150 YEARS | American Museum of Natural History

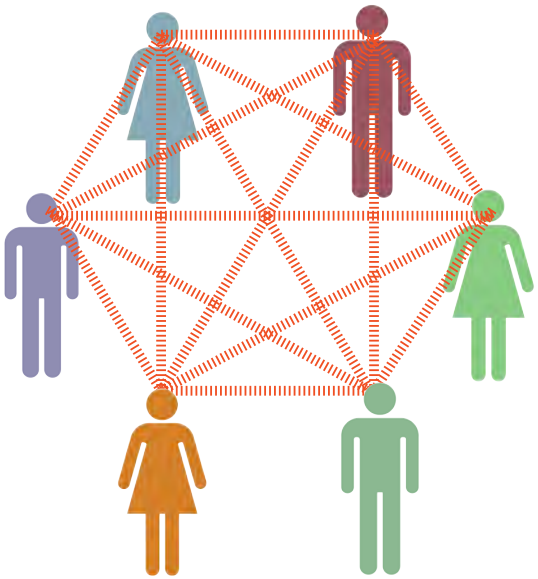
Center for Biodiversity and Conservation
Network of Conservation Educators and Practitioners

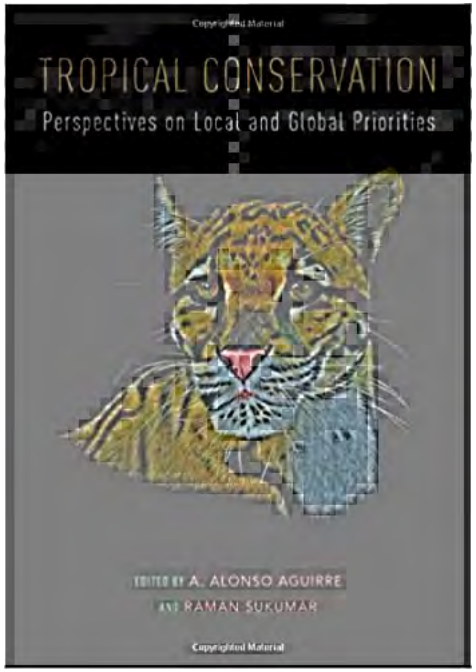
Evidence-based teaching approaches and active-learning online

Suzanne Macey, Ph.D.

Capacity Development

NCEP
Conservation
Teaching &
Learning Studios

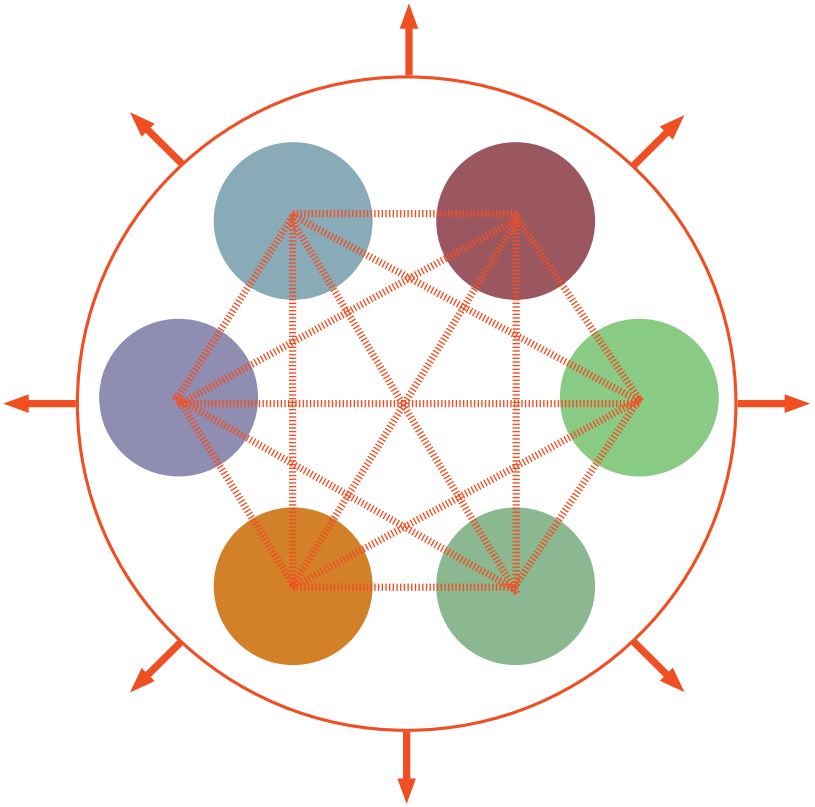




Strengthening Capacity for Biodiversity Conservation in the Southern Tropical Andes through Partnerships of Educators and Practitioners Bravo et al. 2016.
In Tropical Conservation: Perspectives on Local and Global Priorities. Edited by Aguirre A and Sukumar R. Oxford University Press. pp. 417-429.

Capacity Development

- Applying new understanding to action
- Build solutions that are larger than single organizations



Red de Educadores y Profesionales de la Conservación (REPC)

Outputs and Outcomes

526
educators and professionals trained in scientific teaching at faculty development workshops

25
modules developed in Spanish, many tailored to the Southern Tropical Andes context

Over 2 years:

6,200 university students reached by

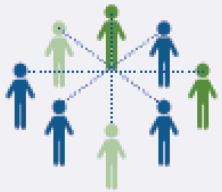
138 university educators trained by

12 faculty liaisons at

9 institutions

275
protected area staff, local community members, instructors, and students participated in

