# Faculty Teaching Institute (FTI)

## June 26, 2023

This material is based upon work supported by APS, AAPT, AAS, and the National Science Foundation under Grant Nos. 2141678, 2141745, 2141769, 2141795, 2142045.

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of APS, AAPT, AAS, and the National Science Foundation.

# Table of Contents

# Workshop information

## Presenters

**Stephanie Chasteen***
*Chasteen Educational Consulting*
*Louisville, CO*
*stephanie@chasteenconsulting.com*

**Ed Prather***
*University of Arizona*
*Tucson, AZ*
*eprather@arizona.edu*

**Colin Wallace**
*University of North Carolina, Chapel Hill*
*Chapel Hill, NC*
*cswphys@email.unc.edu*

**W. Tali Hairson**
*Equitable Development LLC*
*Seattle, WA*
*wtali@eqsdev.com*

**Rachel Scherr***
*University of Washington, Bothell*
*Seattle, WA*
*rescherr@uw.edu*

*Asterisk indicates presenters who are also FTI leadership team members.

## Leadership team

**Melissa Dancy**
*University of Colorado, Boulder*
*Boulder, CO*
*melissa.dancy@gmail.com*

**Laurie McNeil**
*University of North Carolina, Chapel Hill*
*Chapel Hill, NC*
*mcneil@physics.unc.edu*

**Michael Wittmann**
*American Physical Society*
*Bangor, ME*
*wittmann@aps.org*

**Glen Davenport**
**external evaluator**
*Elegant Insights*
*New York, NY*
*glen@gdevaluation.com*

**Andy Rundquist**
*Hamline University*
*St. Paul, MN*
*arundquist@hamline.edu*

**Kathryne S. Woodle**
*American Physical Society*
*Longmont, CO*
*woodle@aps.org*

**Robert Hilborn**
*American Association*
*of Physics Teachers*
*College Park, MD*
*rhilborn@aapt.org*

**Marilyne Stains**
*University of Virginia*
*Charlottesville, VA*
*mstains@virginia.edu*

# Society Partners

## American Association of Physics Teachers

BETH CUNNINGHAM,
EXECUTIVE OFFICER

AMERICAN
ASSOCIATION OF
PHYSICS TEACHERS

ONE PHYSICS ELLIPSE,
COLLEGE PARK, MD
20740-0845

301-209-3311
WWW.AAPT.ORG

Founded in 1930, AAPT is the premier professional society established to advance the greater good through physics education. With the support of our members worldwide, AAPT is an action-oriented organization designed to develop, improve, and promote best practices for physics education as part of the global need for qualified Science, Technology, Engineering, and Mathematics educators who will inspire tomorrow's leaders and decision-makers. We serve our members through networking, publications, and programs, but also reach out to the larger community of physics and science educators—current and future—and we look after issues of significance in science education. Our national office works closely with our dedicated volunteers around the world to promote a better understanding of physics at all levels. AAPT provides networking opportunities through online discussion lists, social media, the Physics and Astronomy Faculty Teaching Institutes (with APS and AAS); Physics Department Chairs Conference (with APS), and our two national annual meetings. The Association supports physics educators through our publications, the American Journal of Physics and The Physics Teacher; Physical Review Physics Education Research (with APS and the APS Forum on Education) and the eNNOUNCER; NSF-funded programs including PhysPort, the Physics Teacher Education Coalition, PhysTEC (with APS); the digital physics library, ComPADRE (with APS and AIP); the Partnership for Integration of Computation in Undergraduate Physics, the Living Physics Portal (educational resources for physics courses for life science students), the Organization for Physics at Two-Year Colleges (OPTYCS), and the student programs and scholarships that we administer, including the Lotze Scholarship for Future Teachers.

## American Astronomical Association

KEVIN MARVEL
EXECUTIVE OFFICER

AMERICAN ASTRONOMICAL SOCIETY

1667 K STREET, NW #800 WASHINGTON DC 20006

202-328-2010
WWW.AAS.ORG

The American Astronomical Society (AAS), established in 1899, is a major international organization of professional astronomers, astronomy educators, and amateur astronomers. Its membership of approximately 8,000 also includes physicists, geologists, engineers, and others whose interests lie within the broad spectrum of subjects now comprising the astronomical sciences. The mission of the AAS is to enhance and share humanity's scientific understanding of the universe as a diverse and inclusive astronomical community, which it achieves through publishing, meetings, science advocacy, education and outreach, and training and professional development. AAS publishes The Astrophysical Journal, The Astronomical Journal, and The Planetary Science Journal, among the most important scholarly journals in the field. The Bulletin of the American Astronomical Society includes reports of broad interest to the astronomical community, commentary about the discipline, science meeting abstracts, and obituaries. More information about the Society's activities and membership is available on the AAS website, aas.org.

## American Physical Society

JONATHAN BAGGER
CHIEF EXECUTIVE OFFICER

AMERICAN PHYSICAL SOCIETY

ONE PHYSICS ELLIPSE COLLEGE PARK, MD 20740-3844

The American Physical Society is a nonprofit membership organization working to advance and diffuse the knowledge of physics through its outstanding research journals, scientific meetings, and education, outreach, advocacy, and international activities. APS represents more than 50,000 members, including physicists in academia, national laboratories, and industry in the United States and throughout the world. Since its formation in 1899, APS has been dedicated to providing its members and the international physics community with the latest research through the most highly respected international physics journals and world-class meetings. The journal collection consists of 17 peer-reviewed journals, including *Reviews of Modern Physics*, the highest-impact journal in physics; *Physical Review Letters*, the most-cited letters journal in physics; a journal on physics education research (*Physical Review Physics Education Research*); and its newest title, *PRX Life*, which focuses on

301-209-3200
WWW.APS.ORG

biological physics research. APS convenes more than 20 scientific conferences per year to connect physicists and disseminate information relevant to the community. Additionally, APS lobbies for physics research funding, carries out studies on important physics-based topics, and promotes the interests of the physics community through public engagement efforts. Through its leadership in the Physics Teacher Education Coalition (PhysTEC), APS is working to improve and promote the education of future physics teachers. Along with PhysTEC, APS partners with AAPT on numerous other education programs including the Effective Practices for Physics Programs (EP3) which informs assessment of all aspects of the undergraduate program, and the STEP UP program which aims to dramatically increase the number of women pursuing undergraduate degrees in physics. For many years, APS has worked to increase diversity in the physics community. Efforts include the APS Bridge Program, a national effort to increase the number of underrepresented minorities that receive a Ph.D. in physics; the National Mentoring Community (NMC) which provides individual mentors to underrepresented undergraduates; and Conferences for Undergraduate Women in Physics (CUWiP), regional conferences to encourage the participation of women in the physics discipline.

AIP

## American Institute of Physics

MICHAEL H. MOLONEY
CHIEF EXECUTIVE OFFICER

AMERICAN INSTITUTE OF PHYSICS

ONE PHYSICS ELLIPSE
COLLEGE PARK, MD
20740-0845

301-209-3100
WWW.AIP.ORG

AIP's mission is to advance, promote and serve the physical sciences for the benefit of humanity. AIP offers authoritative information, services, and expertise in physics education and student programs, science communication, government relations, career services for science and engineering professionals, statistical research in physics employment and education, industrial outreach, and the history of physics and allied fields. AIP Member Societies cover a broad range of fields in the physical sciences and collectively represent more than 120,000 scientists, engineers, educators, and students in the global physical sciences community.

# Acknowledgments & Credits

The information and activities presented in the FTI and this binder are the collective work of a broad range of individuals and organizations. These contributors are acknowledged in specific handouts, slides, and materials. Below are key contributors we would like to acknowledge more broadly:

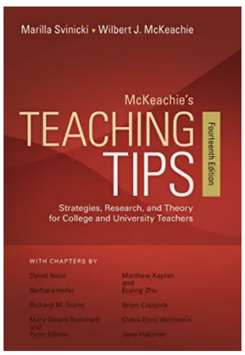
- **Stephanie Chasteen, Edward Prather, and Rachel Scherr** (Chasteen Educational Consulting, University of Arizona, and University of Washington Bothell, respectively), are the architects of the FTI workshop, building on work referenced here and supported by the FTI leadership team.
- **Richard Felder and Rebecca Brent** (Education Designs Inc.) inspired us in numerous ways, through their written work (e.g., *Teaching and Learning STEM: A Practical Guide*), providing us the opportunity to observe their faculty development workshops, presenting sessions at the FTI, introducing us to Robert Boice's "quick starter" faculty advice, providing copies of their session materials, and serving as sounding boards for many of our ideas. Thank you, Rich and Rebecca!
- **W. Tali Hairston** (Equitable Development LLC) provided content for several of the activities and case studies in the equity, diversity, and inclusion (EDI) sessions, and provided reflective feedback on several sessions from an equity lens.
- **Kelly Hogan and Viji Sathy** have inspired and informed us through their inclusive teaching presentations and written work (K. Hogan & V. Sathy 2022. *Inclusive Teaching: Strategies for promoting equity in the classroom*. West Virginia University Press.).
- **Linda Strubbe** (Strubbe Educational Consulting) provided extensive support; drafted many handouts, provided feedback on FTI plans, and her work on instructor agency inspired much of the thinking on the desired FTI outcomes (Strubbe et al., 2020; Phys. Rev. Phys. Educ. Res., 16, 020105), as well as our development of principles of teaching and learning.
- **Sam McKagan and Ellie Sayre** (PhysPort.org), both individually and in their work with L. Strubbe (above), inspired us to think about non-branded instructional techniques and the needs of physics faculty.
- **Ed Prather and Gina Brissenden** (University of Arizona) developed the questions for think-pair-share that inspired and were incorporated into the Conversation Cards.
- **Computer Science Teaching Tips** (accessed at https://www.csteachingtips.org/) inspired our development of Tipsheets.
- The **Academy of Inquiry Based Learning** (http://www.inquirybasedlearning.org/) inspired some of our thinking, and made many valuable materials available online at their website.
- **The Change at the Core (C-CORE) project** at Western Washington University (https://smate.wwu.edu/c-core-website) inspired several of our approaches, including My Action Plan.
- Several physics faculty contributed short videos used in the "Stories from the community" videos: **Marty Baylor** (Carleton College), **Noah Finkelstein** (University of Colorado Boulder), **Scott Franklin** (Rochester Institute of Technology), **Andy Gavrin** (Indiana University), **Matt Gliboff** (University of Washington Bothell), **Natasha Holmes** (Cornell University), **Lisa Goodhew** (Seattle Pacific University), **Laura McCullough** (University of Wisconsin-Stout), **Laurie McNeil** (University of North Carolina), **Mel Sabella** (Chicago State University), **Mac Stetzer** (University of Maine), **John Thompson** (University of Maine), and **Stamatis Vokos** (California Polytechnic Institute). Thank you!

# Recommended reading and online materials

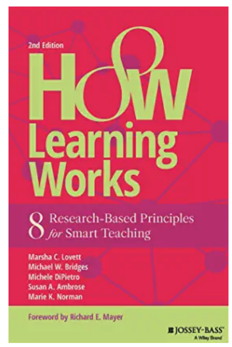
Please see the FTI website for links to the following:

1. **Your personal online folder** with digital copies of the FTI binder and My Action Plan;
2. **FTI online resources,** including relevant links for further information on ideas discussed in the workshop.

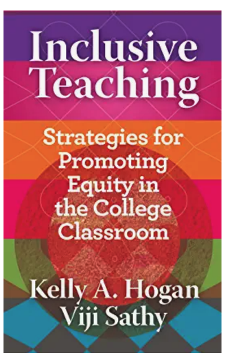
<u>Below are our top recommended readings for topics discussed in the FTI.</u>



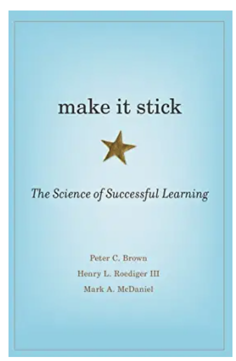

**McKeachie's Teaching Tips, 14th edition**
*McKeachie and Svinicki, 2013*
An essential handbook full of research-based tips and practices for all elements of instruction.



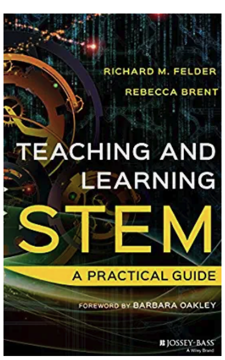

**How Learning Works, 2nd edition**
*Lovett et al., 2023*
A go-to resource for learning what is known about effective instruction, and more about the Principles of Teaching and Learning.



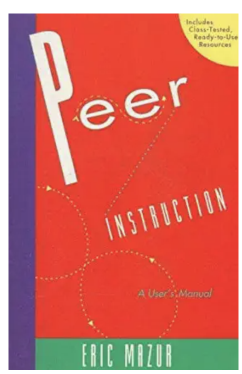

**Inclusive Teaching**
*Hogan and Sathy, 2022*
A fantastic guide to using structure to make learning accessible to all. One of our favorites!




**Make it Stick**
*Brown et al., 2014*
Another go-to resource for research on learning, this one focused on cognition and memory.




**Teaching and Learning STEM: A Practical Guide**
Felder and Brent, 2016
This STEM-focused handbook provides an excellent foundation in teaching well. One of our favorites!




**Peer Instruction: A User's Manual**
*Mazur, 1996*
This classic book describes how to use student discussion around conceptual questions. Includes a large collection of questions.

# Society resources for further engagement

The FTI is committed to assisting you to navigate a fulfilling academic career, achieving a rewarding balance among teaching, service, and research commitments, and connecting you to a supportive disciplinary community whose members are engaged in helping and empowering one another. To this end, here are some resources from the American Physical Society (APS), the American Association of Physics Teachers (AAPT), the American Astronomical Society (AAS), and the American Institute of Physics (AIP). Part of being an effective faculty member is supporting and mentoring your students. Here are some programs you should be familiar with so that you can assist your students as they progress along their career paths.

## Advancing Graduate Leadership (AGL)

AGL is a program that provides opportunities for women and gender minority graduate students and postdocs to expand their networks, discover collaboration opportunities, receive mentor and professional development training, and support others seeking leadership roles.

