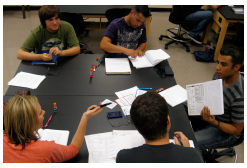
Educational Research on Teaching: Integrating your Research and Teaching Programs



Tuesday July 30th

Kaatje Kraft

with contributions from Karen Kortz, Carol Ormand, and Cindy Shellito

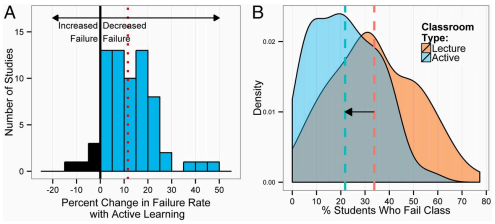
Questions to answer for this session:

- What are examples of educational research and how does that relate to the kinds of research one can do?
- What are resources to help one get started?
- What questions can I answer about my own classroom?

Kinesthetic continuum

- On a line from curious about how the research can inform your teaching to already practicing educational research, put yourself where you currently see yourself.
- Now move to where you would like to see yourself (or stay still if you are content with your current location). Talk with your neighbors:
  - What questions do you have?
  - What are some of the challenges of getting to where you'd like to be on this continuum?

Evidence for Active Learning?



Less failure with active classrooms

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, 1-6, doi: 10.1073/pnas.1319030111.

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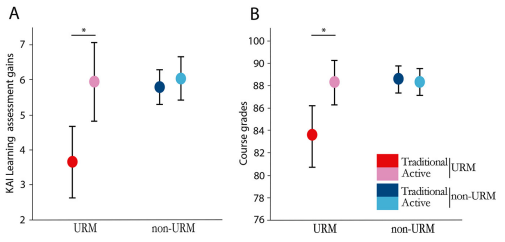
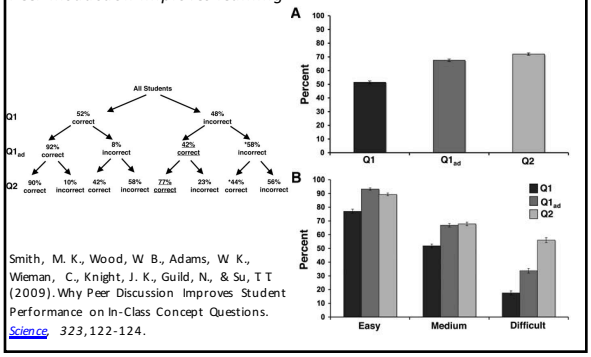


Active learning can close equity gap

Ballen, C. J., Wieman, C., Salehi, S., Searle, J. B., & Zamudio, K. R. (2017). Enhancing diversity in undergraduate science: Self-efficacy drives performance gains with active learning. *CBE-Life Sciences Education*, *16*(4). doi:https://doi.org/10.1187/cbe.16-12-0344

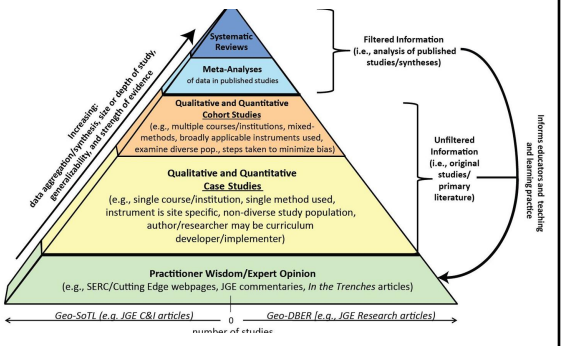
Evidence for Active Learning?

Peer Instruction improves learning



Smith, M. K., Wood, W. B., Adams, W. K., Wieman, C., Knight, J. K., Guild, N., & Su, T. T. (2009). Why Peer Discussion Improves Student Performance on In-Class Concept Questions. *Science*, *323*, 122-124.

Strength of Evidence Pyramid



From St. John and McNeal, 2017.JGE, 65(4),363-372.https://doi.org/10.5408/17-264.1

Brainstorm with your neighbor(s):

- How is research on learning similar to and different from traditional geoscience research?

