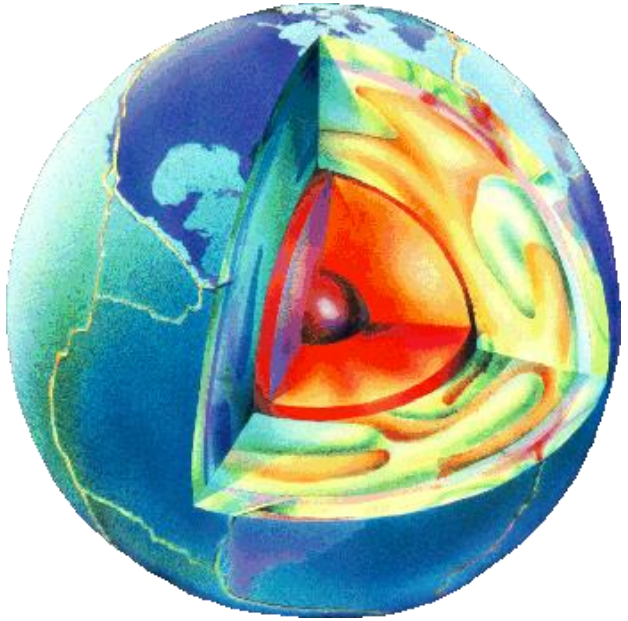
- **Computational skills**
  - More need for computational skills but within the ability to make observations
    - **Basic programming skills**
      - Scripted languages
    - **Coding** - able to code
      - Translate older code to newer codes & systems that are more effective
    - **Ability to analyze algorithms** (with increase in Machine Learning & AI)
    - **Keep up with transition from Supercomputing to Cloud computing**
      - Cloud data manipulation and storage for big data
    - **Modeling** – be able to develop, analyze and evaluate models
  - **Basics of statistics and math** *[should have from undergrad]*
    - Statistics - communicating certainty
    - Higher math - including calculus, differential equations, linear algebra

- *Embracing technology not only as users but as creators*
- *Willingness to step outside of the box to engage in genuine innovation*

Habits of Mind

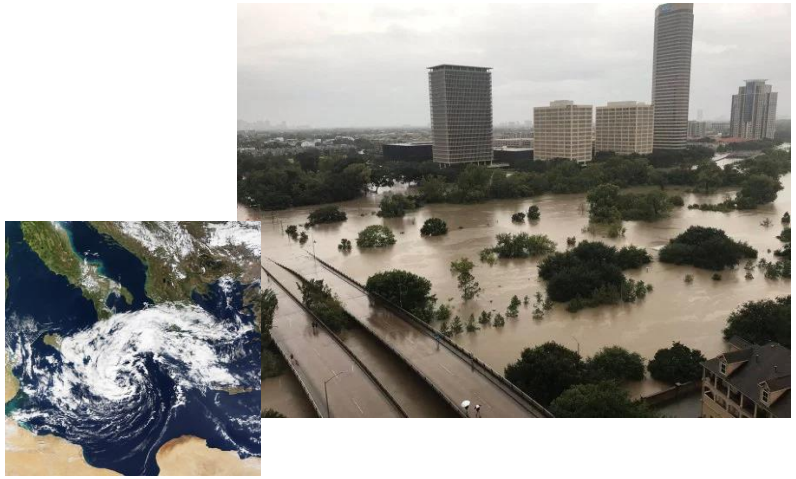
- **Systems Thinking**
  - **Look at entire system - the big picture**
    - **Parts in isolation may act differently than when within system**
  - **View whole system and drill down to details, interactions & limitations**

- **Earth System Thinking**
  - **Earth as a interactive system**
  - **Complex, non-linear, coupled system**
  - **Understand processes & interactions between them**

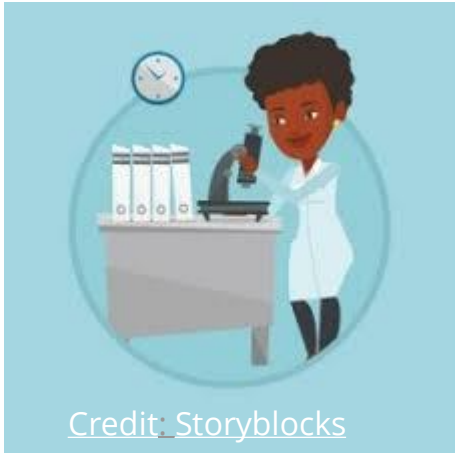


Important Concepts & Abilities

- **Intellectually flexible**
- **Internal drive to do well**
  - Overcome inherent risk aversion in adopting new technology to address major problems
  - Overcome prevalence of fear of failure
- **Willingness to be a life-long learner – learn how to learn**
- **Societal Connection**
  - Understand research needs a purpose
- **Diverse and Adaptable skill set**
  - Specifics less important, but rather evolution potential



- Scientific process
  - Observe, characterize, understand, model, predict, verify
- Importance of simulation
- Good grasp of uncertainty
- Scalability of space and time
- Awareness of risk and impact
- Application driven questions



Credit: Storyblocks

Additional Professional Skills

- Project & Program Management (generally lack) 😔
  - Understanding budgets, project financials
  - Managing people, multidisciplinary projects
  - What factors are driving the decision-making process?
  - Manage time & resources
  - Know how to run a meeting (agenda, time management, relevance, etc.)
- Time-value concepts – understand
- Business Skills (needs much improvement) 😔
  - Economic, data-driven decision-making; risk, uncertainty
  - Innovation & entrepreneurship
  - Leadership, teambuilding, finances/budgeting, project management, problem solving
  - Exposure to basics of business, operations, etc.