Students

aps.org/careers/agl/

## APS Bridge Program

Do you know students from marginalized groups that are interested in graduate school but might not have the necessary coursework, research experience, or guidance to successfully apply for admission and complete a physics Ph.D. program? Encourage them to apply for the APS Bridge Program! The Bridge Program partners with departments that are looking to improve diversity in their institutions and the physics community at large. Departments are able to recruit students from the Bridge application pool, receive valuable resources and information from experts in graduate education, and partner with other departments.

Students

Departments

apsbridgeprogram.org

## APS Careers in Physics Resources

Faculty should bookmark this webpage as it serves as a hub for access to many resources. This webpage is useful for faculty's personal professional development and as a resource for students interested in exploring careers in physics.

- Job Boards: careers.aps.org/jobseekers/ and aps.org/careers/employment/
- Job Fairs APS: aps.org/careers/employment/jobfairs

APS Advancing Physics

aps.org/careers

Students

Faculty

## APS Chapters

Faculty can participate in and promote programs like APS Chapters. The Chapters program supports graduate students, postdocs, and early career scientists and provides resources for members to focus on what is most important to their members. For example past topics include graduate student pay, creating multimedia physics resources, networking, advocacy, and fostering equity. A Chapters team must have a faculty/staff advisor in good standing with APS before an institution can participate in the APS Chapter program.

APS Advancing Physics

aps.org/membership/chapters.cfm

Students

## APS Climate Site Visits

Faculty can request an APS Climate Site Visit to tap the extensive experience of site visitors for insights on creating a more inclusive, welcoming, and supportive environment for everyone, with special attention to women and marginalized groups. Site visits require engagement of faculty, staff, and students in a process that includes a two-day visit and a set of written recommendations.

APS Advancing Physics

aps.org/programs/women/sitevisits

Departments

## APS Conferences for Undergraduate Women in Physics (CUWiP)

Encourage undergraduate women and gender minorities at your

Conferences for Undergraduate Women in Physics

aps.org/cuwip

institution to continue in physics by attending a CUWiP! CUWiPs provide an opportunity to experience a professional conference, gather information about graduate school and professions in physics, and access to other women in physics of all ages with whom they can share experiences, advice, and ideas.

Students

## APS Inclusion, Diversity, and Equity Alliance (APS-IDEA)

APS-IDEA is a network of faculty, students, scientists, and researchers implementing research-based transformational methods to empower and support physics departments, laboratories, and other organizations to identify and enact strategies for improving equity, diversity, and inclusion (EDI). APS supports these teams of physicists through shared communities, online resources, and facilitated cohort development to accelerate results.

Departments

aps.org/programs/innovation/fund/idea.cfm

## APS Industry Mentoring for Physicists (IMPact)

IMPact is a mentorship program that faculty can encourage their students to use if students are interested in pursuing a non-academic career in industrial physics. IMPact connects young physicists to private industry physicists for a 3-4 month mentorship program.

Students

mentoring.aps.org/programs/impact/

## APS National Mentoring Community

Are you interested in gaining experience mentoring students? Are your students interested in finding mentors and accessing special resources? Join the NMC! The NMC facilitates and supports mentoring relationships between Black/African, Latinx, and Indigenous physics students and physics mentors by providing personal and professional development to mentors and mentees, matching mentors and mentees, and providing resources to mentees.

Students
Faculty

aps.org/nmc

## APS Physics Research Mentor Training

Looking for ways to support your students in their research studies? Do you have graduate students or postdocs who could use some mentor training? Start a reading group to work through case studies in the Physics Mentor Training Seminar. This resource is a facilitation guide to a training seminar for physics faculty, postdocs, and graduate students who are in mentorship roles. Themes include: establishing expectations, maintaining effective communication, addressing diversity, and dealing with ethical issues.

Faculty


aps.org/programs/education/undergrad/faculty/mentor-training.cfm

## APS Webinars


aps.org/webinars/

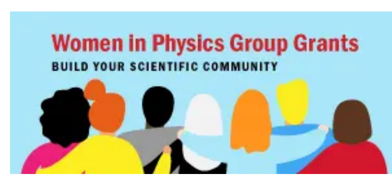
Webinars can be used to connect you with the expertise of individuals who can offer insight into physics careers, educational programs, and professional development for students, working physicists and educators. Topics include; public engagement, industry careers, career exploration, and international physicists.

Students
Faculty

## APS Women in Physics Group Grants

Undergraduate and Graduate members of your college or university's Women in Physics (WiP) group are eligible to apply for a Women in Physics Group Grant. You can serve as a faculty advisor and write a letter of support for your college or university's Women in Physics Group Grant. Successful applicants will receive up to $1,000 to start a new WiP group or enhance an existing one.

Students




aps.org/programs/women/scholarships/wipgrants.cfm

## Data Science Education Community of Practice (DSECOP)

The DSECOP program seeks to support physics educators in integrating data science in their courses.

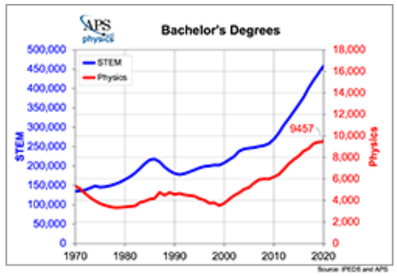
Curriculum

aps.org/programs/innovation/fund/dsecop

## Education Statistics

Faculty must stay informed of current trends in Physics, from employment to demographic enrollment.  Analyzing data will keep your department from falling behind in areas such as recruitment and retention of undergraduate students.

Departments





AIP Statistics resource center: [aip.org/statistics](aip.org/statistics)

APS statistics: [aps.org/programs/education/statistics/index.cfm](aps.org/programs/education/statistics/index.cfm)

## Effective Practices for Physics Programs (EP3)

The EP3 Guide contains information and advice for physics departments and programs in the U.S. to use as they address challenges and make changes and improvements. Departments should approach the Guide as a toolbox to accomplish objectives they have set for themselves.

Departments

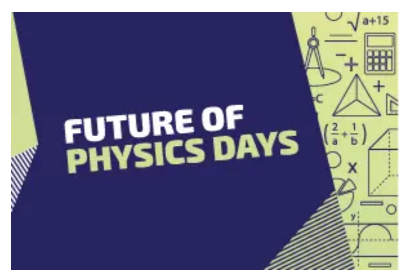
EP3 Effective Practices for Physics Programs

[EP3Guide.org](EP3Guide.org)

## Future of Physics Days

If your undergraduate student(s) plan to attend APS March or April Meetings, encourage them to participate in the Future of Physics Days events. Students can focus on interactive workshops, professional development activities, and career discovery opportunities organized by APS in collaboration with the Society of Physics Students (SPS).

Students




[aps.org/meetings/events/futurephysics/](aps.org/meetings/events/futurephysics/)

## Get the Facts Out (GFO)

Did you know about half of all physics majors have at least some interest in a teaching career but just do not know much about it? Get the Facts Out (GFO) provides data-driven resources for talking about the STEM teaching profession. With tested messaging, GFO users


[getthefactsout.org](getthefactsout.org) can improve perceptions around teaching, build faculty support for teaching, and recruit students to become future teachers.

Students
Faculty

## Inclusive Graduate Education Network (IGEN)

The NSF INCLUDES Alliance: IGEN is a partnership of over 30 societies, institutions, organizations, corporations, and national laboratories poised to lead a paradigm shift in increasing the participation of Black, Latinx and Indigenous students who enter graduate or doctorate level programs in the physical sciences. Its mission is to raise doctoral degree attainment rates of these groups in the physical sciences.

igenetwork.org/

Students
Departments

## International Year of Quantum (IYQ)

The 2025 International Year of Quantum Science and Technology is a global initiative that aims to strengthen national capacities in the basic sciences and science education. Detailed event and activity preparation and organization begins now! If you have ideas for quantum education or public engagement activities, or want to learn about other ways to participate, reach out to the organizers.

quantum2025.org

Departments
Faculty
Students

## Joint Network for Informal Physics Educators and Researchers (JNIPER)

JNIPER is a community of practice for physicists engaged in designing, facilitating, or studying informal physics learning (i.e. public engagement) activities and programs. Faculty looking to get started in public engagement, or to level- up their current engagement efforts, are encouraged to join JNIPER at our next coffee hour, workshop, or on Slack!

aps.org/programs/outreach/jniper

Faculty

## Living Physics Portal

The Living Physics Portal is an online environment for physics faculty to share and discuss free curricular resources for teaching introductory physics for life sciences (IPLS). The objective of the Portal is to improve the education of the next generation of medical professionals and biologists by making physics classes more relevant for life sciences students.

Curriculum

Living Physics Portal
Resources and community for teaching physics for life sciences

[livingphysicsportal.org/](livingphysicsportal.org/)

## National Physics REU Leadership Group (NPRLG)

The NPRLG is an independent organization of REU physics site directors committed to enhancing undergraduate student research experiences through cooperative engagement. The NPRLG is evaluating common assessment tools for eventual use across all Physics REU sites that want to participate, to address NSF's desire for common assessments in the physics REU program.

Faculty

NPRLG
NSF Physics REU Leadership Group

[aps.org/programs/education/undergrad/physicsreu/nprlg.cfm](aps.org/programs/education/undergrad/physicsreu/nprlg.cfm)

## Physicists To-Go / Quantum To-Go

The goal of Physicists To-Go and Quantum To-Go is to inspire K-12 students to pursue physics, science, and technology careers by matching classrooms with physics and quantum professionals. This class visit (virtual and in-person) outreach program offers faculty and professionals within the field of physical science, engineering, and technology an opportunity to participate in community-building activities.

Faculty

QUANTUM TO-GO

[aps.org/programs/outreach/physiciststogo.cfm](aps.org/programs/outreach/physiciststogo.cfm)

## Physics and Astronomy SEA Change

The Physics and Astronomy SEA* Change, a collaboration among AAAS and the Member and Affiliate Societies within the AIP Federation, seeks to support departments interested in systemic change regarding equity, diversity, and inclusion through a comprehensive self-assessment and addressing issues via a 5-year action plan. Departments in this program can apply for a Bronze Award; awarded departments will need to make progress on their action plan and can reapply for the Bronze Award after 5 years.

*SEA = STEMM (Science, Technology, Engineering, Mathematics, and Medicine) Equity Achievement

Departments

AAAS SEA CHANGE | PHYSICS & ASTRONOMY

aapt.org/Programs/Sea_Change/index.cfm

## Physics Teacher Education Coalition (PhysTEC)

Do you want to get more involved with physics teacher education preparation? Are you looking to get started on building your own physics teacher education program? PhysTEC works with physics faculty across the country to address the severe shortage of qualified high school physics teachers by building physics teacher education programs and communities around physics teacher preparation.

Departments

PhysTEC

phystec.org

## Partnership for Integration of Computation into Undergraduate Physics (PICUP)

PICUP provides faculty members with assistance in integrating computation into the physics curriculum. Check out the website to access peer-reviewed and adaptable physics computation educational materials.

PICUP
Partnership for Integration of Computation into Undergraduate Physics

compadre.org/picup/

## Science Trust Project

The Science Trust Project equips physicists with research-based communication skills to more effectively address misinformation about science in their communities. The Science Trust Project provides faculty access to a network of physicists who are interested in addressing misinformation, and a variety of training opportunities including webinars, workshops, and other resources.

Faculty

SCIENCE TRUST PROJECT

aps.org/programs/science-trust.cfm

## Society of Physics Students (SPS)

SPS is a chapter-based society that exists to help students transform themselves into contributing members of the professional community. Don't worry if your institution does not have an official chapter – there are individual and group membership opportunities for your students as well!

Students

spsnational.org

## STEP UP

STEP UP is a national community of physics teachers, researchers, and professional societies mobilizing to help engage young women in physics. STEP UP designs high school physics lessons (that can also be used in undergraduate classrooms) to empower teachers, create cultural change, and inspire young women to pursue physics in college.

stepupphysics.org

## TEAM-UP Together (TU-T)

Building off the influential TEAM-UP report, TU-T's goal is to double the number of African American students earning physics and astronomy bachelor's degrees annually by 2030. Faculty should encourage students to apply for TEAM-UP Together Scholarship Program and look for information about a departmental program,

teamuptogether.org/

which begins in 2023, that will provide funding for physics and astronomy departmental efforts and programs that prioritize and support successful outcomes for African American undergraduates in these fields.

Students
Departments

## Wiki Scientist Program

Faculty are leaders in the field of Physics. Put your knowledge and expertise into action by taking an APS Wiki Scientist Courses. You will learn how to edit and update Wikipedia pages and Wikidata entries in order to improve the public's access to physics through Wikipedia.

Faculty

aps.org/programs/outreach/wiki-course.cfm

# Post-workshop engagement with the FTI

As you continue to develop your MAP (My Action Plan) we are ready to support you through the next year of your teaching and beyond. These vary widely among commitment levels, number of participants, and communication modality. We hope that you will find some that fit your needs. Note: You can also always find up-to-date information about engagement opportunities on the website at [https://www.physport.org/FTI/Stay-Involved/](https://www.physport.org/FTI/Stay-Involved/). In addition, you will be added to the official FTI mailing list so that you can receive monthly post-workshop nudges to remind you to review and reflect on your MAP action plan and so that you can stay in the loop on all things FTI through our quarterly newsletter. See also the **Resources for Further Engagement** at the very end of this binder for opportunities beyond the FTI through professional societies.

## Recognition

### Connections to Centers for Teaching and Learning

Following the workshop, we will reach out to the contact you shared in the Supplemental registration form at your institution's Center for Teaching and Learning so that they are aware of your participation in the FTI. We highly encourage faculty to engage with their local campus resources for their continued teaching and professional development.

### Letters of Support for Teaching Portfolios

If you submit a written reflection on your MAP (My Action Plan) one-year following the workshop, the American Association of Physics Teachers (AAPT), the American Physical Society (APS), and the American Astronomical Society (AAS) can provide you with a personalized letter documenting that aspect of your teaching growth for your reappointment, promotion, or tenure portfolio. These types of letters have been impactful for many past workshop participants as they navigate their careers.

## FTI engagement opportunities

### Core Communication Tool (CCT)

All of you will be added to our core communication tool that we will decide on this week. The top choices are Slack, Discord, or an email Listserv. Leadership team members will be regularly adding to the conversation and all other events will be announced there.