6 field courses



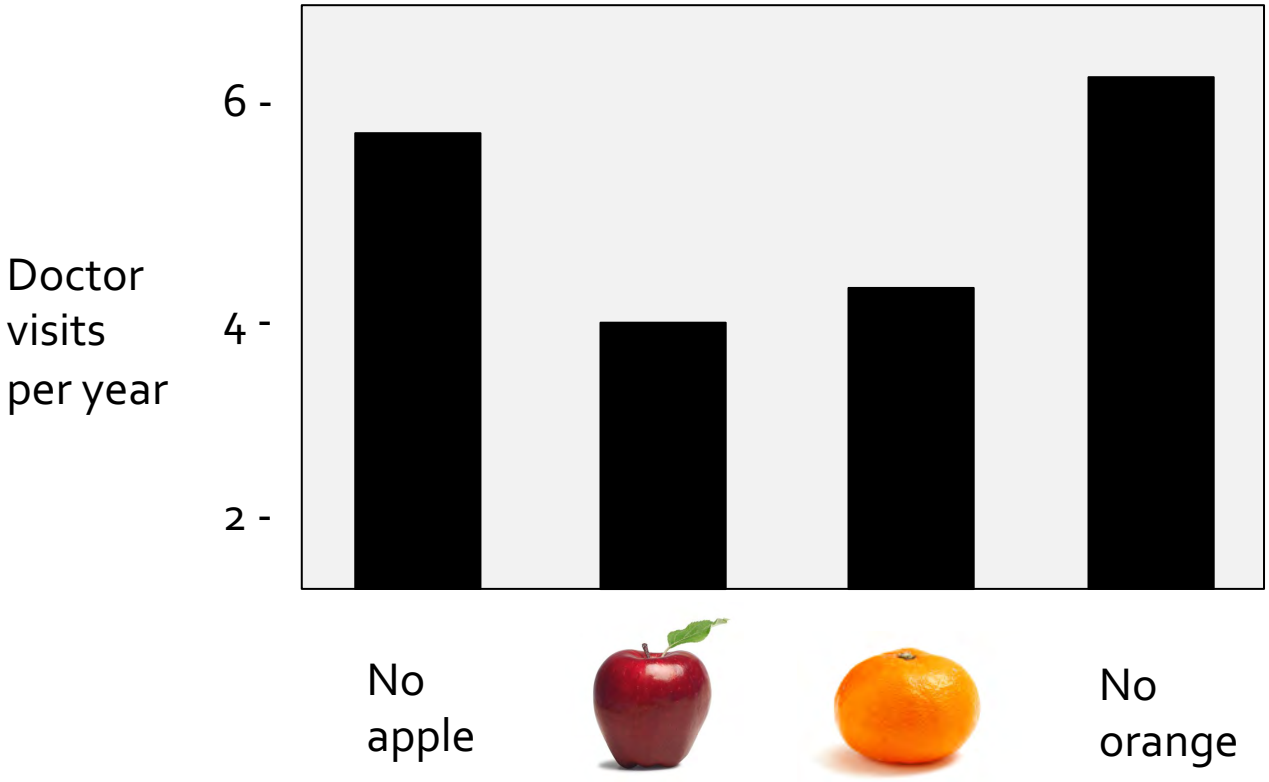
250
participants in the inaugural, "I Congreso Nacional Educación para la Conservación de la Biodiversidad y Medio Ambiente"

Supported curriculum development for:

2 certificate conservation programs, and

1 master's program

"An apple a day keeps the doctor away"


Doctor visits per year
6 -
4 -
2 -
No apple
No orange

Handelsman, Miller, and Pfund 2007

Teaching like a scientist

Be rigorous

Make teaching decisions based on the evidence about what works best, and evaluate your results

Teaching like a scientist

Think critically

Ask yourself: what knowledge can I share, AND what do I want them to learn?

How will I know that they did?

How will they know?

Teaching like a scientist

Be creative

Be aware of all your options, consider discussing your ideas in a community of teachers

Teaching like a scientist

Experiment

Try new things

Look for ways to advance your skills and knowledge

Test your assumptions!

Assumptions about teaching

- What are at least two assumptions you might be making about teaching and learning?

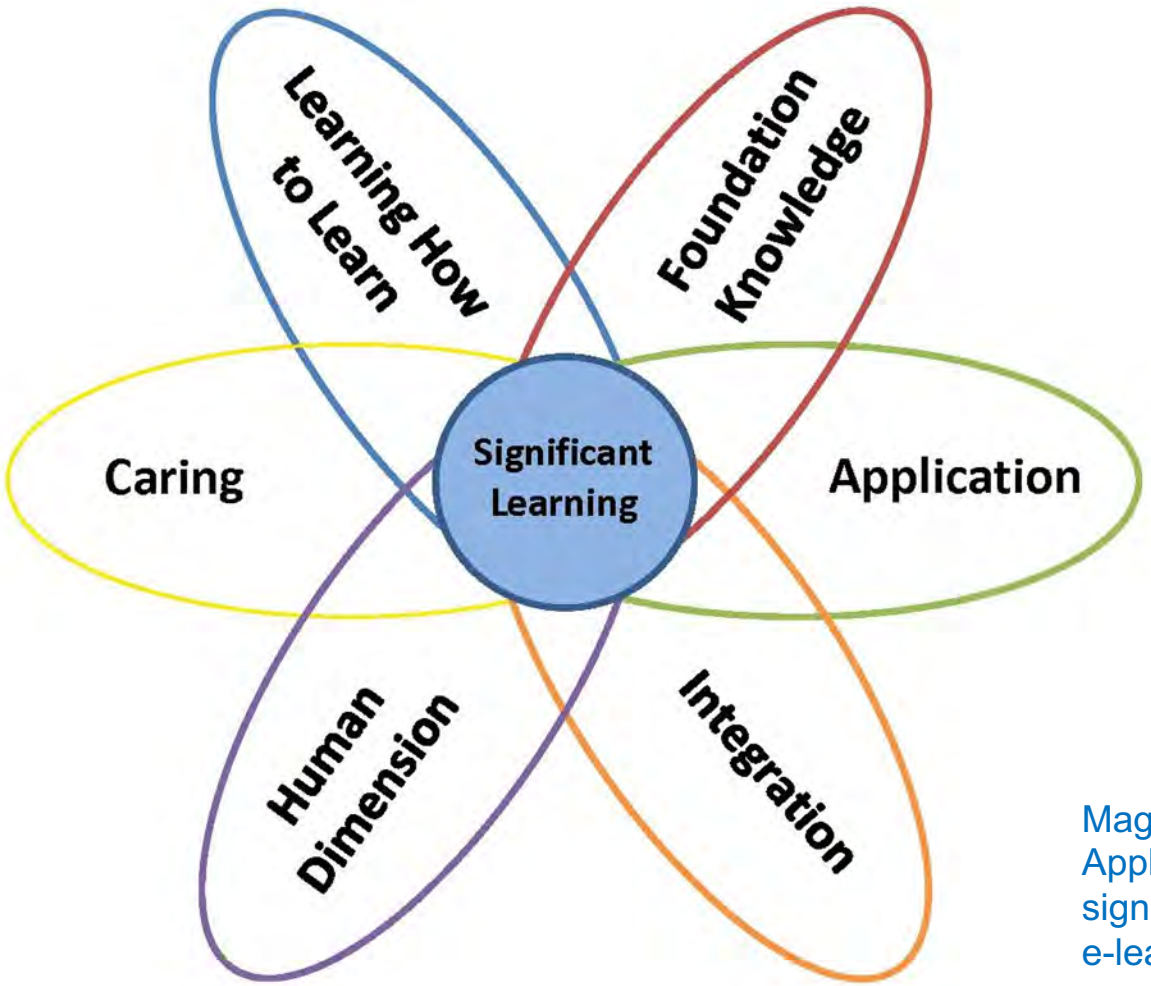
- Express them as a hypothesis that could be tested

"If_____, then _____."

