Enhancing Quantitative Training Frameworks in Solid Earth Geophysics

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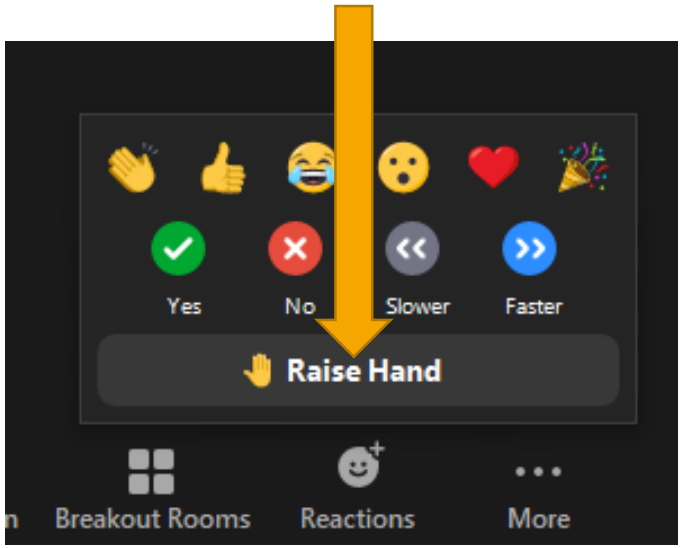
- **To expand on its ability to convene experts, NASEM can bring people together to engage on a specific topic and be part of a community of practice, as we are doing here today.**

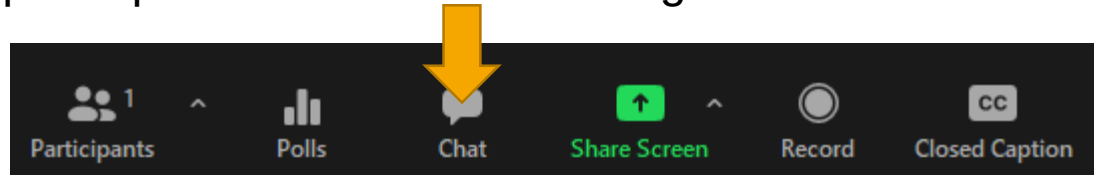
Raise Hand and Chat Features

To raise your hand, click on the “Reactions” button on the bottom right hand of your screen. You should be able to find it between the “Breakout Rooms” and “More” features. Once you click on the “Reactions” button, many choices will pop up including the “Raise Hand” option as seen below.

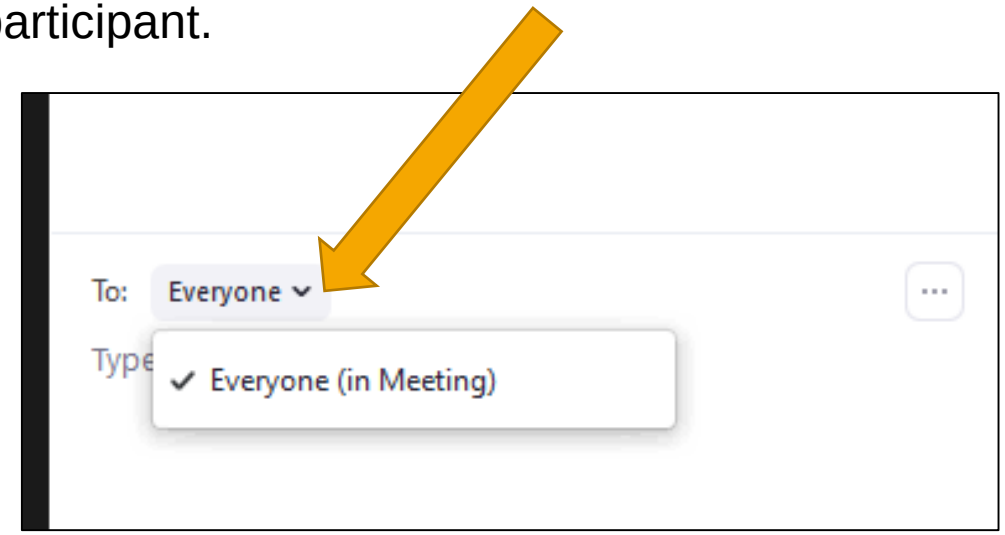


If a participant is on the phone only they can press *9 to raise their hand.