## Faculty Online Learning Community (FOLC)

If you choose to join a FOLC you will be partnered with about 10 colleagues from this FTI Workshop. You will all meet virtually every other week supporting each other as you hear from guests (typically practitioners of methods and ideas you want to learn more about) and each other about your teaching journey. The FOLC will also support you in completing a Scholarship of Teaching and Learning project.

## Inclusive STEM Teaching Project & Online Learning Community

FTI is partnering with leaders of the Inclusive STEM Teaching Project (https://www.inclusivestemteaching.org/) to organize a special six-week FTI-specific online learning community to accompany the Inclusive STEM Teaching massive open online course (MOOC). This program is designed to advance the awareness, self-efficacy, and ability of STEM faculty to cultivate inclusive learning environments for all their students and to develop themselves as reflective, inclusive practitioners. Those engaging in the FOLC are strongly encouraged to participate in this course, as the FOLC programming itself will pause during this period in the fall. The MOOC is also offered regularly, twice per year.

## Teaching Critiques

Using our CCT we'll be on the lookout for people who need specific feedback on materials (syllabi, exams, labs, etc) or on teaching methods or attempts. We'll schedule a teaching critique where those who sign up will commit to digesting the material, which could include watching a video of someone's teaching, for example, and coming to provide support to one or more colleagues who are seeking it. These kinds of conversations among teachers who aren't in each others' evaluation chains are often quite productive.

## Free Help Sessions

Members of the leadership and presenter team will periodically schedule help sessions open to anyone to talk about both common issues and issues raised in the CCT. This is a great way to spend an hour to hear more detail about various approaches and to get your questions answered.

## Physics Teaching Podcast

We plan to host and publish a podcast all about the issues that you want to hear about. We'll use the CCT to seed the ideas, and we'll reach out to experts and practitioners from all over to help us have a fun and educational conversation that you can listen to in your car.

This page intentionally left blank

# Workshop materials

## All handouts used in the FTI are in this section, in order of use.

We will also refer to the following tabs during the workshop:

**My Action Plan** (MAP; mostly online)

**The universe of teaching and assessment strategies**

**Teaching practices sheets**

**Tipsheets**

This page intentionally left blank

# SCHEDULE

All meals and sessions will take place at the Hamilton Hotel unless otherwise noted.

Note that sessions will also refer to the following pages which appear after the workshop handouts:

- **The universe of teaching and assessment strategies** (Tab 3, page 113)
- **Teaching practices sheets** (Tab 4, page 133)
- **Tipsheets** (Tab 5, page 157)

| Day 1: Monday, June 26 | *Getting started* | |
|---|---|---|
| **Time (ET)** | **Session(s)** | **Page** |
| 08:00 - 09:00 | **WORKING BREAKFAST** | |
| 09:00 - 10:00 | Welcome to the FTI! | 37 |
| 10:00 - 11:00 | Your career: Imagining your role | 42 |
| 11:00 - 11:15 | **STRETCH BREAK** | |
| 11:15 - 11:30 | Stories from the community | – |
| 11:30 - 12:30 | Considering your identity and belonging | 50 |
| 12:30 - 1:30 | **WORKING LUNCH & WELCOME FROM SOCIETY CEOS** | |
| 1:30 - 2:00 | Considering your identity and belonging (continued) | |
| 2:00 - 2:30 | Foundations: Principles of teaching and learning | 51 |
| 2:30 - 3:15 | Experiencing the active class | 55 |
| 3:15 - 4:00 | **LONGER BRAIN BREAK** | |
| 4:00 - 5:00 | Foundations: Lesson design | 57 |
| 5:00 - 6:00 | Reflection: Discussions in pods, action planning, your questions | 67 & MAP online |
| *6:00* | *End of workshop day* | |
| 6:30 - 7:30 | **WORKING DINNER AT HOTEL** | |

| 7:30 - 8:30 | **FTI SOCIAL AT HOTEL** | |
|---|---|---|
| **Day 2: Tuesday, June 27** | ***Teaching strategies*** | |
| **Time (ET)** | **Session(s)** | **Page** |
| 08:00 - 09:00 | **WORKING BREAKFAST** | |
| 09:00 - 09:15 | Welcome to day 2! | – |
| 09:15 - 09:30 | PhysPort can help! | 71 |
| 09:30 - 10:15 | Teaching: Information delivery and individual work | 73 |
| 10:15 - 11:00 | Teaching: Whole class discussions | 77 |
| 11:00 - 11:15 | **STRETCH BREAK** | |
| 11:15 - 12:15 | Teaching: Think-pair-share | 78 |
| 12:15 - 12:30 | Engaging with the FTI after the workshop | (26) |
| 12:30 - 1:30 | **WORKING LUNCH** | |
| 1:30 - 2:15 | Teaching: Quantitative and collaborative problem solving | – |
| 2:15 - 2:45 | Teaching: Simulations, demonstrations, and visualizations | – |
| 2:45 - 3:15 | Formative assessment | 84 |
| 3:15 - 4:00 | **LONGER BRAIN BREAK** | |
| 4:00 - 4:15 | Formative assessment (continued) | |
| 4:15 - 4:45 | Reflecting on your teaching | 85 |
| 4:45 - 5:45 | Reflection: Discussions in pods, action planning, your questions | 86 & MAP online |
| 5:45 - 6:00 | "Midterm" feedback: Stop, start, continue | 87 |
| *6:00* | *End of workshop day* | |
| 6:30 | **DINNER ON YOUR OWN** | |

| **Day 3: Wednesday, June 28** | ***Going deeper*** | |
|---|---|---|
| **Time (ET)** | **Session(s)** | **Page** |
| 08:00 - 09:00 | **WORKING BREAKFAST** | |
| 09:00 - 09:15 | Welcome to day 3! | – |
| 09:15 - 10:30 | Teaching: Tutorials and other worksheets | 91 |
| 10:30 - 11:00 | Teaching: Common questions and sticky situations about group work | |
| 11:00 - 11:15 | **STRETCH BREAK** | |
| 11:15 - 11:45 | Teaching: Common questions and sticky situations about group work | – |
| 11:45 - 12:30 | First day & student engagement | 95 |
| 12:30 - 1:30 | **WORKING LUNCH** | |
| 1:30 - 2:30 | Teaching inclusively | 97 |
| 2:30 - 3:15 | Summative assessment | 99 |
| 3:15 - 4:00 | **LONGER BRAIN BREAK** | |
| 4:00- 4:15 | Summative assessment (continued) | |
| 4:15 - 4:45 | Teaching: Labs | 101 |
| 4:45 - 5:15 | Discussions in pod groups | 102 |
| 5:15 - 6:00 | Individual action planning session #1, and your questions | MAP online |
| *6:00* | *End of workshop day* | |
| 6:30 | **DINNER ON YOUR OWN** | |
| 8:00 - 9:00 | Tenure discussion (optional) | – |

| Day 4: Thursday, June 29 | *Action planning* | |
|---|---|---|
| **Time (ET)** | **Session(s)** | **Page** |
| 07:30 - 09:00 | **WORKING BREAKFAST** | |
| 08:00 - 9:00 | NSF panel discussion with Program Officers (optional) | Online slides |
| 09:00 - 09:15 | Welcome to the final day of the FTI! | – |
| 09:15 - 10:15 | Your career: Doing your role well | 105 |
| 10:15 - 10:45 | Bringing it all together: Course and unit design | 108 |
| 10:45 - 11:15 | Individual action planning session #2 | MAP online |
| 11:15 - 12:15 | Collective action planning session | – |
| 12:15 - 12:30 | Final words | – |
| *12:30* | *End of workshop day* | |

# Day 1

## Faculty Teaching Institute (FTI)

**Welcome to the FTI!**

**Your career: Imagining your role**

**Stories from the community**

**Considering your identity and belonging**

**Foundations: Principles of teaching and learning**

**Experiencing the active class**

**Foundations: Lesson design**

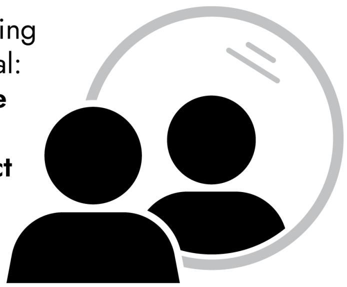
**Discussion in pod groups, your questions, and action planning**

This page intentionally left blank

## Journal Prompt 1: Why are you here?

We will ask you to do one-minute papers in your teaching journal several times in this workshop. Please write the number of the writing prompt in your journal and then answer this prompt there.

Teaching journal: **pause and reflect**



Take one minute to write your thoughts.

You will NOT be asked to share what you write.
This is just for you.

- **Why are you here?**
- **What are you hoping to get from the workshop?**



## Handout: Community Agreements and Discussion Guidelines

These guidelines are provided to help ensure we can all engage in inclusive, equitable, and productive discussions throughout the workshop.

### Community agreements

1. Share talk time
2. Listen actively
3. Value differences and respect everyone's expertise
4. Be present
5. Stories stay, lessons leave
6. Create an inclusive, collegial, and respectful environment
7. If you see something, say something
8. Have fun!

Credit: Discussion guidelines are adapted from the Inclusive Astronomy Conference (2015) and the Inclusive STEM Teaching Project (InclusiveSTEMteaching.org) and inspired by the "Boulder Summit" on professional development.

**1. Share talk time**

If you have been participating disproportionately, let others participate. Alternatively, if you haven't said much, you are encouraged to participate more. A frequent occurrence in discussions is that members of historically overrepresented groups dominate the discussion. Who is talking the most? Who is asking the most questions? Who are the first people to be called on? Who is being left out?

**2. Listen actively**

Use active listening strategies to ensure that all perspectives are heard; listen to understand, challenge one another respectively, speak to your own experience, and use "oops/ouch" if intentions go wrong; see "suggestions to support productive conversations" below.

**3. Value differences and respect everybody's expertise**

The collective teaching expertise in this room is immense. We have created a workshop to enable all present to share that expertise and wisdom. Respect the expertise and experiences of the people in the room – presenters, staff, and participants.

**4. Be present**

You are asked to stay as present as you can. If, at any point, you find that you are not learning or contributing, you have the right and responsibility to make necessary changes. Please leave non-urgent email and text conversations until after hours, or excuse yourself from the meeting.

**5. Stories stay, lessons leave**

We encourage you to share what you are learning at the meeting: however, we request that you not share personal narratives from participants without first obtaining their permission.

**6. Co-create an inclusive, collegial, and respectful environment**

We are committed to providing equal opportunity for and treatment of all event attendees. In keeping with the APS, AAPT, and AAS Codes of Conduct[1], we expect that all attendees (including presenters, participants, and staff) will conduct themselves in a professional manner that is welcoming to all participants and free from any form of discrimination. Disruptive, bullying, or harassing behavior of any kind will not be tolerated.

**7. If you see something, say something**

If you have concerns about any issues at the meeting, we encourage you to speak directly to a FTI organizer or email our evaluator Glen Davenport (glen@gdevaluation.com). If you do not feel comfortable talking to someone directly, and/or the issue is a serious violation of the Codes of Conduct, you may file a report at the EthicsPoint service: https://www.aps.org/meetings/policies/code-conduct.cfm.

---

[1] See https://www.aps.org/meetings/policies/code-conduct.cfm, https://www.aapt.org/aboutaapt/organization/code_of_conduct.cfm, and https://aas.org/policies/ethics

## Discussion Guidelines

You will be having many conversations with colleagues about issues ranging from personal values to teaching to departmental politics. Below are suggestions to keep in mind to support productive conversations, particularly around sensitive topics like equity, diversity and inclusion (EDI).

**1. Speak to your own experience using "I" statements.**

Using "I" or "we" statements often helps with avoiding generalizations and ensuring respect for alternative viewpoints. In discussions about DEI, this helps with avoiding generalizations and also the dynamic of explaining back to someone about the very oppressions they face.

**2. Listen to understand.**

Often we listen just long enough to formulate a response to what another person is saying, and then wait our turn to speak. Practice listening to what each person is saying with your full attention, to ensure you are hearing the merit of what they are expressing, and to fully understand their perspective. Strive for intellectual humility so that you're open to ideas that may challenge you.

**3. Assume that people are sharing with the best intentions.**

Strive to give others the benefit of the doubt when they are making meaning of the material. On the flip side, do try to think about the impact of your words before you speak them.

**4. Use "oops ouch" when good intentions go wrong.**

If you say something that is hurtful or problematic and you realize it, you can say "oops" to acknowledge it and then try again. Alternatively, if someone else says something hurtful or problematic, then you can say "ouch," which serves as a marker that something went wrong.

6**. Use "both/and" thinking (rather than "either/or" thinking**).

The use of "either/or" thinking often oversimplifies situations, making it more difficult to productively share divergent or alternative ideas and resolve conflicts. In contrast, "both/and" thinking allows us to recognize that ideas can complement one another rather than conflict with one another.

**7. Recognize that your identity informs your perspective.**

Your race, class, gender, sexuality, ability, educational background, and other aspects of your experience inform your perspectives and your reactions to others. Do your best to recognize these "positionalities" and strive to understand that not everybody will hold the same perspective as you.

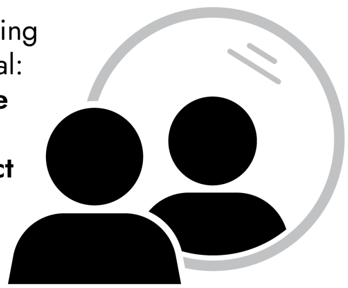
**8. Lean into discomfort when you are able.**

Discomfort can be valuable and promote learning. In particular, discussions about racism, sexism, heterosexism, cissexism, ableism, and religion may offer valuable opportunities for reflection even as we may not feel at ease talking about them. That said, you should feel free to pass on any discussion prompt that you feel might be harmful or not productive.

## Journal prompt 2 (ONLINE): Why does teaching physics and astronomy matter?

Take one minute to write down your thoughts in your **ONLINE** teaching journal. Do this one online so you can choose whether you like journaling on paper, or online.

Teaching journal: **pause and reflect**



You WILL discuss your thoughts in your pod groups.