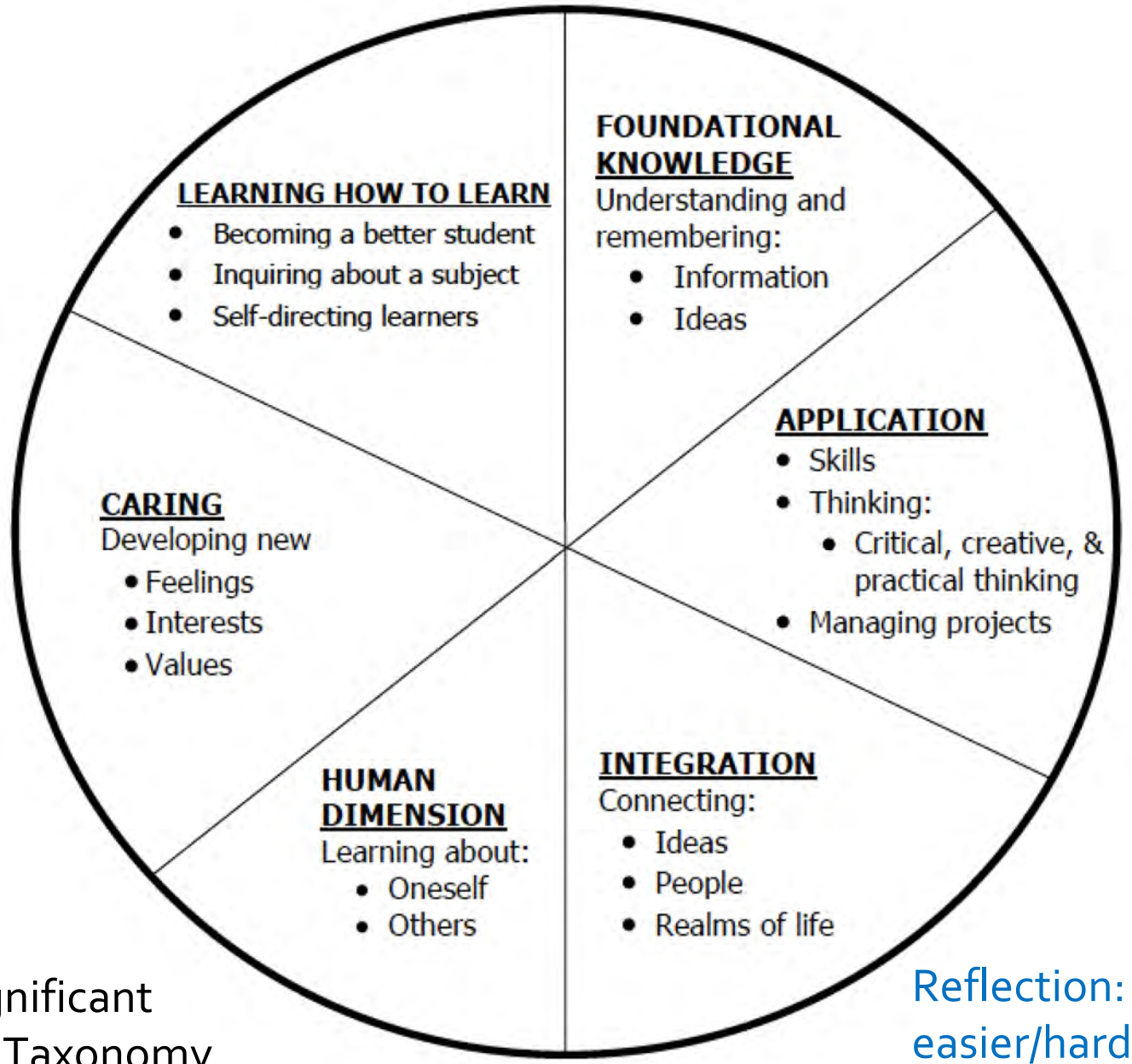
Student Learning

Student Learning

Fink's Significant Learning Taxonomy



Magnussen, L. (2008). Applying the principles of significant learning in the e-learning environment.