Similarities to Geoscience Research:

- Answering significant and interesting questions
- Testing hypotheses (often with experiments)
- Collecting data via observations
- Interpreting large, incomplete data sets (sometimes using statistical analyses)
- Inferring process and cause from observed behaviors
- Collaborating with scientists in other fields
- Data only good if instrument is calibrated/valid and reliable
- Qualitative vs. quantitative
- Theoretical vs. applied

Differences from Geoscience Research:

- Human subjects!
  - IRB (Institutional Review Board)
    - St. John, K. (2016) JGE 64(2) 99-100.
  - So many possible confounding factors….
- Your classroom *may* be your laboratory
- How you collect data
  - Instruments used
- Attitude of other faculty/administrators
- Less professional support

Getting Started

- Read the science education literature & other key meta-studies
- Go to research on learning sessions at conferences (e.g. GSA)
- Read successful educational research proposals

http://nagt.org/nagt/geoedresearch/toolbox/index.html

A Community Framework for GER

nagt.org/209169

Example Future GER Projects

- Conceptual understanding of Environment, Ocean, Atmosphere, Climate:
  - Grand Challenge 1: How do we identify and address the challenges to conceptual understanding specific to each discipline: environmental science, ocean sciences, atmospheric sciences and climate science?
  - Grand Challenge 2: How do we teach complex interconnected Earth Systems to build conceptual understanding of, for example, climate change?
  - Grand Challenge 3: What approaches are effective for students to understand various models (numerical and analytical) that are used for prediction and research in atmospheric, oceanic, and climate sciences, including model limitations?
  - Grand Challenge 4: How do the societal influences, affective elements, personal background and beliefs, and prior knowledge impact students conceptual understanding of Earth system sciences?

Grand Challenge 1 Research Projects

- Literature review of what we already know from student conceptions, across different populations
- Identify the most common barriers to conceptual understanding including misconceptions and pre-conceptions

Grand Challenge 2 Research Projects

- Identify examples from other disciplines (e.g., physics) that can provide context for future research on conceptual change
- Testing instructional strategies that have shown impact on learning to a broad range of learning environments and populations
- Examine the learning progression research from K-12 literature to inform GER strategies for implementing curriculum that works to develop student understanding of complex Earth systems
- Study how conceptual understanding evolves from intro to upper level courses within different programs and how we should prepare geoscience majors for graduate school and the profession.

Grand Challenge 3 Research Projects

- Work with the cognitive spatial and temporal reasoning and cognitive problem solving, quantitative reasoning and models communities to apply their work to the fluid Earth community
- Expand current research on learning impacts of various models
- Research students' attitudes towards models and modeling, and the efficacy of different approaches to stimulate students' interest in learning about models.

Grand Challenge 4 Research Projects

- Use research-based evidence in developing curriculum and formal and informal instructional guides for instructors on how to teach controversial topics like climate change
- Work to better understand the efforts and agenda of groups that work to undermine understanding of anthropogenic climate warming in order to inform students about the misinformation
- Connect with social scientists who are doing similar work to broaden the impact of reach of the research and assure multiple disciplinary perspectives are considered

Your own practice

- Spend a few minutes coming up with a small research question you can implement next year.
  - What question do you want to answer? What is something you'd like to know about your students/your practice?
  - What are the next steps to answer this question? Develop an action plan and time frame
  - Who/what are some resources you may want to consider to help you?

Other Resources

- St. John, K (Ed.) (2018). A Community Framework for Geoscience Education Research. National Association of Geoscience Teachers: https://nagt.org/nagt/geoedresearch/GER_framework/index.html
- GER Toolbox: http://nagt.org/nagt/geoedresearch/toolbox/index.html
- Earth & Mind Blog: https://serc.carleton.edu/earthandmind/index.html
- Discipline Based Education Research Report (2012): https://www.nap.edu/catalog/13362/discipline-based-education-research-understanding-and-improving-learning-in-undergraduate
- Outcome of DBER Report (2015): https://www.nap.edu/catalog/18687/reaching-students-what-research-says-about-effective-instruction-in-undergraduate

Ready to publish? Some tips

- ***Strategies for aspiring authors for "Journal of Geoscience Education"***
  - Do your homework, and put your work in a literature-based context.
  - Provide a well-defined purpose with methods that are appropriately explained and applied.
  - Description of the study setting and population
  - Evidence of effectiveness is essential to a strong argument: conclusions need to be evidence based with validity and reliability
  - Do not just report results; discuss why they are meaningful both to your particular situation and more broadly.
  - Have IRB approval

Remember, you don't have to do this alone: don't be afraid to collaborate

St. John et al. (*2016*) Un-packaging Manuscript Preparation and Review Guidelines for Curriculum and Instruction and Research Papers. JGE: 64(1):1-4.

- ***Strategies for aspiring authors of "In the Trenches"***
  - Document your experiences with new teaching methods in an informative, accessible, and entertaining way
  - Share your thoughts about teaching and interesting ideas – start a trend!
  - Share you great photos with the NAGT community (or have your students share their photos)