- **Why does teaching physics and astronomy matter...**
  - **To you?**
  - **To your students?**
  - **To the world?**

# Active learning increases student performance in science, engineering, and mathematics

Scott Freeman[a,1], Sarah L. Eddy[a], Miles McDonough[a], Michelle K. Smith[b], Nnadozie Okoroafor[a], Hannah Jordt[a], and Mary Pat Wenderoth[a]

[a]Department of Biology, University of Washington, Seattle, WA 98195; and [b]School of Biology and Ecology, University of Maine, Orono, ME 04469

Edited* by Bruce Alberts, University of California, San Francisco, CA, and approved April 15, 2014 (received for review October 8, 2013)

**To test the hypothesis that lecturing maximizes learning and course performance, we metaanalyzed 225 studies that reported data on examination scores or failure rates when comparing student performance in undergraduate science, technology, engineering, and mathematics (STEM) courses under traditional lecturing versus active learning. The effect sizes indicate that on average, student performance on examinations and concept inventories increased by 0.47 SDs under active learning ($n$ = 158 studies), and that the odds ratio for failing was 1.95 under traditional lecturing ($n$ = 67 studies). These results indicate that average examination scores improved by about 6% in active learning sections, and that students in classes with traditional lecturing were 1.5 times more likely to fail than were students in classes with active learning. Heterogeneity analyses indicated that both results hold across the STEM disciplines, that active learning increases scores on concept inventories more than on course examinations, and that active learning appears effective across all class sizes—although the greatest effects are in small ($n \leq 50$) classes. Trim and fill analyses and fail-safe $n$ calculations suggest that the results are not due to publication bias. The results also appear robust to variation in the methodological rigor of the included studies, based on the quality of controls over student quality and instructor identity. This is the largest and most comprehensive metaanalysis of undergraduate STEM education published to date. The results raise questions about the continued use of traditional lecturing as a control in research studies, and support active learning as the preferred, empirically validated teaching practice in regular classrooms.**

constructivism | undergraduate education | evidence-based teaching | scientific teaching

Lecturing has been the predominant mode of instruction since universities were founded in Western Europe over 900 y ago (1). Although theories of learning that emphasize the need for students to construct their own understanding have challenged the theoretical underpinnings of the traditional, instructor-focused, "teaching by telling" approach (2, 3), to date there has been no quantitative analysis of how constructivist versus exposition-centered methods impact student performance in undergraduate courses across the science, technology, engineering, and mathematics (STEM) disciplines. In the STEM classroom, should we ask or should we tell?

Addressing this question is essential if scientists are committed to teaching based on evidence rather than tradition (4). The answer could also be part of a solution to the "pipeline problem" that some countries are experiencing in STEM education: For example, the observation that less than 40% of US students who enter university with an interest in STEM, and just 20% of STEM-interested underrepresented minority students, finish with a STEM degree (5).

To test the efficacy of constructivist versus exposition-centered course designs, we focused on the design of class sessions—as opposed to laboratories, homework assignments, or other exercises. More specifically, we compared the results of experiments that documented student performance in courses with at least some active learning versus traditional lecturing, by metaanalyzing 225 studies in the published and unpublished literature. The active learning interventions varied widely in intensity and implementation, and included approaches as diverse as occasional group problem-solving, worksheets or tutorials completed during class, use of personal response systems with or without peer instruction, and studio or workshop course designs. We followed guidelines for best practice in quantitative reviews (*SI Materials and Methods*), and evaluated student performance using two outcome variables: (*i*) scores on identical or formally equivalent examinations, concept inventories, or other assessments; or (*ii*) failure rates, usually measured as the percentage of students receiving a D or F grade or withdrawing from the course in question (DFW rate).

The analysis, then, focused on two related questions. Does active learning boost examination scores? Does it lower failure rates?

## Results

The overall mean effect size for performance on identical or equivalent examinations, concept inventories, and other assessments was a weighted standardized mean difference of 0.47 ($Z$ = 9.781, $P$ << 0.001)—meaning that on average, student performance increased by just under half a SD with active learning compared with lecturing. The overall mean effect size for failure rate was an odds ratio of 1.95 ($Z$ = 10.4, $P$ << 0.001). This odds ratio is equivalent to a risk ratio of 1.5, meaning that on average, students in traditional lecture courses are 1.5 times more likely to fail than students in courses with active learning. Average failure rates were 21.8% under active learning but 33.8% under traditional lecturing—a difference that represents a 55% increase (Fig. 1 and Fig. S1).

### Significance

**The President's Council of Advisors on Science and Technology has called for a 33% increase in the number of science, technology, engineering, and mathematics (STEM) bachelor's degrees completed per year and recommended adoption of empirically validated teaching practices as critical to achieving that goal. The studies analyzed here document that active learning leads to increases in examination performance that would raise average grades by a half a letter, and that failure rates under traditional lecturing increase by 55% over the rates observed under active learning. The analysis supports theory claiming that calls to increase the number of students receiving STEM degrees could be answered, at least in part, by abandoning traditional lecturing in favor of active learning.**

Author contributions: S.F. and M.P.W. designed research; S.F., M.M., M.K.S., N.O., H.J., and M.P.W. performed research; S.F. and S.L.E. analyzed data; and S.F., S.L.E., M.M., M.K.S., N.O., H.J., and M.P.W. wrote the paper.

The authors declare no conflict of interest.

*This Direct Submission article had a prearranged editor.

Freely available online through the PNAS open access option.

See Commentary on page 8319.

[1]To whom correspondence should be addressed. E-mail: srf991@u.washington.edu.

This article contains supporting information online at www.pnas.org/lookup/suppl/doi:10.1073/pnas.1319030111/-/DCSupplemental.

**TIP SHEET**
Starting your career

## Journal prompt 3: Faculty responsibilities

Teaching journal: **pause and reflect**

Take one minute to write out your thoughts on the following questions about faculty responsibilities and roles. You WILL be asked to share these ideas with a neighbor.

- **What are you most confident about?**
- **Where do you feel you have the most opportunity for growth?**

## Your notes on faculty roles

Use the space below to capture other ideas from this session about these aspects of your role.

| | |
|---|---|
| **Teaching** | **Research** |
| **Service** | **Balancing roles** |
| **Other** | |

## Neighbor brainstorm: The role of trusted colleagues

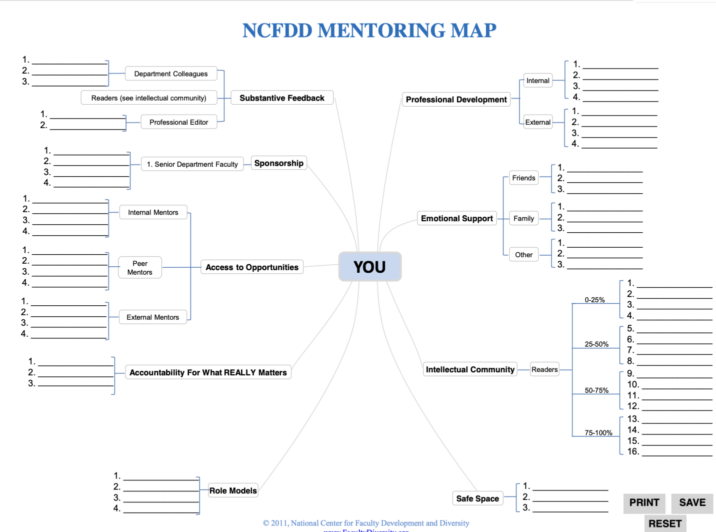
With a neighbor, brainstorm the answers to the following prompt:

- **What are some ways that colleagues can help you with navigating your role?**

You may use the space below to take notes.

## Mentoring map (optional homework)

While optional, we suggest mapping your current mentoring network to help you identify areas of support and unmet needs. This mapping activity is available at https://www.facultydiversity.org/ncfddmentormap.



## Handout: Multiple measures of teaching

How will you collect information on your teaching effectiveness for promotion and tenure? Collecting <u>multiple measures</u> will give you a more robust collection of evidence for your packet. However, these measures are NOT just useful for promotion and tenure, but also to guide your own teaching improvement. More on that later in the workshop!

| **Assessment voice** | **Examples** |
|---|---|
| **Student voice** | • End-of-term evaluation forms<br>• Student feedback survey<br>• Student focus group or interview |
| **Faculty peer voice** | • Classroom observations<br>• Peer review letter<br>• Peer review of teaching materials |
| **Instructor (self) voice – you!** | • Course portfolio<br>• Documentation of teaching approaches<br>• Evidence of student learning<br>• Lecture recording<br>• Teaching portfolio or dossier (typically a compilation of the items in this box)<br>• Teaching statement<br>• Personal narrative / teaching narrative<br>• Written teaching reflections |

*Information in this handout is adapted from* Transforming Higher Education - Multidimensional Evaluation of Teaching *(teval.net), University of Colorado Boulder* Teaching Quality Framework *(TQF; https://www.colorado.edu/teaching-quality-framework) and the EP3* Assessment Instruments *section (https://ep3guide.org/guide-overview/assessment-instruments). More information at those resources.*

## Student voice

**End-of-term evaluation forms**

Student end-of-term evaluation forms are typically mandatory, administered centrally by the institution at the end of the semester, and use a standardized survey. They are heavily subject to bias, thus penalizing certain groups; they should thus be used in combination with other measures. In a teaching portfolio you might demonstrate positive changes in student evaluations over time or connect student evaluations to other multiple measures of teaching.

**Student feedback surveys**

Anonymous student feedback surveys given mid-term and/or at the end of the course are very useful for collecting student perspectives. These surveys can be done during or outside of class, with polling software, an online form, or on paper. These are typically developed and given informally by the instructor for purposes of formative assessment of the class structure and effectiveness. For example, "What is something that is working well for you in the class so far?" You might draw from these responses for promotion and tenure portfolios, providing student comments or quotations for illustrative purposes.

**Student focus group/interview**

Focus groups can be conducted with students in a particular course, often by a teaching and learning center staff. This will provide information about student perception of the course effectiveness, and their experiences.

**Exit survey or interview**

Upon completion of the major or course of study, the department may interview or survey students. These responses may be useful in a teaching portfolio.

## Faculty peer voice

**Classroom observations**

Observations of your teaching can be done by another instructor, or teaching and learning staff. Classroom observations can play an important formative assessment role for one's own teaching, providing insight from a critical friend, guided by a few key questions the instructor would like the observer to address.

**Peer review letter**

A peer review letter (usually of support) is written by a colleague about an instructor's teaching and is usually part of a tenure or promotion package. The peer review letter can include commentary from classroom observations, student evaluations, and peer review of teaching materials (see below).

**Peer review of teaching materials**

Another instructor may review a teaching or course portfolio; syllabus; and/or course documents such as readings, worksheets, slides, assignments, and exams. The reviewer provides specific feedback on strengths and areas for improvement. The review may be guided by a rubric or other departmental documents.

## Instructor self-voice

**Course portfolio**

A course portfolio is a reflective notebook that an instructor creates on one course, including artifacts and commentary. The course portfolio is similar to a teaching portfolio but focused on a single course.

**Documentation of teaching approaches**

Sample course materials can be particularly helpful for communicating your course approaches to others, especially for the purpose of promotion and tenure. Example documentation could include course descriptions, sample syllabi, changes made each term, sample assignments, assessments, feedback to students, handouts, and lecture outlines and/or slides. Each piece of evidence should be accompanied by some sort of explanation. Other documentation can include professional development activities (such as the FTI), teaching-related publications, and honors or awards.

**Evidence of student learning**

Evidence of student learning is very informative for your own teaching improvement, as well as for promotion and tenure. Relevant evidence includes exam results, student papers, lab books, validated assessments or inventories of student learning or attitudes, samples of student work throughout the semester, or other data across the term demonstrating improvement. Unsolicited letters from students are also fair game. You can also identify common themes in students' level of understanding, connected to a learning goal. See the handout *Universe of student-centered assessment techniques* for more ways to assess student learning.

**Lecture recording**

The instructor can ask a colleague or their department to set up a recording for an in-person teaching session, especially a lecture component, for the instructor to self-observe afterward. It is also easy to record online classes, e.g., on Zoom. These recordings can then be used for a teaching portfolio to highlight exemplary teaching moments.

| | |
|---|---|
| **Teaching portfolio or dossier** | A teaching portfolio or dossier is a selective, thoughtful compilation of materials to provide evidence of teaching quality. A portfolio may include a teaching statement, a description of teaching accomplishments, sample course materials, student outcomes, supporting evidence, and annotations of that evidence. Teaching portfolios are usually compiled by the instructor and may be electronic or hard-copy. They can be developed over time, with an instructor adding to a portfolio every term. |
| **Teaching statement or narrative** | A teaching statement is a purposeful and reflective essay about the author's teaching beliefs and practices. It is an individual narrative that includes the instructor's beliefs about the teaching and learning process, and also concrete examples of the ways in which they enact these beliefs in the classroom. A great teaching statement gives a clear and unique portrait of the author as a teacher (avoiding generic or empty philosophical statements about teaching). |
| **Written teaching reflection** | A written teaching reflection gives instructors an opportunity to write some notes to themselves about an aspect of their teaching practice and how it can improve. More detail and reflective prompts are given in the *Constellation of teaching reflection strategies* sheet (p131). Documenting these reflections over time can demonstrate self-improvement for promotion and tenure. Annual teaching reflections can be useful for a teaching portfolio, to document progress, and share next steps. |


*Information in this handout is adapted from the following sources:*

- Transforming Higher Education - Multidimensional Evaluation of Teaching*:* [*teval.net*](teval.net)
- *EP3 Initiative (2021).* Assessment Instruments *Version 2022.1, in A Guide to Effective Practices for Physics Programs (EP3), edited by S. B. McKagan, D. A. Craig, M. Jackson, and T. Hodapp, American Physical Society:* *https://ep3guide.org*
- *University of Colorado Boulder* Teaching Quality Framework (TQF)*:* *https://www.colorado.edu/teaching-quality-framework/*
- UGA DeLTA Guide to Self-Reflection for Faculty*:* *https://seercenter.uga.edu/wp-content/uploads/sites/41/2021/12/UGA_DeLTA_Guide_to_Self-Reflection_for_Faculty.pdf*
- *Vanderbilt University* Teaching Statements page*:* *https://cft.vanderbilt.edu/guides-sub-pages/teaching-statements/*
- *Western Washington University.* How to Prepare a Course Portfolio*:* *https://www.wwu.edu/teachinghandbook/evaluation_of_teaching*

## Example annual teaching reflections

Below are two real-life annual teaching reflections which were submitted to administration. These are used with permission from the University of Georgia's Project DeLTA[2].