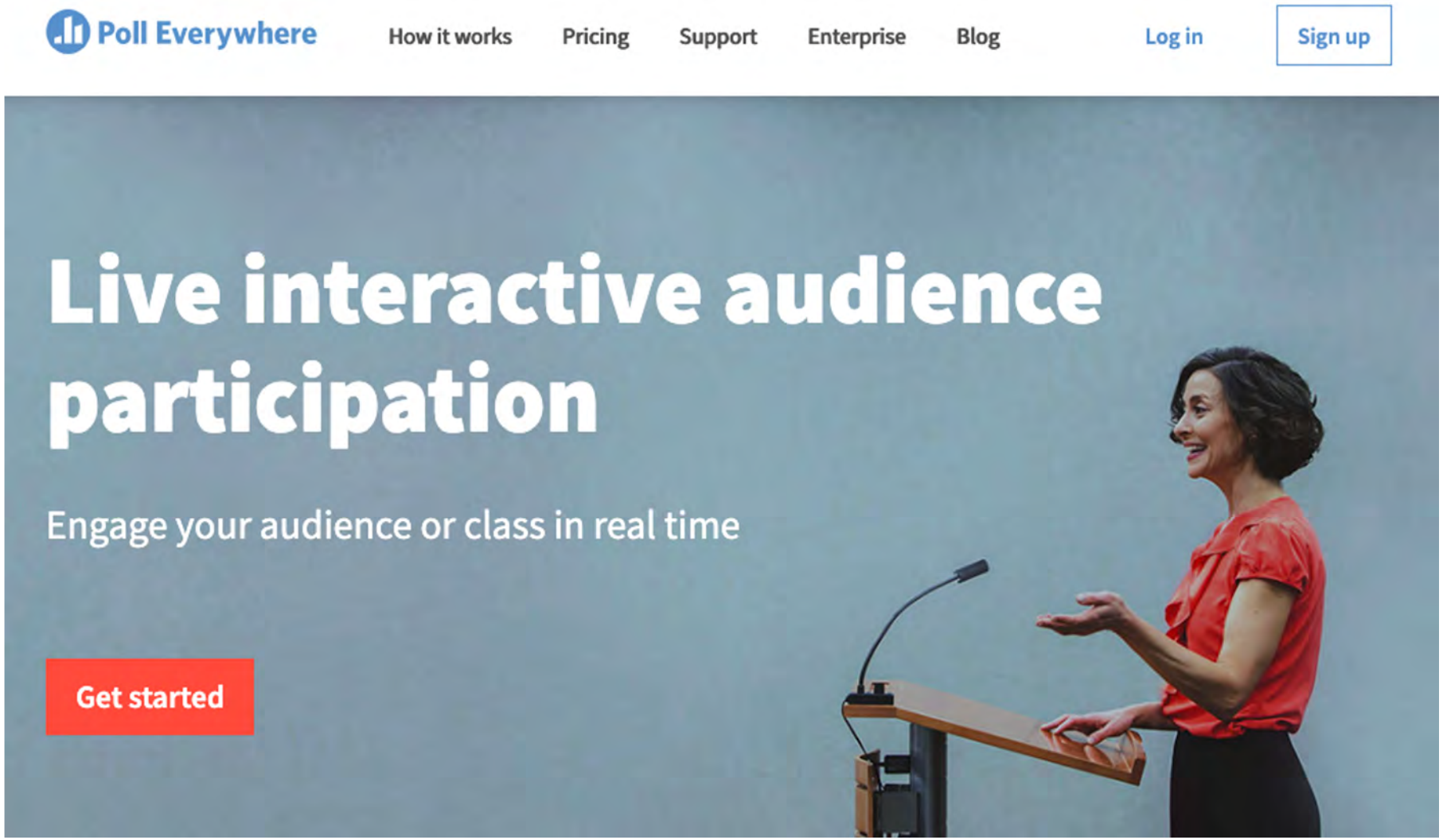


Fink's Significant Learning Taxonomy

Reflection: which are easier/harder for you?

Reflection: which are easier/harder for you?

Polleverywhere.com



A framework : 3 Questions

- What do I want students to know, understand, and be able to do?
  Goals and objectives
- What is the best way to get there?
  Activities
- How will I know if I did?
  Assessment

3 steps for scientific teaching

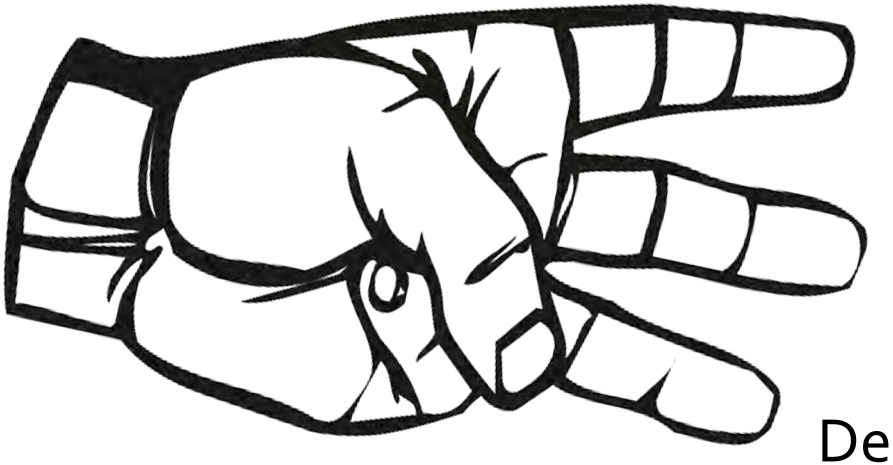
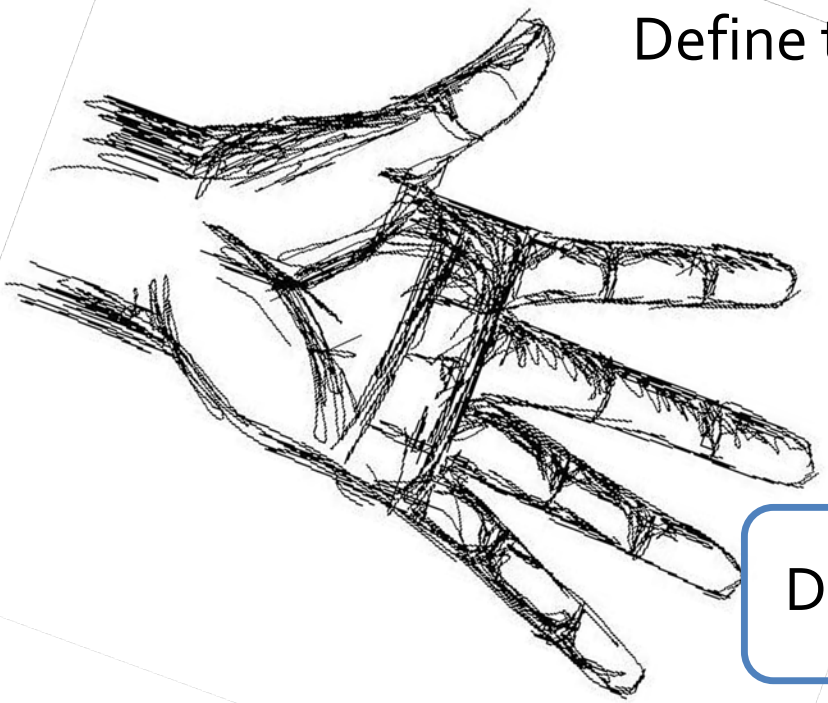


