

Physics Education Research (PER) seminar: inaugural meeting

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2015-09-08

Opening remarks

- Frequency: meet every 3-4 weeks
- Format: more interactive than passive
- Audience: everyone
- Theme: bridging theory and practice

Goals and outcomes of these seminars

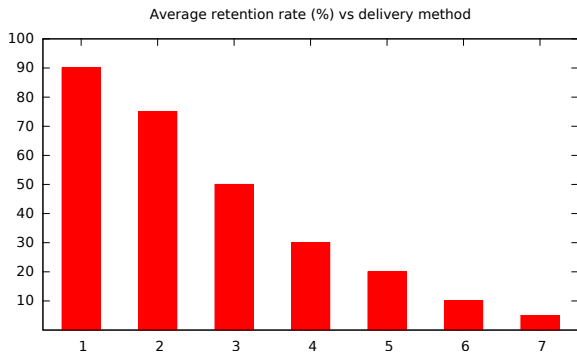
Goal:

- Understand best practices in teaching and learning.

Outcomes:

- Recognize and apply demonstrably effective methods, e.g., backward design, scientific teaching, constructivism, atomism.
- Scale applications to the level of the lesson, course, degree, and institution.
- Apply and interpret assessments of learning, e.g., formative, summative, pre- and post-testing.
- Form a community of informed and active educators who share their experience.

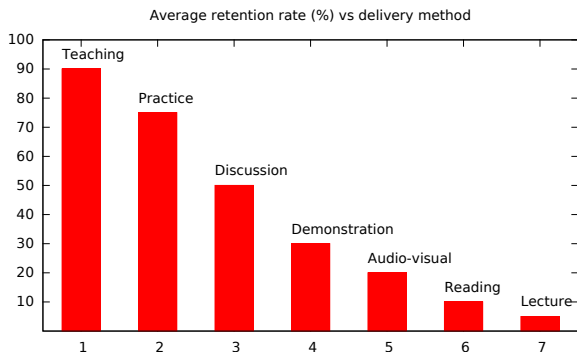
Task: match the delivery method with its effectiveness



- Audio-visual
- Demonstrations
- Discussion
- Lecture
- Practice
- Reading
- Teaching

Figure: Source: National Training Laboratory, Maine (ntl.org).

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How people learn

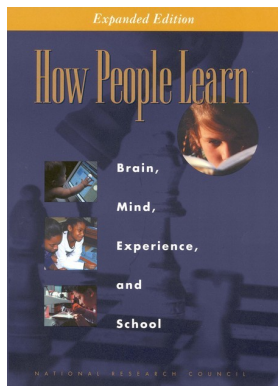


Figure: Source: National Academies Press (nas.edu)

“How people learn” is a meta-analysis of the teaching literature completed by the NSF in 1999. Take-home lessons for effective teaching:

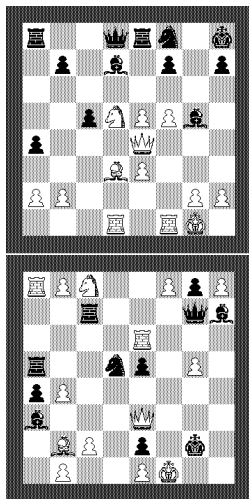
- 1 confront misconceptions,
- 2 build conceptual frameworks,
- 3 coach metacognition.

In the next 3 slides, I will give a brief example of each.

How people learn: confront misconceptions

- Problem: people approach a new topic with pre-conceived notions. If these notions are not dispelled, then people will try to incorporate new knowledge using incorrect, contrived, irrational, and complex scenarios.
- Solution: directly confront the pre-conceived notions with irreconcilable information, creating a so-called dissonance in the learner's mind.
- Example: seasons
 - Misconception: changing Earth-Sun distance causes the seasons.
 - Dissonant information: perihelion is on January 4, seasons are reversed in the northern and southern hemispheres, Earth's orbit is only 1% non-circular.

How people learn: build conceptual frameworks



- Problem: long-term recall and competence in an area of inquiry is absent when people are unable to organize knowledge in a way that facilitates recall.
- Solution: teach some material in depth, providing many examples of the same concepts at work.
- Example: the chessboard challenge
 - Chess masters greatly out-performed non-experts in recalling the top position; masters and non-experts performed equally well in recalling the bottom position; why?

Figure: Source: Chase & Simon 1973

How people learn: coach metacognition

- Problem: people lack motivation for learning, cannot gauge their own level of competence, use their time inefficiently.
- Solution: integrate metacognitive skills into the learning experience.
- Examples:
 - Provide motivations for learning other than grades, e.g., real-world applications.
 - Provide opportunities for formative evaluation: low-risk, short in time, frequent, formally or informally graded, encourages correction of errors.
 - Communicate goals, and specific tasks that indicate achievement of the goals.
 - Use instructional strategies built upon theories of human information processing, e.g., VARK (visual, aural, reading/writing, kinesthetic).

An example from “Classical mechanics” (Phys 320)

What concepts are present in the exercise?

PER seminar series: highlights of the coming months

- What to expect
 - Backward design (Wiggins & McTighe 1998)
 - Cognitive taxonomies and action verbs (Bloom; Krathwohl; others)
 - Collaborative learning techniques (Barkley et al. 2004)
 - Classroom assessment techniques (Angelo & Cross 1993)
- What not to expect
 - Philosophy of education (Noddings 2011)
 - Journal club

The final word...

...rests today with Carl Wieman

“...it is no longer appropriate to use lecture teaching as the comparison standard, and instead, research should compare different active learning methods, because there is such overwhelming evidence that the lecture is substantially less effective.”

Source: <http://www.pnas.org/content/111/23/8319.full.pdf>