### Example 1: Exams were too difficult

This is an example of a written reflection from a faculty member who is in their first year of teaching.

**Teaching challenge considered this year:** During my first year of teaching, students commented on teaching evaluations that my exams were too difficult. They complained that class made the material seem easy, yet when they took my exams they felt completely unprepared.

**Evidence collection:** Over the summer, I conducted an analysis of the relationship between my exam questions and the practice questions provided in class. Practice questions included clicker questions and questions for small- and large-group discussions.

**Analysis of evidence:** My analysis revealed that students had sufficient practice on easier topics and multiple-choice items. However, I had not provided sufficient practice for students on challenging topics and short-answer questions. More specifically, only 20% of the in-class questions I posed covered challenging topics and required short answers and written explanations.

**Evidence-based teaching decisions about what and how to change:** I discussed my findings with an Assistant Director in the Center for Teaching and Learning. We came up with the idea to end each class with a short-answer question covering a challenging topic. gave students ten minutes to answer the question. After class, I reviewed a subset of responses and provided feedback to students for the next class period. I implemented this strategy last fall. In my end-of-course evaluations, many students noted how much they appreciated the in-class practice questions, and I had noticeably fewer complaints about the difficulty of my exams

[2] *DeLTA is supported by the NSF IUSE award 1821023. [https://seercenter.uga.edu/delta-project/](https://seercenter.uga.edu/delta-project/). These reflections are from the document* [UGA DeLTA Guide to Self Reflection for Faculty](https://seercenter.uga.edu/wp-content/uploads/sites/41/2021/12/UGA_DeLTA_Guide_to_Self-Reflection_for_Faculty.pdf) *[https://seercenter.uga.edu/wp-content/uploads/sites/41/2021/12/UGA_DeLTA_Guide_to_Self-Reflection_for_Faculty.pdf](https://seercenter.uga.edu/wp-content/uploads/sites/41/2021/12/UGA_DeLTA_Guide_to_Self-Reflection_for_Faculty.pdf).*

## Example 2: Students asking for answers in a flipped classroom

This is an example of a written reflection from a faculty member who is in their second year of trying a flipped classroom approach.

**Teaching challenge considered this year:** Two years ago I adopted a flipped classroom approach. My students watch video lectures in advance of class, and during class they complete case studies that situate the content in real-life contexts and require problem-solving. I have found a new enthusiasm for teaching using this approach, but I was discouraged because many students constantly asked me for keys to the case studies and resisted fully completing the problems on their own.

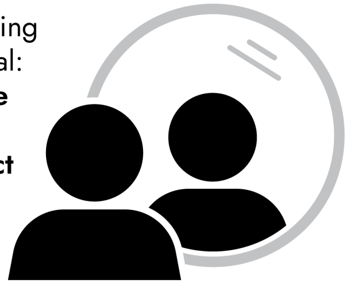
**Evidence collection:** Last semester I invited the CTL to conduct a mid-semester formative feedback session with my students, and I asked them to specifically gather feedback about how to improve students' engagement with case study learning.

**Analysis of evidence:** The CTL reported that most students like the cases. It took them a while to get used to watching videos in advance and completing the cases each week, but they now realize the cases align well with exams. However, the number one concern students voiced was that they needed me to lecture more. The CTL helped me understand students' suggestion that providing a short lecture at the beginning of class could make students feel more oriented to the material and better able to connect the new class material with prior classes.

**Evidence-based teaching decisions about what and how to change:** I learned from this experience that students appreciated the case studies. I realized how important it is to keep creating exam questions based on the case. I reflected on my decision to use minimal lectures and felt this was important to continue because I know students need time to work through the material for themselves. However, I had not previously considered how lost some students feel if I ask them to jump right into the case without orientation to the concepts that are to be learned, which they call lecture. I responded to students' concerns during the next class period. I explained that I would not be lecturing much more frequently because of the importance of giving them time during class to make sense of the material with my guidance. However, I committed to changing the way I introduce cases by beginning every class period with a 10-15 minute introduction that shows students what they are supposed to learn and how it connects with prior material.

## Journal prompt 4: Identity freewrites

Teaching journal: **pause and reflect**



Freewrite: **Your experience of _____.**
(Facilitators in the session will provide the rest of this prompt.)

## Situations to consider

1. **On the first day of class, you will introduce yourself.**
   a. What will you say?
   b. Bring to mind one of the frames of identity and belonging that is important to you. Will you include this part of your identity in your introduction? Why or why not?
2. **At some point in your class, you ask your students if anyone has a question. One raises their hand and asks, "Why are we learning about this? So far it doesn't seem useful or relevant."**
   a. What "gut reaction" do you have to this question? There's no right answer here; this is about your personal response.
   b. For some people, interactions like this raise the issue of instructor authority. What social and cultural messages have you received about what it means to have authority in the classroom? Do you agree or disagree with these messages?
   c. Bring to mind one of the frames of identity and belonging that is important to you. How does this aspect of your identity shape your sense of instructor authority?
3. **A student compliments your pants.**
   a. What is your gut reaction?
   b. Which of your frames of identity and belonging might be shaping your gut reaction?

## Activity: Components of a powerful learning experience

Think back to a powerful learning experience you have had.

| **Describe the experience:** |
|---|
| |

What made the experience so powerful? List as many separate things as you can. Leave the 2nd column blank for now.

| **What made this experience so powerful?** | **Principle** |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |

## 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.*

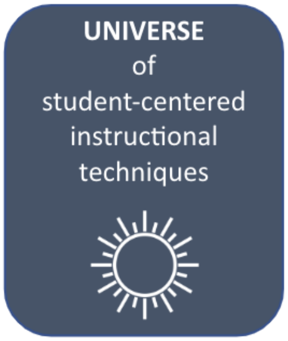
### 6. Scaffolding builds up skills.

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.*

## How can I help students learn?

### What is **student-centered instruction?**

**Student-centered instruction places the focus on the learner (rather than the instructor), emphasizing student ideas and thinking.** Student-centered instruction includes a range of practices such as the use of student learning outcomes, scaffolding to help build mastery, the use of active learning, and opportunities for useful feedback. Our Principles of Teaching and Learning are essentially principles of effective student-centered instruction. *Also known as student-centered learning, learner-centered education*



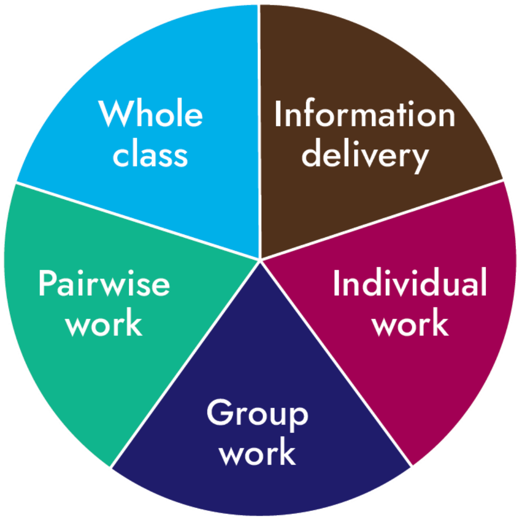

### What is **active learning?**

**Active learning involves students doing things to construct their understanding and reflect on what they are learning**. Active learning can include a range of practices such as students solving problems, practicing skills, formulating questions, discussing, brainstorming, working in teams, and reflecting on their learning. Note that not all active learning involves peer-peer collaboration.

**The FTI focuses on student-centered instruction,** with active learning as one main way to achieve student-centered instruction. Below are core strategies that can be used to help students learn and are the foundation of the sessions in the FI.

## How can I help students learn?

Five core strategies.



## One-minute paper: Experiencing the Active Class

Take one minute to write your thoughts: **What did it feel like to be a learner in this activity?**



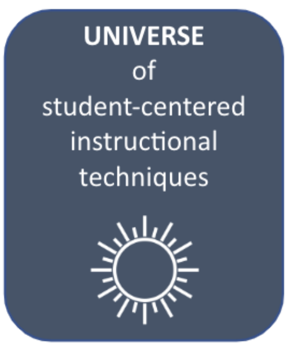
## Neighbor debrief: Experiencing the Active Class

**With your neighbor:**

1. What are TWO OR THREE good things that stood out to you in the mock classroom? Consider actions, moves, and teaching activities.
2. WHICH PRINCIPLE does each thing seem to best align with?
3. How did that influence your experience as a learner?

| What stood out to us? | What Principle(s) are at play here?<br>How did that influence our experience? |
|---|---|
| | |
| | |

| | |
|---|---|
| | |
| | |




Remember the *Universe* sheet (p117) with many more options for student-centered instruction.

**SESSION**
Experiencing the active class

## Journal prompt 5: Insights from mock classroom

Teaching journal: **pause and reflect**

Take one minute to write your thoughts:

- **What are one or two key insights you are taking away from this mock classroom activity?**

## Von Korff et al. paper

Please see the printed handouts in your folder for this paper.

## Inclusive STEM Teaching MOOC video and handout

We will show a brief video about how active learning strategies support inclusive teaching practices, from the Inclusive STEM Teaching Project. **We highly recommend enrolling in this online course;** find the next offering at https://www.inclusivestemteaching.org/.

INCLUSIVE STEM TEACHING PROJECT

<u>Handout to accompany video</u>
In the table below are common examples of active-learning strategies that can be implemented in courses. In the first column, the name of the strategy is listed, the second column contains a description, and the last column contains an explanation of why this strategy is useful.

| **Strategy** | **Description** | **Why use it?** |
|---|---|---|
| Pause procedure | The lecturer pauses periodically (e.g., two or three times) during an hour-long class and has students clarify their notes with a partner. | Introduce active learning into a traditional lecture before assigning only highly reflective collaborative group work. The pause procedure breaks up the lecture and keeps students engaged and has been found to improve student test scores. (ref: prince) |

| | | |
|---|---|---|
| Minute Paper | Written in one to three minutes. At an appropriate point during the lecture, the instructor asks students to write a minute paper in which they summarize the major point or points so far in the lecture or write the most important thing that they have learned from the previous day's lecture. | Students must actively engage in thinking about the content presented if they are to remember and use the information. This activity can be used to assess student understanding of the concepts, it stimulates thinking among students, and it can provide you with feedback about what students are learning from the lecture. But remember, if you ask for feedback, remember to respond to their concerns. |
| Think-pair-share activity | Students are given a topic first to think about individually, then to discuss and develop with a partner, and then with their partners to share with the rest of the class. | Similar to the minute paper, think-pair-share activity can be used to assess student learning in real time. It allows students to think by themselves and then discuss with a partner to check or change their ideas before having to share it to the entire group. |
| Polling classroom response systems (clicker responses) | Polling classroom response systems, such as poll everywhere and i-clickers, allow students to use their cell phones or laptops to respond to multiple-choice questions that the instructor poses. Once the polling closes both the instructor and the students can view the proportion of students selecting each possible response. | Similar to the minute paper, polling can be used to assess student learning in real time. These polls can be used as a formative assessment or as a tool to gauge understanding and reveal misconceptions at the beginning, middle or end of a class. Polling through response systems is good for large classes and decreases pressure on individual students, particularly those who are shy. Polling can be combined with think-pair-share activities so the students have an opportunity to talk with their partner about the topic before they have to choose an answer. |

| | | |
|---|---|---|
| Jigsaw Method (Elliot Aronson) | Students are assigned to an expert group where they complete a task that is part of a larger problem to be solved. Students then go to their home-base group where they share their part of the solution with other group members. Each group member in turn learns the different aspects of the solution that their group mates have been working on and together they solve the problem. By design each student must cooperate with and depend on their peers to successfully complete the task. | Johnson Johnson and Smith (2014) define cooperative learning as the instructional use of small groups so that students work together to maximize their own and each other's learning. In cooperative groups, the class is divided into small groups each of which is assigned a different task. In order for cooperative learning assignments to work well they must be rigorously structured. |

*The primary sponsor for the Inclusive STEM Teaching Project is the National Science Foundation (NSF), Directorate for Education and Human Resources (EHR), and Division of Undergraduate Education (DUE). This project is supported under DUE grants 1821684; 1821571; 1821528; 1821510; 1821574.*

**TIP SHEET**
Course or class design

# Guided notes: Course Planning

## Learning outcomes and backwards design

The first part of course planning and design is to determine what topics are included in the course, and what you want students to learn about these topics. These student learning outcomes then drive the instruction and assessment for the course.

**Student learning outcomes (SLOs) are:**

- A statement of what students should be able to do as a result of learning about a topic.
- Stated as: "Students should be able to...."[action verb]."
- Limited to 2-5 per topic.
- Used to describe learning in a class, topic, module, or course. (We focus on topic-level SLOs in the FTI).

**Examples:**

1. A student should be able to project a given vector into components in multiple coordinate systems.
2. A student should be able to translate a physical description of an upper-division electromagnetism problem to a mathematical equation necessary to solve it.

**COMPLETE**

Identify a topic you have taught recently:

**Topic:**

What do you want students to be able to do as a result of learning about that topic?
Hint: Try to avoid using the word "understand."

**SLO version 1:**

**Specific, measurable verbs for student learning outcomes**

| Lower-order learning | Higher-order learning | Non-content learning |
|---|---|---|
| • Define<br>• List<br>• Match<br>• Recognize<br>• State<br>• Label<br>• Describe<br>• Discuss<br>• Paraphrase<br>• Explain<br>• Identify<br>• Locate<br>• Select<br>• Solve<br>• Use<br>• Show<br>• Organize<br>• Demonstrate<br>• Interpret<br>• Sketch (simple) | • Differentiate<br>• Organize<br>• Relate<br>• Compare<br>• Contrast<br>• Distinguish<br>• Examine<br>• Experiment<br>• Test<br>• Argue<br>• Defend<br>• Judge<br>• Critique<br>• Design<br>• Conjecture<br>• Develop<br>• Formulate<br>• Investigate<br>• Sketch (complex/process) | • Come to see themselves as…<br>• Decide to become…<br>• Interact with others around…<br>• Get excited about…<br>• Be more interested in…<br>• Value…<br>• Be able to construct knowledge about…<br>• Frame useful questions…<br>• Be able to (read/study/find information) effectively… |

**Checklist for effective student learning outcomes (SLOs)**

- ☐ Does the SLO identify what a student should be able to do or say as a result of learning (and not just identify the topic they should learn)?
- ☐ Is it clear how you might test whether students achieved the SLO?
- ☐ Do the verbs have a clear meaning? (e.g., avoid the use of the words "understand" or "know")
- ☐ Is the SLO aligned with the level of cognitive understanding expected of students? (i.e., higher- or lower-level understanding)
- ☐ Do the SLOs cover the range of types of desired learning (e.g., facts, concepts, processes, skills, big ideas, metacognition, beliefs)?
- ☐ Is the SLO written using language and terminology that is student-friendly?
- ☐ Is it possible to write the SLO so it is relevant and useful to students?