Chart Goals & Objectives

Plan Assessment & Evaluation

Design Active & Aligned Learning

5 steps for scientific course design



Define the Context

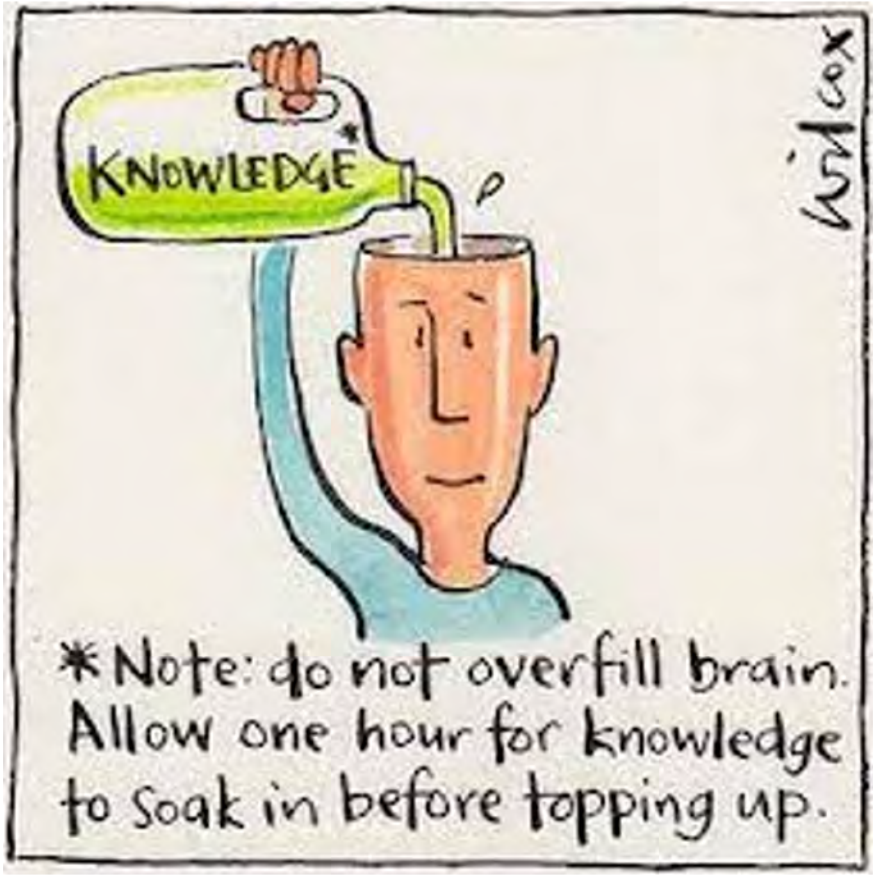
Chart Goals & Objectives

Plan Assessment & Evaluation

Design Active & Aligned Learning

Integrate

What do we know about learning?

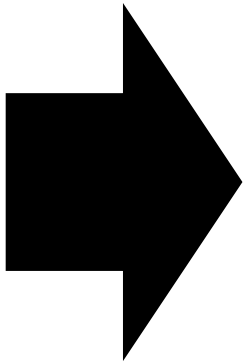


Students are not empty vessels to be filled with knowledge

- Students are not empty vessels, they construct knowledge: engage pre-existing knowledge
- Students need guidance to structure their knowledge: set and share clear learning objectives, provide guiding scaffold
- Students should monitor their own learning: give opportunities / feedback to advance thinking and skills
- Students should be active participants: create participatory and collaborative environments

Teacher-centered Paradigm

What is the teacher doing?



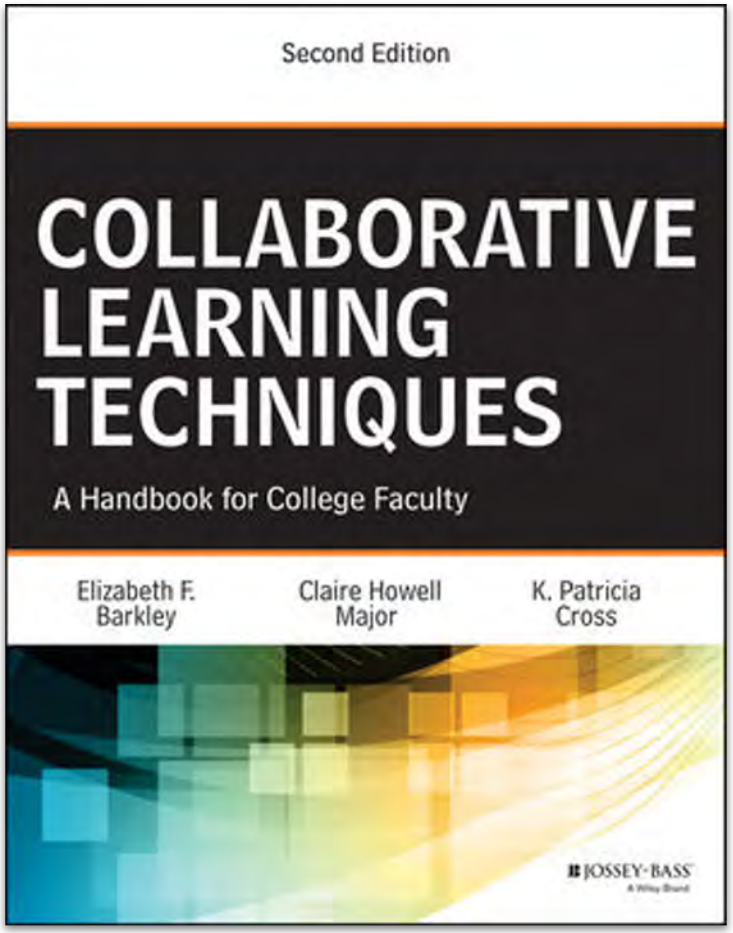
Learner-centered Paradigm

What is the student doing?

The role of teachers and students changes in important ways

Possible techniques to use

- Debates and role play
- Student-led, focused discussions
- Case studies
- Student presentations
- Class and field exercises
- Collaborative learning techniques
- Breakout rooms/groups



Barkley, Major, and Cross (2014)

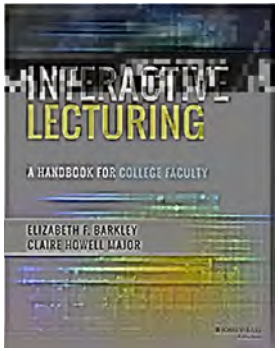
What about traditional lectures?

They should be considered as the best tool in some contexts, such as:

- Presenting new discoveries or developments
- Providing an overview of a topic
- Synthesizing information that is dispersed among several sources

Note: Recorded lectures should be short (<6 mins)

Lectures can be interactive



- Think-Pair or **Think-Pair-Share**
- **Pass the Chalk** – hand a student a piece of chalk and s/he must answer your next question; they then choose another student to pass the chalk. *Digital version: "popcorn"*
- **"Twitter" post** – ask students to define a term or describe a concept in under 140 characters

EDUCATIONFORUM

THE PIPELINE

Scientific Teaching in Practice

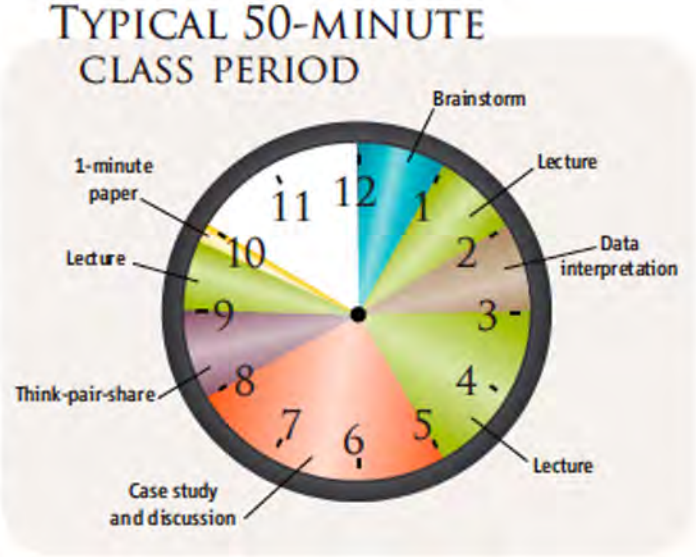
A new generation of university scientists is learning to teach using a scientific teaching approach.

