Principles of Teaching and Learning

1 Prior knowledge and motivation

Connect to students' prior knowledge and motivations to leverage students' powerful ideas and interests and attend to where they struggle.

"What do you think of when I say 'Force'?"

2 Active engagement

Use active engagement so that students do the work of making sense of the material themselves and make meaningful connections.

"What do you think will happen when...?"

3 Social interaction

Use social interaction so that students can verbalize their thinking and coach one another.

"Turn to your neighbor and discuss."

4 Feedback & reflection

Provide feedback and reflection opportunities so that students can reflect on and adjust their learning ("metacognition").

"Let's do a quick poll..."

5 Inclusive & supportive classrooms

Use inclusive classroom strategies and create a supportive and welcoming climate to support learning for the widest variety of students.

"I'd like to hear from at least 3 students...."

6 Scaffolding

Start simple and provide early support so students can build skills and concepts. Then gradually step back and provide less structure.

"I've set up the problem, what is the next step?"

These items are adapted from M. Lovett, M. Bridges, M. DiPietro, S. Ambrose, and M. Norman (2023). How Learning Works: 8 Research-Based Principles for Smart Teaching *(2nd ed.). Jossey-Bass; L. E. Strubbe, A. M. Madsen, S. B. McKagan, and E. C. Sayre (2020). Beyond teaching methods: Highlighting physics faculty's strengths and agency.* Physical Review Physics Education Research, *16(2), 020105.*

Principles of Teaching and Learning, Explained

1. Prior knowledge and motivation matters

Students learn best when material connects to what they know and is meaningful and relevant: We build knowledge by creating connections to existing knowledge. Additionally, students' motivation determines, directs, and sustains what they do to learn. *Example: Prompt students to think about relevant experiences.*

2. Active engagement builds understanding

To deeply understand a concept, we must do the work of making sense of it for ourselves. This means that learning requires doing and reflecting, and organizing knowledge, rather than watching and listening. *Example: Ask students to predict what they think will happen in a demonstration, then discuss, observe, and discuss.*

3. Social interaction builds understanding

Learning socially is very effective. When we interact with others, we learn by verbalizing our thinking, hearing ideas in the words of our peers, and co-constructing our understanding through collaborative sense-making. *Example: Have students work in groups to articulate their reasoning about a conceptual question.*

4. Feedback & reflection improve learning.

Practice, coupled with targeted feedback, enhances the quality of our learning. Targeted, timely feedback is one of the most essential aspects of learning, helping students to reflect on their experience and thus monitor and adjust their approaches to learning ("metacognition"). *Example: Use polling questions and reflective writing.*

5. Inclusive classrooms support learning for all

An equitable and inclusive classroom climate can support learning for a wide variety of learners, not just historically marginalized groups. Create a supportive class environment where students feel welcomed, with activities and assessments that support learning. *Example: Learn student names and use structured active learning.*

6. Scaffolding builds up skills.

Students must acquire component skills and practice using them to achieve mastery. As experts, we have typically forgotten how complicated it is to develop competence. Give instructional support ("scaffolding"): Break tasks down, provide concrete structure, demonstrate techniques, and help students practice. Reduce these supports over time. *Example: Ask students to complete a partially worked problem before solving a problem from scratch.*