*Non-content learning outcomes adapted from D. Fink, "human dimension," "caring" and "learning how to learn" dimensions of learning outcomes; see L. D. Fink (2013).* Creating significant learning experiences. *Jossey-Bass. Other content adapted from S. Chasteen (2022).* How do I develop student learning outcomes for physics courses. https://www.physport.org/recommendations/Entry.cfm?ID=125086.

**What is lower-order and higher-order learning/thinking?**

| |
|---|
| **Lower-order learning is....**<br><br>**Higher-order or deeper learning is...** |

**Is your SLO lower-order or higher order?**

My SLO is:

- ☐ Lower order
- ☐ Higher order
- ☐ I'm not sure

**REVISE**

Do any of the verbs on the previous page help you to clarify your SLO? Do a quick revision of your SLO.

| |
|---|
| **SLO version 2:**<br><br>**How might I assess this SLO?** |

## Outcomes, instruction, and assessment in the course are all ***aligned*.**

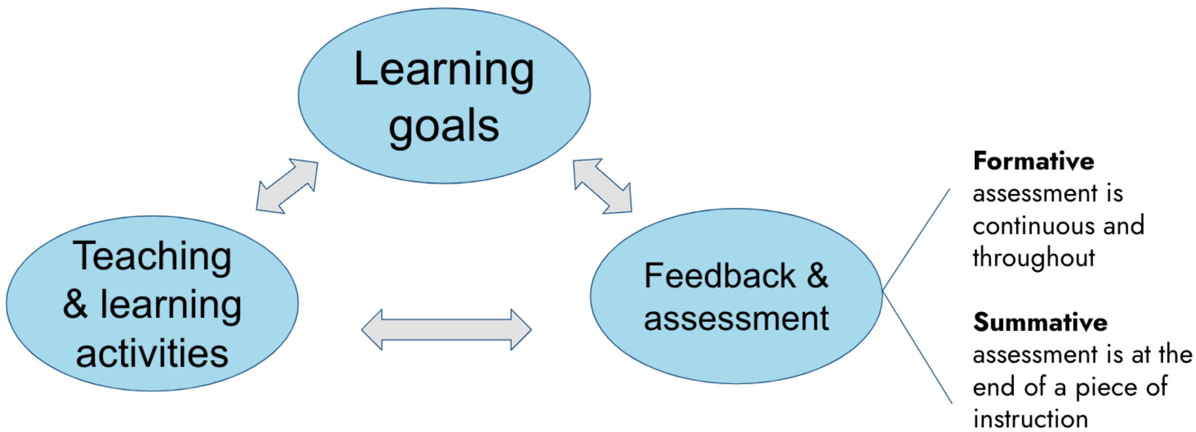



*Image adapted from L. D. Fink (2013).* Creating significant learning experiences. *Jossey-Bass.*

### ASSESSMENT

Formative assessment is…

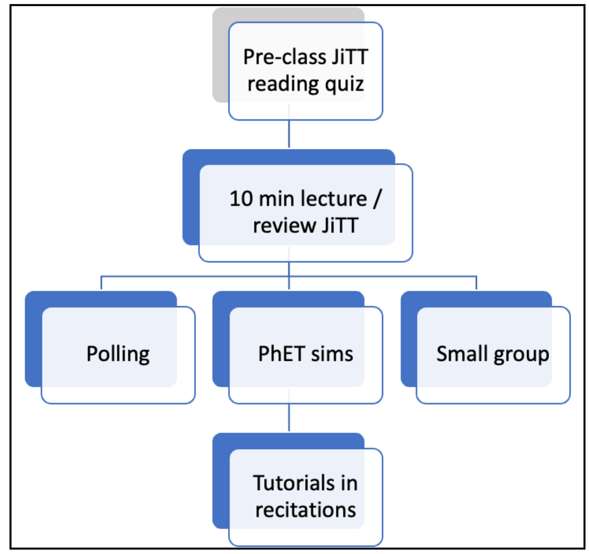
Summative assessment is…

Below are examples of alignment.
**Sketch out a possible alignment for your SLO.**

| | **SLO** | **Instruction** | **Assessment** |
|---|---|---|---|
| | Desired result | Learning experiences to achieve SLO | Evidence of learning |
| **This session** ("Foundations: Lesson design"). | Participants will know that there is evidence that student centered instruction is effective. | Read and discuss a paper with this evidence. | We could ask you to summarize evidence in a quiz, or write a one-minute paper. |
| **Previous session** ("Experiencing the Active Class"). | Students will be able to interpret a velocity vs time graph to determine the properties of the exoplanet system. | Did an active lecture and set of Think-pair-shares to provide background and practice with interpreting graphs. | Formative: Fill in the blank questions and Think-Pair-Share questions<br>Summative: Exam Questions |
| **Your SLO (optional, will return to this later)** | | | Formative:<br><br>Summative: |

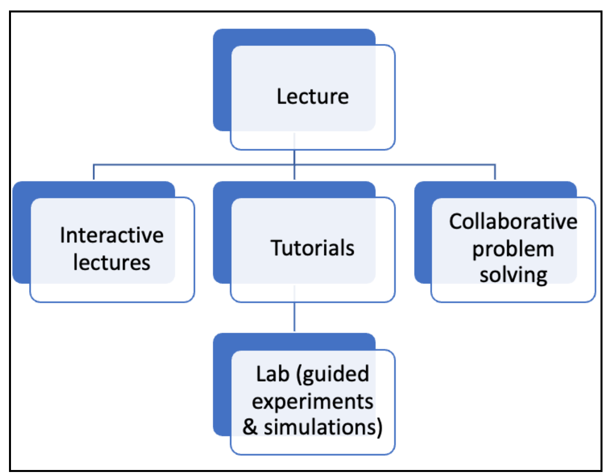
## Examples of student-centered course designs

### Course A: Large class + recitations



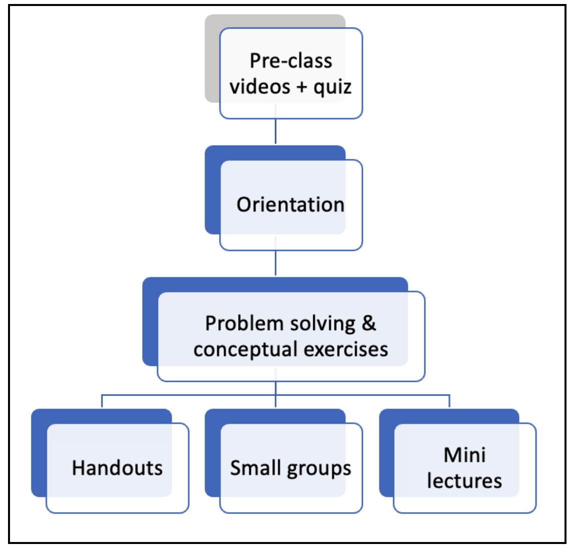

- **Text** is a conceptual physics textbook.
- **Classroom** is 300+ stadium seating
- **Before class** students complete a Just-in-Time Teaching (JiTT) reading quiz
- **Class structure:** Starts with a review of the JiTT quiz, followed by a 10-15 minutes interactive lecture. Classes use 5-8 conceptual polling questions with ABCD cards, and small group activities, and students predict the results of at least one PhET simulation or demonstration.
- **Recitations** use the Washington Tutorials
- **Assessment** includes homework problem sets, reflective writing prompts done once a week in class, 5 quizzes, and a final.
- **Grading** is 15% homework, 25% participation, 35% quizzes, 25% final exam.

### Course B: Small class + labs



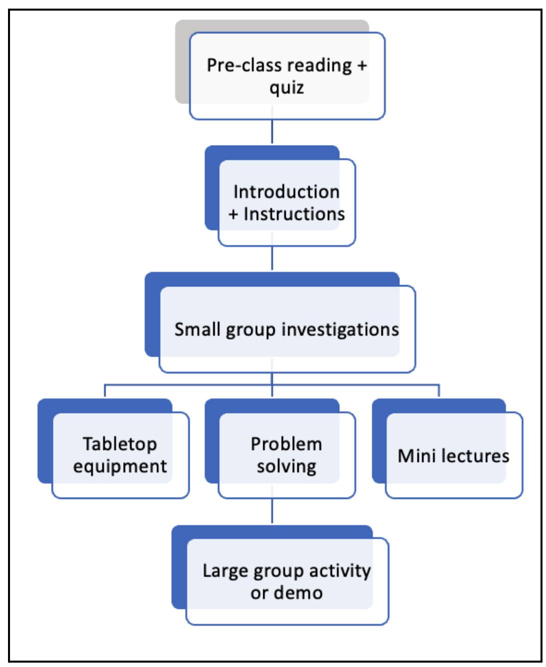

- **Text** is a calculus-based physics textbook.
- **Classroom** is a 60-person hall with fixed seats.
- **Class structure:** Begins with a review of previous material and SLOs; One-third of lectures are interactive lectures with slides, 2-8 conceptual polling questions using phone-based software, or one-minute free-writes to open-ended questions. One-third of lectures are group work using Washington Tutorials. One-third of lectures are small group quantitative problem-solving sessions using 1-2 Minnesota context-rich problems.
- **Labs** are somewhat coordinated with lectures using guided experiments with simple equipment and simulations.
- **Assessment** includes homework (lowest two dropped); 4 online, take-home, open-note comprehensive midterm exams; 1 in-class open-book, open-note final.
- **Grading** consists of 25% homework (graded on a 1-5 scale, including credit for annotating, 25% lab, 10% class participation assignments, 20% midterms, and 20% final exam.

## Course C: Flipped Class




- **Text** is online and open source
- **Classroom** is organized around small tables.
- **Before class** students watch instructor-made videos and complete a short pre-lecture quiz.
- **Class structure:** Begins with an orientation to the in-class activities of the day. Class sessions are devoted to structured conceptual exercises and group problem-solving, guided by handouts. Class ends with an online "exit ticket" for accountability and feedback. Mini lectures are given as needed.
- **Assessment** includes an automated system with a mastery approach for homework; students can redo assignments until they are correct. There are online weekly graded quizzes but no midterms. The final exam is online, untimed, and open book.
- **Grading** consists of 15% pre-class quizzes, 15% live lecture activities, 20% HW, 15% weekly quizzes, 20% labs, and 20% final exam.

## Course D: SCALE-UP or Studio class




- **Text** is online and open source
- **Classroom** is a specialized classroom with round tables with a laptop on each table, dual projectors, and multiple whiteboards.
- **Before class:** Students complete a reading assignment and short quiz.
- **Class structure:** The class begins with an introduction and instructions. Class sessions are devoted to completing hands-on investigations and group problem-solving, guided by handouts. Mini lectures are interspersed throughout class periods. Each class ends with a large group activity or demo.
- **Assessments** use a mastery approach; students can redo assignments and quizzes.
- **Grading** based on mastery of assignments and quizzes, earning a B. To earn an A, the student must complete a final project.

*Course examples are inspired by the "case studies" in the Academy of Inquiry Based Learning (http://www.inquirybasedlearning.org/). Course A is inspired by Ed Prather and CU Boulder courses, Course B by Andrew Boudreaux (Western Washington University), Course C by Rachel Scherr (University of Washington Bothell) and Course D by the physics courses at Colorado School of Mines (https://minesmagazine.com/9992/).*

## One-minute paper: Like & Learn

Reflect on today's workshop activities.

| What did you like? |
| --- |
| |

| What do you want to learn more about? |
| --- |
| |

This page intentionally left blank

# Day 2

## Faculty Teaching Institute (FTI)

**PhysPort can help!**

**Teaching: Information delivery and individual work**

**Teaching: Whole class discussions**

**Teaching: Think-pair-share**

**Teaching: Quantitative and collaborative problem-solving**

**Teaching: Simulations, demos, and visualizations**

**Formative assessment**

**Reflecting on your teaching**

**Discussion in pod groups, your questions, and action planning**

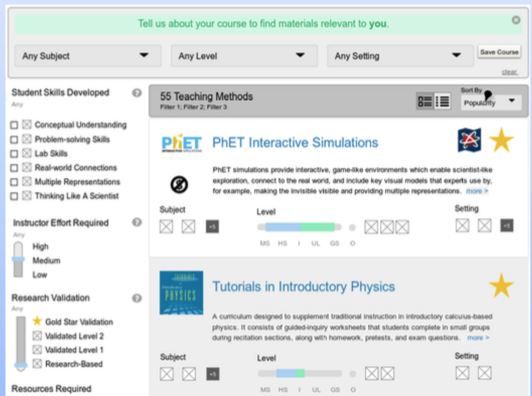
This page intentionally left blank

# PhysPort
Supporting physics teaching with research-based resources

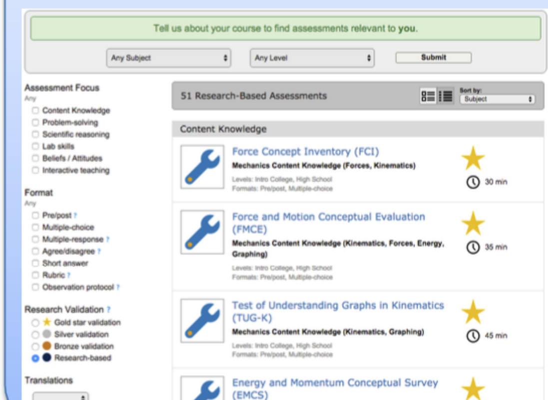
NSF AAPT

The go-to place for resources based on physics education research (PER)

## Guides to 50+ research-based teaching methods




## Verified educators can download 100+ research-based assessments




## Video workshops for TA/LA training and faculty PD



## Data Explorer

Instant analysis and visualization of concept inventories in physics

See other side for details

## **Expert Recommendations** by PhysPort staff and experts in PER

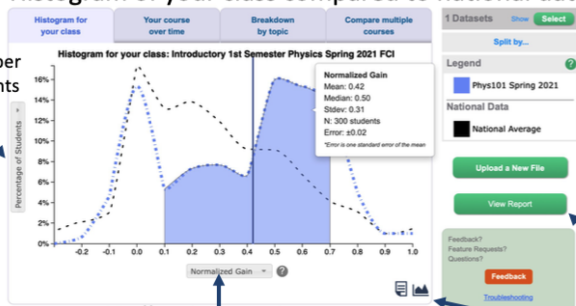
- How can I set clear expectations, and motivate students, so that they engage in active learning?
- Where can I find good questions to use with clickers or Peer Instruction?
- How can I create an inclusive and equitable classroom with culturally responsive education?
- How can I train teaching assistants and/or learning assistants?
- And many more…

**www.physport.org**

# Data Explorer
by PhysPort

## Histogram of your class compared to national data

OR number of students




OR effect size, raw gain, or score

Export a customized PDF report for use in tenure and promotion reports, teaching portfolios etc.