Sarah Miller,[1] Christine Pfund,[2] Christine Maidl Pribbenow,[1,3] Jo Handelsman[1]*

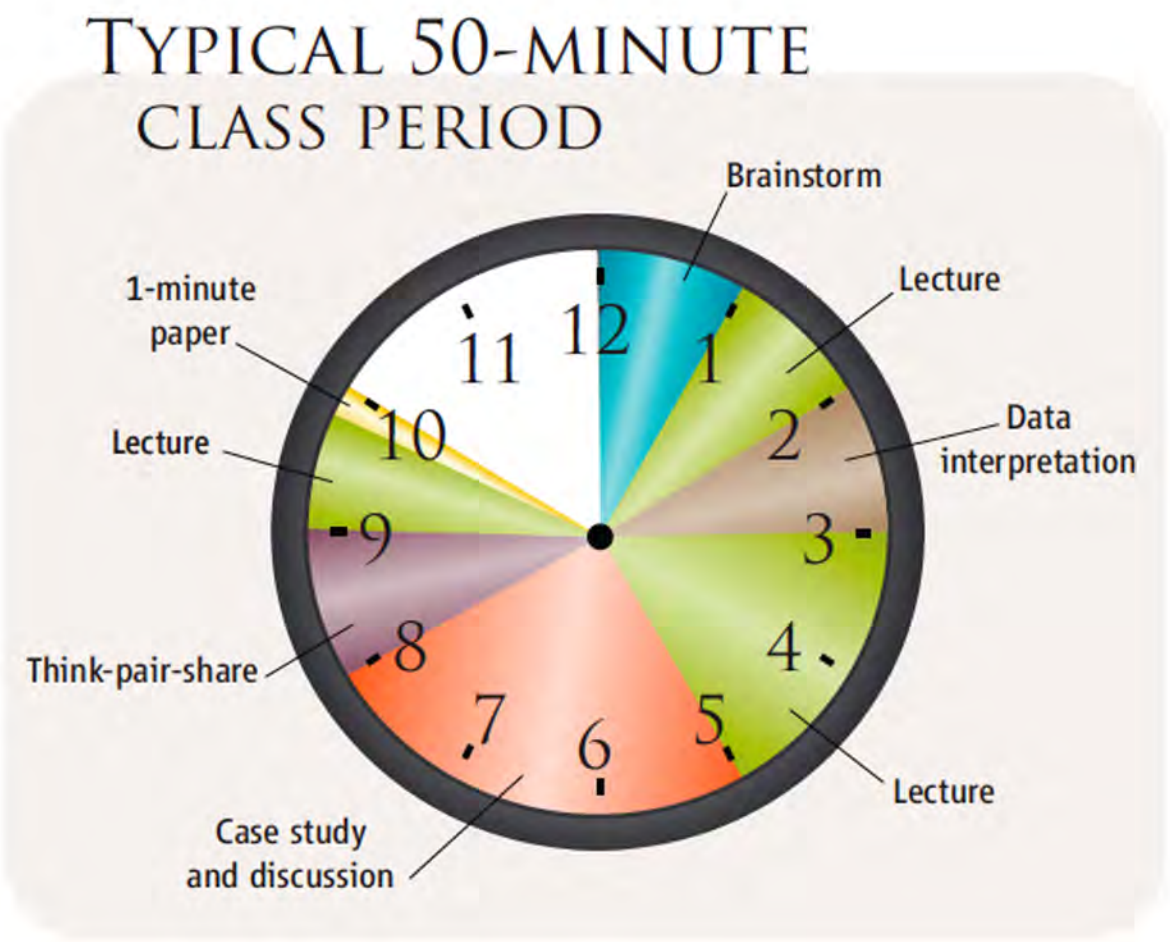
The United States educates and trains outstanding scientists. Doctoral students emerge as rigorous experimentalists and strong analytical thinkers, intellectually prepared for the diverse employment opportunities that await them. Problems persist, however, in two areas: preparing undergraduate students as scientists and preparing graduate students to teach (*1*, *2*). Both deficiencies can be addressed by implementing programs that train graduate students to teach. Although there have been repeated calls for such programs (*1*–*3*), and descriptions of some (*4*), little work has assessed their impact on the practices and philosophies of the participants.

In contrast to graduate education, undergraduate science education is based largely on facts rather than analytical thinking. Effective teaching methods based on how people learn

materials and their implementation in the classroom. Fellows partner with UW-Madison biology instructors to develop teachable units, built on a scientific teaching framework (*5*), that address challenges in the instructors' courses. As they develop their materials in teams of two to three, fellows learn an iterative process of instructional design: develop concrete learning goals, design activities to meet the goals, and revise instruction based on evaluation of progress toward the goals. Peer review and dissemination are embedded in the process. Details about coursework, the



Classroom implementation. Analysis of teachable units developed by fellows for lecture-style classes revealed that 66% of class time was devoted to active learning events.



Classroom implementation. Analysis of teachable units developed by fellows for lecture-style classes revealed that 66% of class time was devoted to active learning events.

"Instruction"

~ 40% of the time

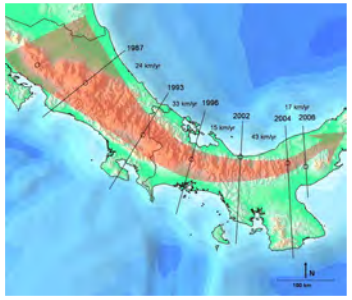
Think about…

When is it important for my students to do something toward their mastery of concepts or skills, or for deeper reflection?

When is it important for for me to provide synthesis, instruction, guidance, feedback?