- **Ethics & Professionalism**
  - Integrity & its importance to science & research process
  - Understanding plagiarism, self-plagiarism
  - Proper attribution to original source
  - Rules for scientific citation & research
  - Knowing how to search for research

- **Social dynamics** (generally lacking; limiting) 😔
  - People skills –interpersonal behavioral and cultural
    - Ability to work with people who are different & from different cultures
  - Corporate skills – culture clash: academia vs industry, government & business
    - Be able to distill everything down to making it relevant to the CEO or Manager
    - Time - value of money
    - Learning how to take direction – directed work

Professional Development

- Training on how to get a job
  - Resumes, applications, interviews
  - Where to search
  - Knowledge of careers
  - Knowing options & how to leverage their skills or gain skills/knowledge
- Networking – how to do, what not to do, where to go/be
- Virtual presence/brand
  - Current presence on social media & how that effects hiring/career
  - Self marketing
  - Representing that extra expertise

- Interviewing skills
  - Can be learned
  - Do's & Don'ts
- Ability to move up & transition within organization (1st job not last)

Changes since 2018

- **Need expanded knowledge of global energy usage and the full spectrum of resources**
  - **Alternative energy professionals in higher demand**
  - **Profession geologists need to be better versed in factual landscape for energy.**
- **Energy industry –"great crew change" has happened**
  - **Skills required to find and produce oil and gas are very similar or identical to those needed for things like carbon capture and storage. These skills are, and will remain to be, in high demand.**
- **Pandemic greatly accelerated technology development enabling remote work**
  - **Future will be a mix of remote and in person modes of work**
  - **More work will be done remotely (including scientific meetings)**
  - **Remote work is a great option, especially for programmers/data scientists, as it provides a better work/life balance**

2018 Report – areas lacking emphasis

- Networking skills are increasingly critical to career progress
- Professional Organization participation
  - gives access to forefront of knowledge and to the people developing that knowledge
  - most effective networking processes, enabling career advances and access to alternatives hard to obtain in other ways
- Software skills - many entry-level jobs today
  - software writing primary requirement
  - followed by understanding geosciences as context for that software
- Geoscience education prepares students for success in other fields
  - broad critical thinking, problem solving, collaboration, and communication skills
- Geoscientists as leaders, innovators and company creators
  - being more than adept at performing tasks or working on small teams
  - developing breakthrough ideas or starting companies

Needed skills

- Data science & computer programming skills – increasing important
  - Data science, computer programming skills, data management/processing abilities
    - some exposure to programming, even if it's as simple as MatLab or Excel macros.
  - The importance of quantitative and digital skills has increased (e.g., data analytics, basic scripting and coding).
    - basic skills (e.g. math, programming, etc.) over tools, because the tools will change.
  - Every STEM student should learn some programming or coding! Again, even if it is simple scripting, logical algorithms, macros, or similar entryways into programming
  - Skills related to the increasing amount of available data and computing power
    - HP computing, cloud computing, AI/ML, data management, ...
- Fundamental skills and attributes required have not changed
  - solid foundational geoscience and geophysics, critical thinking, and business acumen; broad integrators
- Skills that will be needed both now and for the future
  - outside field-mapping experience, sed/strat, structural geology, GIS expertise

Preparation needed

- “Geology and Public Policy” course, covering energy - minerals - environmental protection - disaster mitigation
- Know how to read and understand rules, regulations and statutes and how to write reports to meet regulatory requirements
  - Writing guidance documents to implement rules; reviewing reports to determine if the work complies with rules; having sufficient knowledge of field work to problem solve or identify if the work was done well or poorly
- Business aspects of consulting, like writing scopes of work, developing clients, and working with regulators.
- A robust knowledge of science is necessary to guide policy implementation.
  - Basic overview of how laws are passed, rule reading and interpretation, report writing, and setting up and implementing field work.
  - Field work should include site assessments and determining what field data to take and the best methods to obtain samples (e.g. groundwater, surface water, soils, etc.)

Increasingly needed skills

- **Skills that enable inter- and trans-disciplinary work.**
  - **increasing demand to go beyond collaborations within the geosciences and include economics and other social sciences**
  - **connect science (even basic science) with improved societal outcomes**
- **Skills that relate to the ethics of science**
  - **DEI or JEDI, ethics of open science, new forms of publishing, co-production of knowledge, …**
- **Prepare students for the possibility of private sector employment, using a variety of methods such as internships, invited lectures, or job fairs**
- **Avoid programs / advisors that discourage you to take classes outside your immediate field of study and expect to keep learning long after you leave campus**

Breakout Session #1: Skills and competencies needed for future geoscience workforce.

- **What skills and competencies make PhD and MS graduates successful today in a wide variety of geoscience careers? Does it differ for MS and PhD graduates, or differ in level of competency?**
- **What from the 2018 Geoscience Employers Workshop needs updating or more specifics? (i.e. what changes have occurred in the workplace and what wasn't covered or stressed sufficiently). How has the pandemic changed needed skills or the development of these skills in graduate programs?**
- **What changes do you see in your field and organization over the next ten years that will require different competencies? What new or improved skills do you predict graduates will need in the future?**
- **How can we prepare our students to be leaders, innovators and creators?**

Remember – all careers (including academics)