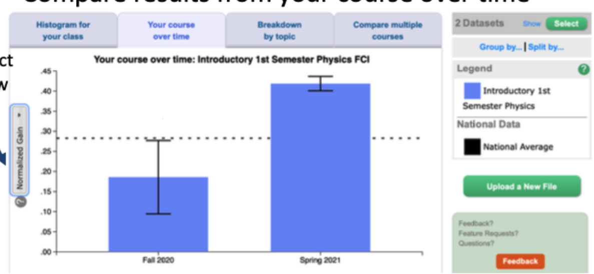
Download matched assessment data and plots

## Assessments available now:

| | | | | | |
|---|---|---|---|---|---|
| AMS | CDPA | FCI | MPEX | QMS | SGCE |
| ADT2 | DIRECT | IBCM | MUQ | QPCS | TOAST |
| AAPS | EMCA | CTSR | MBT | RCI | TUG-K |
| BEMA | EMCS | LSCI | QMCA | RKI | TUV |
| CLASS | ECA | LPCI | QMCS | SPCI | TCE |
| CSEM | FMCE | MCS | QMFPS | STPFaSL | TCS |

## Compare results from your course over time

OR effect size, raw gain, or score

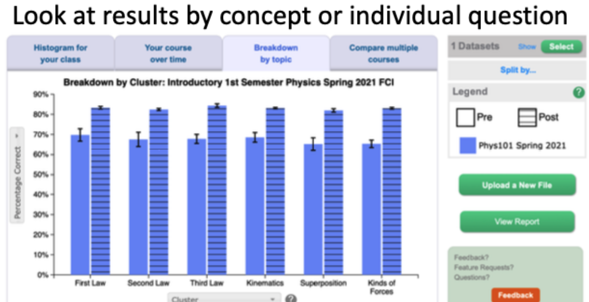



**Comparing among your data**

**Gain:** The gain for Introductory 1st Semester Physics Spring 2021 is significantly higher than the gain for Introductory 1st Semester Physics Fall 2020.
**Effect size:** The effect size for Introductory 1st Semester Physics Spring 2021 is significantly higher than the effect size for Introductory 1st Semester Physics Fall 2020.
**Pre score:** The pre score for Introductory 1st Semester Physics Spring 2021 is significantly higher than the pre score for Introductory 1st Semester Physics Fall 2020.
**Post score:** The post score for Introductory 1st Semester Physics Spring 2021 is significantly higher than the post score for Introductory 1st Semester Physics Fall 2020.

"One click" statistics performs appropriate statistical comparisons automatically

## Look at results by concept or individual question

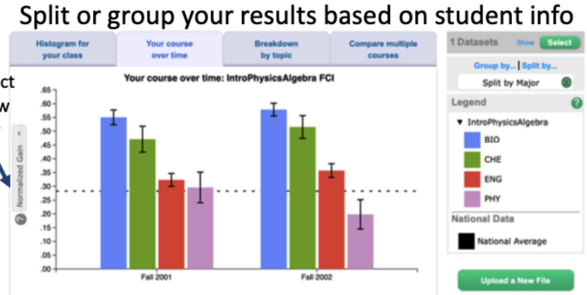



OR question

- Look at pre-test results by questions or concept to get a sense of where your students are starting.
- Look at normalized gain by question or concept to look for areas to improve your teaching in subsequent terms.

## Split or group your results based on student info

OR effect size, raw gain, or score




**Group/split by student information* including:**

**Section**

**Academic Record**
- Course Grade
- GPA
- Major
- Year in School
- Expected Grad. Year
- Institution Name

**Demographics**
- Gender
- Race
- Ethnicity

**Background**
- High School Physics
- SAT or ACT
- Highest Math Level

*Using any labels you provide within each category

## Guided notes: Presentation and lecture



What is a presentation or lecture good for?

What is a presentation or lecture not good for?

What are ways that traditional lecturing can disadvantage some students?

What are 3 things I can do to make my presentation more effective and inclusive?

-

Pause and reflect (next page):

Pause and reflect:

- How did this lecture just work for me?

- How did this guided note-taking help me?

- How might others in the workshop have experienced the lecture similarly or differently to me?

- What do you hope for your students that's not happening (yet) in the presentation parts of your course?

For other material in this session see the following practices sheets:

PRACTICES SHEET Reading & JiTT

PRACTICES SHEET Homework

PRACTICES SHEET Grading

## Handout: Example guided notes from slide deck

*Courtesy of Noah Finkelstein, University of Colorado Boulder*

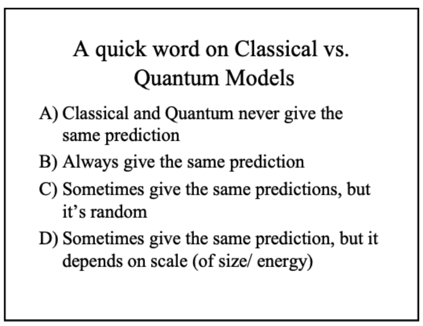
**Guided notes given to students in advance of lecture:**

- These are a subset of the full lecture slides, done in handout mode.
- In Week 1, 2, and 4 Dr. Finkelstein discusses how to use these guided notes.
- These are optional for students, but he does not want to miss the key points by transcribing ideas that are in the slides.
- These are available before class for a preview, and to guide the readings.
- About ⅓ of students use these, either on paper or for digital note-taking

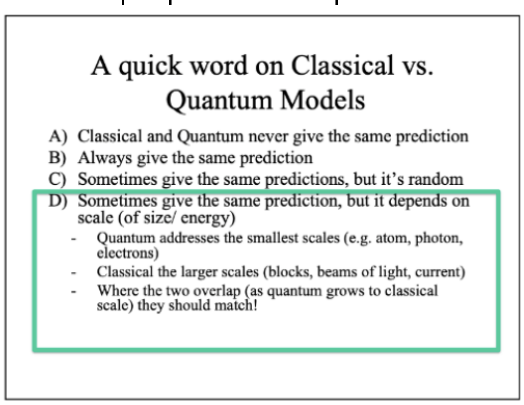
**Full slide deck of notes**

- includes class announcements, Just-in-Time Teaching responses, answers to polling questions, and more detail
- Posted immediately after class

Example slide:




Example posted notes post-lecture



## Transparency in Learning and Teaching (TILT) template

More at https://tilthighered.com/tiltexamplesandresources

### Transparent Assignment Template



*This template can be used as a guide for developing, explaining, and discussing class activities and out-of-class assignments. Making these aspects of each course activity or assignment explicitly clear to students has demonstrably enhanced students' learning in a national study.*[1]

**Assignment Name**
**Due date:**

**Purpose:** *Define the learning objectives, in language and terms that help students recognize how this assignment will benefit their learning. Indicate how these are connected with institutional learning outcomes, and how the specific knowledge and skills involved in this assignment will be important in students' lives beyond the contexts of this assignment, this course, and this college.*

**Skills**: The purpose of this assignment is to help you practice the following skills that are essential to your success in this course / in school / in this field / in professional life beyond school:

*Terms from Bloom's Taxonomy of Educational Objectives may help you explain these skills in language students will understand. Listed from cognitively simple to most complex, these skills are:*

- *understanding basic disciplinary knowledge and methods/tools*
- *applying basic disciplinary knowledge/tools to problem-solving in a similar but unfamiliar context*
- *analyzing*
- *synthesizing*
- *judging/evaluating and selecting best solutions*
- *creating/inventing a new interpretation, product, theory*

**Knowledge**: This assignment will also help you to become familiar with the following important content knowledge in this discipline:

- ...
- ...

**Task:** *Define what activities the student should do/perfom. "Question cues" from this chart might be helpful: http://www.asainstitute.org/conference2013/handouts/20-Bloom-Question-Cues-Chart.pdf. List any steps or guidelines, or a recommended sequence for the students' efforts. Specify any extraneous mistakes to be avoided. If there are sound pedagogical reasons for withholding information about how to do the assignment, protect students' confidence and sense of belonging in college with a purpose statement something like this: "The purpose of this assignment is for you to struggle and feel confused while you invent and test your own approach for addressing the problem..."*

**Criteria for Success:**

*Define the characteristics of the finished product. Provide multiple examples of what these characteristics look like in real-world practice, to encourage students' creativity and reduce their incentive to copy any one example too closely. Engage students in analyzing multiple examples of real-world work before the students begin their own work on the assignment. Discuss how excellent work differs from adequate work. This enables students to evaluate the quality of their own efforts while they are working, and to judge the success of their completed work. It is often useful to provide or compile with students a checklist of characteristics of successful work. Students can also use the checklist to provide feedback on peers' coursework. Indicate whether this task/product will be graded and/or how it factors into the student's overall grade for the course. Later, asking students to reflect and comment on their completed, graded work allows them to focus on changes to their learning strategies that might improve their future work.*

The author developed an earlier version of this template at the University of Illinois, Urbana-Champaign.

[1] Winkelmes, Mary-Ann. "Transparency in Teaching: Faculty Share Data and Improve Students' Learning." *Liberal Education* 99,2 (Spring 2013); Winkelmes et al, "A Teaching Intervention that Increases Underserved College Students' Success." *Peer Review* 18,1/2 (Winter/Spring 2016).

**PRACTICES SHEET**
Whole class discussion

## Whole Class discussion case studies

### Case study Part I: Nobody responds

Prof. Chen has finished modeling how to solve a juicy problem on an inelastic collision and has turned to the class and asked: "do you have any questions"? She is surprised that no one raises their hands and is wondering if she should just move on as she knows that many of her students struggle on her exams with these kinds of problems.

- What is Prof. Chen trying to accomplish by stopping to ask if her students have questions?
- What are Prof. Chen's options at this moment?

### Your advice for Dr. Chen.

Imagine you are Prof. Chen's "critical friend" colleague who has been watching the class. You want to give her some suggestions for the future.

- On your own: Review the HANDOUT: Whole class practices.
- Think-pair-share: What are some ideas you get from this practices sheet for Prof. Chen?

### Case study Part II: Calling on students

Prof. Chen loved your feedback and thanked you profusely. She let her students know the problem that they just worked on homework will be used in a whole class discussion, and let students know that they might be called on. She starts a similar problem on the board and asks students the question, "What is the next step in this solution"?

- What are some ways that Prof. Chen might call on her students?

## Journal prompt 6: Reflect on today's sessions so far

Teaching journal: **pause and reflect**

Take one minute to reflect on this morning's sessions.

- **Are there any ideas you may want to take up from this morning's sessions (Information delivery, individual work, whole class)?**
- **Are there any 'aha moments' you would like to capture?**

## What do students and instructors need?

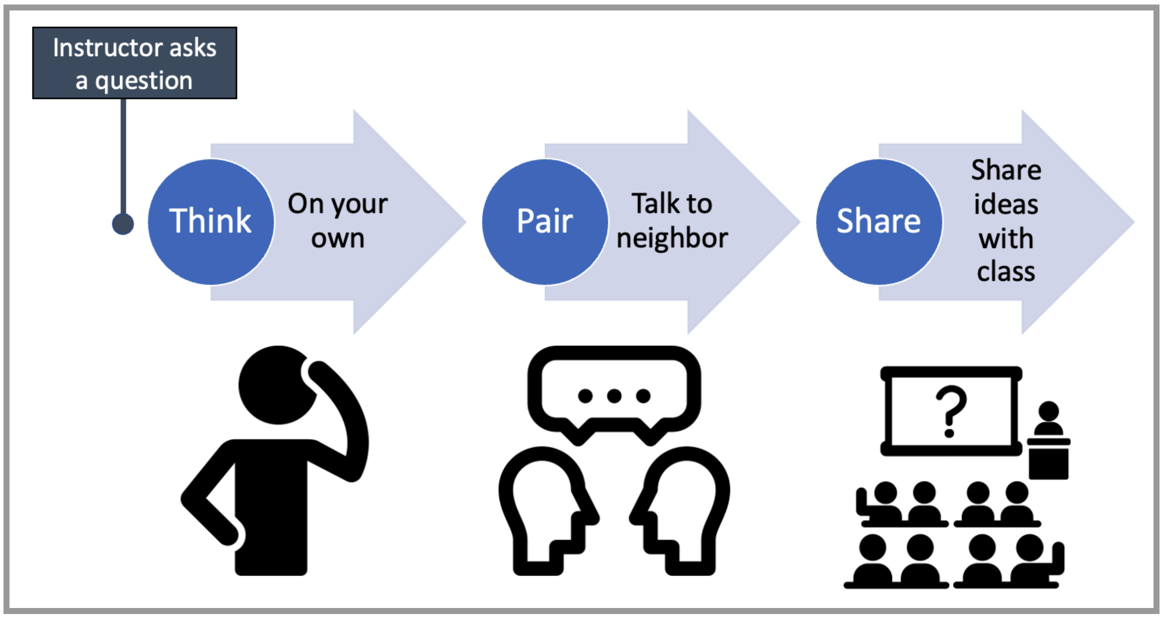
Here is a different way of looking at the Principles of Teaching and Learning, from both the student and instructor perspective.