Exercise 1: Biodiversity Threats

Applying Critical Thinking
to the Amphibian Decline Problem



→ Rubric

Intervention: Rubric Exercise (Y/N)

Exercise 2: Managing Invasive Species

Applying Critical Thinking to
an Invasive Species Problem

→ Rubric

Freely available online as part of the NCEP module collection! https://ncep.amnh.org

Study findings

- Students can measurably improve their skills in one term by
  - 34% critical thinking (Porzecanski et al. in review)
  - 29% data analysis (Bravo et al. 2016)
  - 40% oral communication (Sterling et al. 2016)

- In-class study and reflection leads to higher gains in skills

Freely available online as part of the NCEP module collection! https://ncep.amnh.org

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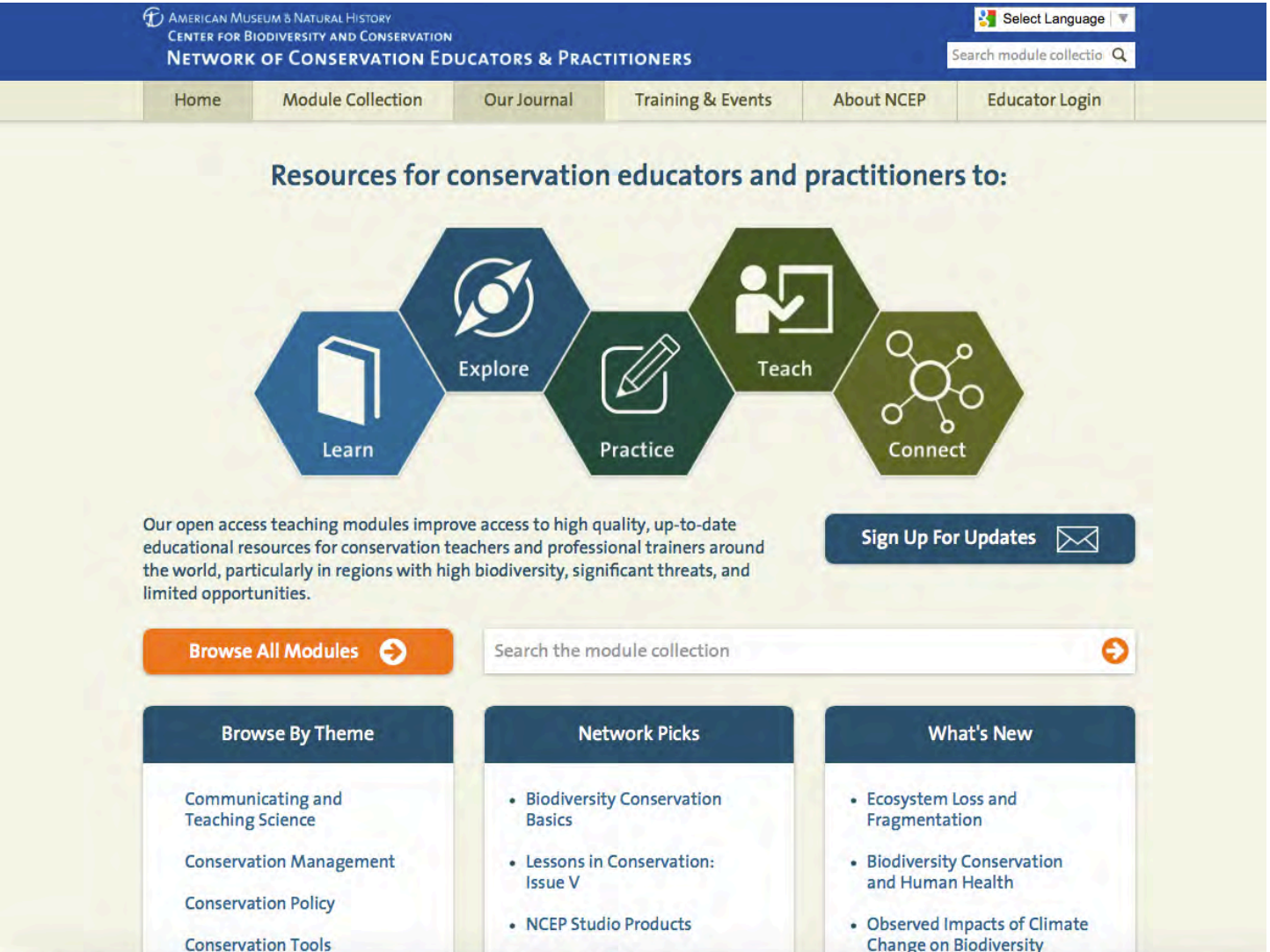
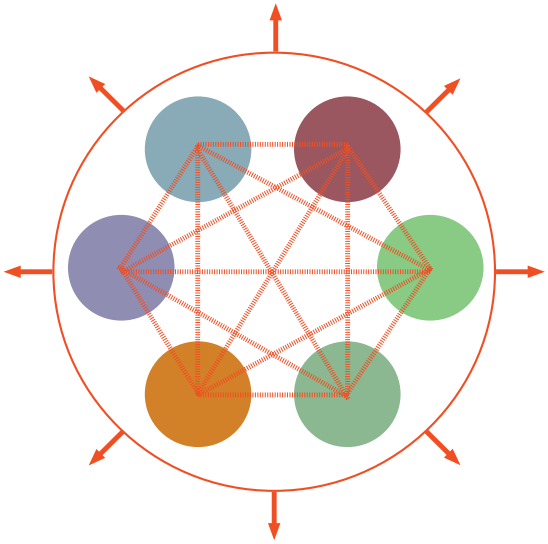


179 modules;
32 in Spanish
28 in French

Following the Evidence

Active teaching can improve student learning, attitudes, performance, and retention in STEM fields.

List of references provided at end of presentation.



OnlineQuestions.org or Padlet.com

Thank you.

List of references/resources

Allen, D., & Tanner, K. (2005). Infusing active learning into the large-enrollment biology class: seven strategies, from the simple to complex. *Cell biology education*, *4*(4), 262-268.

Armbruster, P., M. Patel, E. Johnson, and M. Weiss. 2009. Active learning and student-centered pedagogy improve student attitudes and performance in introductory biology. CBE-Life Science Education 8 (3): 203-213.

Bradforth, S. E., E. R. Miller, W. R. Dichtel, A. K. Leibovich, A. L. Feig, D. Martin, and T. L. Smith. 2015. Improve undergraduate science education: it is time to use evidence-based teaching practices at all levels by providing incentives and effective evaluations. Nature 523 (7560): 282-285.