Click “Chat” to instant message with other participants while in the meeting.



In the Chat panel that opens on the right side of your screen, click the dropdown to select if you want the message to go to everyone in the meeting or a single participant.



Motivation

Geoscientists utilize vast and growing global data bases, including satellite-derived observation of Earth and planets, real-time networks spanning a range of sensors that enable 4D analyses of surface and subsurface processes. **Solid Earth geophysical processes are at the core of many scientific and societally-relevant problems**. Examples include:

- renewable and non-renewable resource evaluation and management
- geospatial analyses and national security
- earthquake, volcano, landslide, tsunami hazard
- sealevel rise and global change

Geosciences Undergrads Lack Technical Training

- **Undergrad Geosciences majors – packed major rarely offering space for programming and applied math**; sometimes even lacking stats or limited curve fitting and regression.
- Geospatial training largely is restricted to commercial ArcGIS ‘black box’
- Prior NASEM meetings highlighted **growing deficit of geoscientists in HPC and geophysics careers**
- Rapid growth of renewable energy and decline of employment opportunities in petroleum exploration also motivates re-assessment of core knowledge and skills needed to fit future demand
- **Notable declines in number of geodesists, geomagnetists, and other geophysics specializations - are we losing future faculty to data sciences?**

Skills gap restricts graduate school options

Grad students with geosciences majors (excluding the few with geophysics majors) enter grad school lacking

- computational skills
- stats and applied math skills (DiffEQs, Linear algebra)
- Lack pre-reqs for Data Sciences, ML, Maths grad classes.

Need to move beyond ad hoc adjustments

Problem not unique to geophysics – spans science fields

Why now: Part 1 ?

Students want to be a part of Data Sciences but they have critical gaps in skills and knowledge.

Employers want data scientists with geosciences training.

COVID19-response highlights the role of data sciences in topics of great societal relevance.

Our goal: How to increase the number and diversity of geophysics graduates to fill the growing needs of employers;

How to enable students to pursue their interests in geosciences (e.g., data science) ?

Why Now Part II: Perspective of Employers

- **“80-20 problem”** across sciences: 80% of time spent on data wrangling/analyses, only 20% on interpretation
- Declining number of graduates trained in space-based and geometric geodesy, potential fields, electromagnetism = national security risk (noted by NGA, NASA, NOAA, USGS)*
- **Diversity, inclusion, equity show incremental change**
- Grads are unprepared for new directions in geoinformatics, cyberinfrastructure, quantum computing
- Risk as stated by Darryl Willis, now VP of Energy at Microsoft: Faster to train data scientists in geosciences than to train geosciences grads in data science methods.

- *National Academies of Sciences, Engineering, and Medicine (NASEM), 2020. *Evolving the Geodetic Infrastructure to Meet New Scientific Needs*. The National Academies Press, Washington, D.C., 124 pp. https://www.nap.edu/catalog/25579/evolving-the-geodetic-infrastructure-to-meet-new-scientific-needs]

Critical Challenges

- Geosciences is the least diverse science field in terms of under-represented groups
- HBCUs and some minority-serving institutions lack geosciences undergrad degree programs
- Opportunities to recruit and retain those from under-represented groups in geophysics remains a challenge: retention depends on attentive '**scaffolding'** (e.g., mentoring, in-class research experiences, structured advising)

Plan for Meeting

Exciting advances in opportunities, but a lag in changes to our undergraduate and graduate curriculum to provide geosciences students with the skillsets to become key players in data sciences.

Day 1:

Identify and synthesize critical curricular and research needs;

What are the impacts of curricular changes on number and diversity of grads?

Day 2:

Overview of current training opportunities through internships, bootcamps

Synthesize critical questions for the next step :

- Immediate (e.g., summer programs)
- Larger questions require more in-depth study

Potential outcomes of this meeting

Possible Outcomes:

- **NASEM study?**
- **Workshop with report?**
- **Pilot program or other activity ?**
- **Coordinated intensive summer learning experiences?**