Bravo, A., A.L. Porzecanski, E.J. Sterling, N. Bynum, M. Cawthorn, D. Fernandez, L. Freeman, S. Ketcham, T. Leslie, J. Mull, and D. Vogler. 2016. Teaching for higher levels of thinking: developing quantitative and analytical skills in environmental science courses. *Ecosphere,* April: 7(4): 1-20

Brownell, S. E., and K. D. Tanner. 2012. Barriers to faculty pedagogical change: Lack of training, time, incentives, and… tensions with professional identity? CBE-Life Sciences Education 11 (4): 339-346.

Burrowes, P. A., and G. M. Nazario. 2001. Preparing students for the transition from a teacher-centered to a student-centered environment: Active exercises that work at the university level. Pedagogia 35 (2001): 135-141.

Burrowes, P. A. 2003. A student-centered approach to teaching general biology that really works: Lord's constructivist model put to a test. The American Biology Teacher 65 (7): 491-502.

Chopin, S. F. 2002. Undergraduate research experiences: The translation of science education from reading to doing. The Anatomical Record 269 (1): 3-10.

Connell, G. L., D. A. Donovan, and T. G. Chambers. 2016. Increasing the use of student-centered pedagogies from moderate to high improves student learning and attitudes about biology. CBE-Life Science Education 15 (1): 1-15.

Ebert-May, D. C. Brewer, and S. Allred. 1997. Innovation in large lecture—teaching for active learning. BioScience 47 (9): 601-607.

Freeman, S., E. O'Connor, J. W. Parks, M. Cunningham, D. Hurley, D. Haak, C. Dirks, and M. P. Wenderoth. 2007. Prescribed active learning increases performance in introductory biology. CBE-Life Science Education 6 (2): 132-139.

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*, *111*(23), 8410-8415.

Guo, P. J., Kim, J., & Rubin, R. (2014, March). How video production affects student engagement: An empirical study of MOOC videos. In *Proceedings of the first ACM conference on Learning@ scale conference* (pp. 41-50).

Haak, D. C., J. HilleRisLambers, E. Pitre, and S. Freeman. 2011. Increased structure and active learning reduce the achievement gap in introductory biology. Science 332 (6034): 1213-1216.

Hagenbuch, B. E., Bynum, N., Sterling, E., Bower, A. H., Cigliano, J. A., Abraham, B. J., ... & Rhode, J. M. (2009). Evaluating a multi-component assessment framework for biodiversity education. *Teaching Issues and Experiments in Ecology*, *6*(3), 1-18.

Knight, J. K. and W. B. Wood. 2005. Teaching more by lecturing less. Cell Biology Education 4 (4): 298-310.

Lord, T. R. 1999. A comparison between traditional and constructivist teaching in environmental science. The Journal of Environmental Education 30 (3): 22-27.

Magnussen, L. (2008). Applying the principles of significant learning in the e-learning environment. *Journal of Nursing Education*, *47*(2), 82-86.

Mazur, E. 2009. Farewell, lecture. Science 323 (5910): 50-51.

Nordlund, L. M. 2016. Teaching ecology at university—Inspiration for change. Global Ecology and Conservation 7 (2016): 174-182.

Rodenbusch, S. E., P. R. Hernandez, S. L. Simmons, and E. L. Dolan. 2016. Early engagement in course-based research increases graduation rates and completion of science, engineering, and mathematics degrees. CBE-Life Sciences Education 15 (2): ar20.

Ryan, M. R., and H. Campa III. 2000. Application of learner-based teaching innovations to enhance education in wildlife conservation. Wildlife Society Bulletin 28 (1): 168-179.

Seidel, S. B., and K. D. Tanner. 2013. "What if students revolt?"—considering student resistance: origins, options, and opportunities for investigation. CBE-Life Sciences Education 12 (4): 586-595.

Sterling, E.J., A. Bravo, A.L. Porzecanski, N. Bynum, R. Burks, J. Linder, T.A. Langen, D.S. Fernandez, and D. Ruby. 2016. Think before (and after) you speak: Practice and self-reflection build student confidence and bolster performance in oral communication skills. *Journal of College Science Teaching.* July. 45(6): 87-99.

Sundberg, M. D., and G. J. Moncada. 1994. Creating effective investigative laboratories for undergraduates. BioScience 44 (10): 698-704.

Tanner, K. D. 2009. Talking to learn: why biology students should be talking in classrooms and how to make it happen. CBE-Life Sciences Education 8 (2): 89-94.

Theobald, E. J., Hill, M. J., Tran, E., Agrawal, S., Arroyo, E. N., Behling, S., ... & Grummer, J. A. (2020). Active learning narrows achievement gaps for underrepresented students in undergraduate science, technology, engineering, and math. *Proceedings of the National Academy of Sciences*, *117*(12), 6476-6483.

Udovic, D., D. Morris, A. Dickman, J. Postlethwait, and P. Whetherwax. 2002. Workshop biology: demonstrating the effectiveness of active learning in an introductory biology course. BioScience 52 (3): 272-281.

Wieman, C. 2007. Why not try a scientific approach to science education? Change: The Magazine of Higher Learning 39 (5): 9-15.

Wood, W. B. 2009. Innovations in teaching undergraduate biology and why we need them. Annual Review of Cell and Developmental Biology 25 (2009): 93-112.

Books

Ambrose, S. A., Bridges, M. W., DiPietro, M., Lovett, M. C., & Norman, M. K. (2010). *How learning works: Seven research-based principles for smart teaching*. John Wiley & Sons.
Angelo, T.A. & P.K. Cross. 1993. *Classroom Assessment Techniques* (2nd ed.). San Francisco: Jossey-Bass.
Barkley, E. F., and C.H. Major. 2016. *Learning Assessment Techniques: A Handbook for College Faculty*. Jossey-Bass, San Francisco, CA, USA.
Barkley, E. F., and C.H. Major. 2018. *Interactive Lecturing: A Handbook for College Faculty*. Jossey-Bass, San Francisco, CA, USA.
Fink, L. D. (2013). *Creating significant learning experiences: An integrated approach to designing college courses*. John Wiley & Sons.
Handelsman, J., Miller, S., & Pfund, C. (2007). *Scientific Teaching*. Macmillan.

Collection of online resouces
https://docs.google.com/spreadsheets/d/16qGcV7vkMtyVnDGARwJBJHSiWMQsqTexk9tk3EbX2Gw/edit?usp=sharing

Inclusive Teaching Resources

- Diversity chapters in "Scientific Teaching," Handelsman et al.
- "Situational Factors to Consider," Dee Fink
- Columbia's Guide for Inclusive Teaching