| | **Students need...** | **Instructors need...** |
|---|---|---|
| **Physics / Astronomy** | Deep engagement in rich physics/astronomy | To inquire into student thinking |
| **Social** | Collaborative sense-making | To foster an engaging and equitable environment |
| **Reflection** | Information for self-improvement | To offer compassionate ongoing assessment |

*Adapted from S. L. Laursen and C. Rasmussen (2019). I on the prize: Inquiry approaches in undergraduate mathematics.* International Journal of Research in Undergraduate Mathematics Education. 5,129.
[https://doi.org/10.1007/s40753-019-00085-6](https://doi.org/10.1007/s40753-019-00085-6)

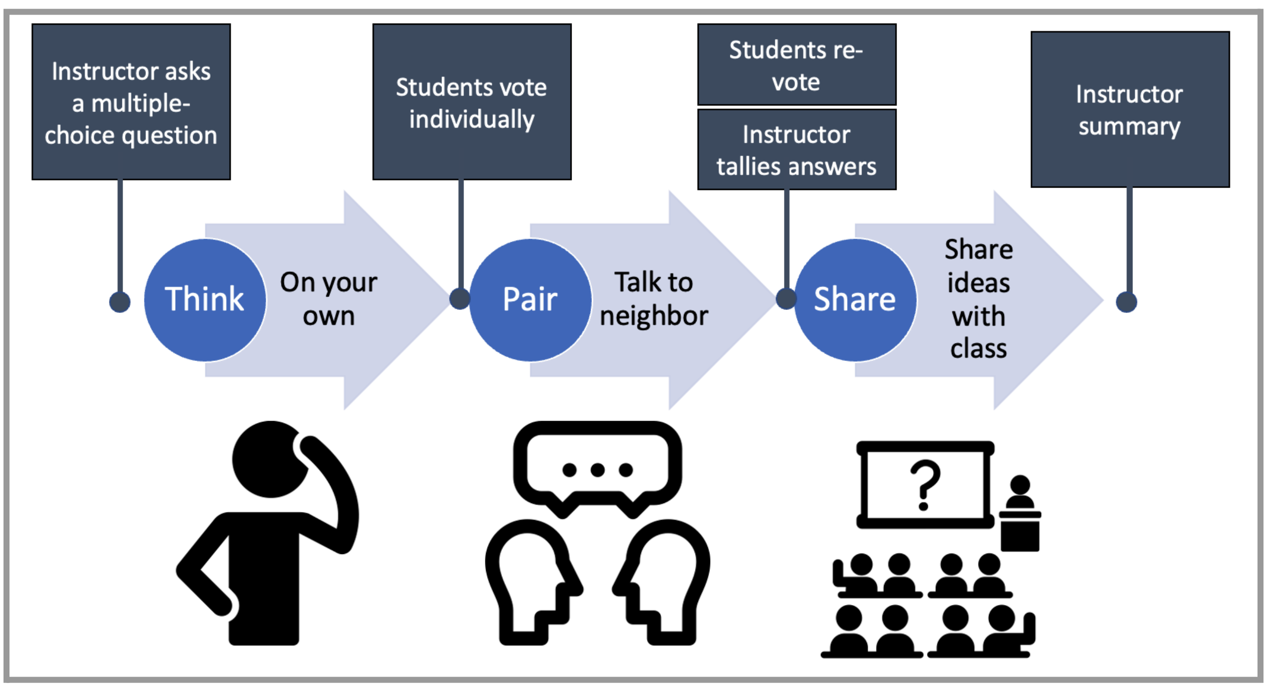
# Think-pair-share (TPS) cycle

## Generic TPS cycle




## TPS with polling

For use with multiple-choice questions and some sort of voting system (e.g. colored cards, clickers.)



# Think-pair-share poll questions

## When to ask TPS questions

Consider asking TPS questions throughout the class:

- BEFORE introducing a topic, to motivate the topic or provoke thinking
- DURING the topic to apply knowledge, elicit misconceptions, or exercise skills
- AFTER the topic to relate to the big picture, review, or recap

## Types of think-pair-share (TPS) questions

You can use TPS with a wide variety of types of questions. A wide range of questions will help your students achieve a wider variety of student learning outcomes (SLOs).

- **Conceptual questions,** based on common difficulties
- **Representation** questions which ask students to translate (e.g., between a diagram and an equation)
- **Questions that use images** such as interpreting graphs or selecting among appropriate images
- **Predicting** the outcome of a simulation, experiment or demonstration
- **Opinion or survey** questions
- **No one right answer** questions to elicit discussion
- **One step** in a problem or derivation
- **A series** of connected questions to lead students through reasoning or a problem solution.

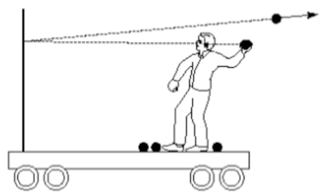
Can you see each of these types (except for "series") in the questions on the next pages?

*Credit: S. Chasteen workshop materials (https://www.colorado.edu/sei/resources/workshops/clicker-peer-instruction-workshop-materials); E. Mazur (1991).* Peer Instruction: A User's Manual. *Prentice Hall; D. Bruff (2009).* Teaching with Classroom Response Systems. *Jossey-Bass.*

## TPS question gallery

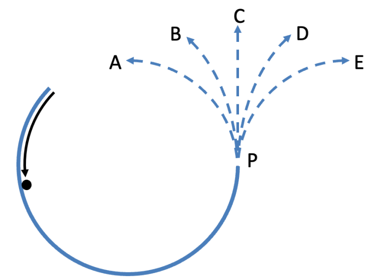
You're on a cart, initially at rest, throwing balls at a partition that is rigidly mounted on the front of the cart. **If the balls bounce straight back, as in the figure, then is the cart put in motion?**

A. Yes, left
B. Yes, right
C. No
D. Don't know



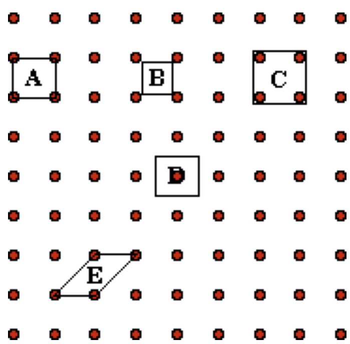
*Credit: Eric Mazur: Peer Instruction*

A ball is rolling around the inside of a circular track. The ball leaves the track at point P. **Which path does the ball follow?**



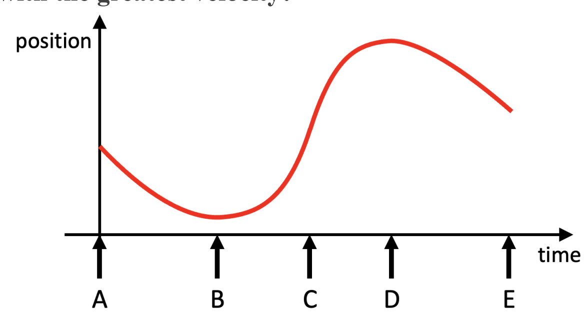

*Credit: Eric Mazur: Peer Instruction*

**Which of the parallelograms in the figure below are unit cells?**




*Credit:*
[http://www.jce.divched.org/JCEDLib/QBank/collection/ConcepTests/](http://www.jce.divched.org/JCEDLib/QBank/collection/ConcepTests/)

John is walking to school. This graph shows his position as a function of time. **When is John moving with the greatest velocity?**




*Credit: UBC Carl Wieman Science Education Initiative*

You want to do as little work as possible while carrying a heavy box. **Should you be careful not to let it move up and down at all as you walk?**

A. Yes
B. No
C. It depends

*Credit: Ian Beatty, UNC Greensboro*

**Consider a vector field defined as the gradient of some well-behaved scalar function:**

$$\mathbf{v}(x, y, z) = \nabla T(x, y, z).$$

**What is the value of $\oint_C \mathbf{v} \cdot d\mathbf{l}$?**

A. Zero
B. Non-zero, but finite
C. Can't tell without a function for T

*Show students a demonstration that a lightbulb will light when a current is run through a weak acid solution.*

**If the acid solution is increased to 100% strength, what will happen to the brightness of the lightbulb?**

A. Brighter
B. Dimmer
C. Completely dark
D. Don't know.

Given the two differential equations where C1 + C2 = 0.

$$\frac{1}{X}\frac{d^2X}{dx^2} = C_1 \qquad \frac{1}{Y}\frac{d^2Y}{dy^2} = C_2$$

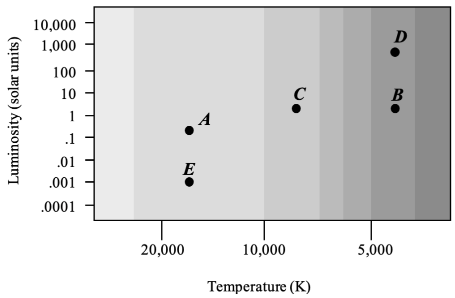
**Which coordinate should be assigned to the negative constant (and thus the sinusoidal solutions)?**

A. x
B. y
C. C1 = C2 = 0, in this case
D. It doesn't matter

*Credit: Steve Pollock, CU Boulder*

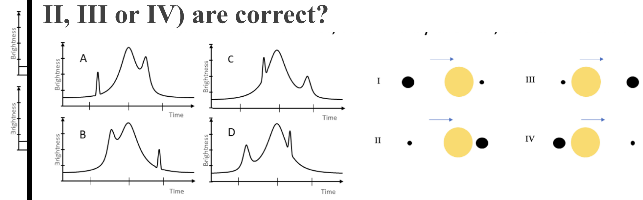
**Which of the following is the correct ranking for the size of the objects A-E, from largest to smallest?**

A. E=A>C=B>D
B. D=B>C>A=E
C. D>B=C>A>E
D. E>A>C=B>D
E. None of the above



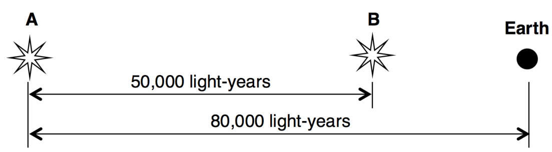

*Credit: Ed Prather, U. of Arizona*

Aliens living in the Andromeda Galaxy are observing a distant star in the Milky Way. Our solar system moves across their line of sight from left to right. They observe Venus, the Sun, and then Saturn. **Which brightness vs. time graph (A, B, C or D) and which solar system (I, II, III or IV) are correct?**




A. Graph A and diagram II
B. Graph B and diagram IV
C. Graph C and diagram I
D. Graph D and diagram III
E. None of these graphs are correct

*Credit: Ed Prather, U. of Arizona*




Star A appears 90,000 years old to an observer orbiting Star B. H**ow old would Star A appear to an observer on Earth?**

A. 30,000 years old
B. 40,000 years old
C. 50,000 years old
D. 60,000 years old

*Credit: Ed Prather, U. of Arizona*

*(In an E&M course applying the method of relaxation computational approaches)*

If we choose to use

$$\frac{df}{dx} \approx \frac{f(x_i + a) - f(x_i)}{a}$$

**Where are we computing the approximate derivative?**

A. A
B. $x_i$
C. $x_i + a$
D. Somewhere else

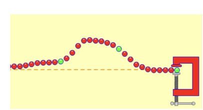
*Credit: Danny Caballero, Michigan State U.*

**Which of the following are you least comfortable using to solve problems?**

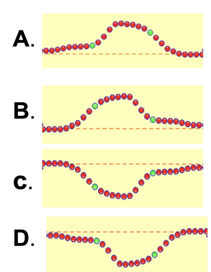
A. Kinematics
B. Newton's Laws
C. Work-Energy theorem
D. Momentum-Impulse theorem
E. Angular Momentum-Angular Impulse Theorem

*Credit: Ian Beatty, UNC Greensboro*

*Using PhET Interactive simulation "Waves on a string."* **What will this wave look like after it reflects?**



Fixed end




*Credit: Trish Loeblein, PhET Simulations*

**Tell me how the pace of the class is so far.**

A. I'm bored – speed up
B. I'm with you
C. Slow down a little
D. I'm totally lost

**For me, the first homework was..**

A. Entirely a review
B. Mostly a review with a few new things
C. Somewhat of a review, with many new things
D. Completely new

*Credit: Danny Caballero, Michigan State U.*

## Think-pair-share implementation rubric

**Did the presenter….**

- ☐ Present the question clearly and simply (letting them read it and/or reading it aloud) without adding information or discussing it further?
- ☐ Allow time for the students to read and think about the question, and ask "Who needs more time"?
- ☐ Get the students to vote simultaneously and anonymously?
- ☐ Decide whether it's appropriate to disclose the distribution of answers from the first vote?
- ☐ Give students a prompt that would motivate them to engage in discussion and explain their reasoning?
- ☐ Indicate how long students would be allowed to discuss?
- ☐ Circulate to listen in on student discussions, provide help, and gauge whether students need more time?
- ☐ Inform students when discussion time is almost over?
- ☐ Get the students to vote a second time simultaneously and anonymously?
- ☐ Interactively debrief the final vote results with students, including discussing the reasoning behind correct and incorrect answers?

**Did the question…**

- ☐ Promote engaging and rich discussion?
- ☐ Have distinct answer choices that represent likely student reasoning difficulties?

TPS can use technology for polling. See also the *Constellation of educational technologies (p129)* for other technology enhancements to a course.
TPS is often used in large courses: the *Tipsheet : Teaching Large Classes (p164)* has other ideas.
And don't forget the *TPS Practices* sheet (p142).



## Journal prompt 7: Formative assessment of your SLO

Teaching journal: **pause and reflect**

Review the Student Learning Outcome (SLO) you wrote down yesterday (pages 59-61).

- **How might you formatively assess that SLO?**
- **Are there ideas you want to capture for your MAP (My Action Plan)?**

See also these Tip Sheets and Universe Sheets for more information on formative assessment.

**UNIVERSE** of formative assessment techniques

**PRACTICES SHEET** Exams & quizzes

**PRACTICES SHEET** Grading

**TIP SHEET** Assessing students

## Exit Ticket: Formative Assessment

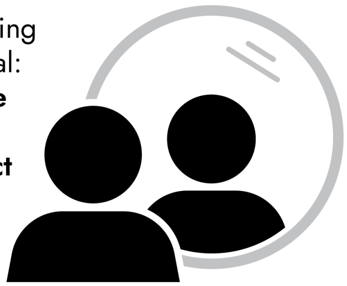
- What are at least two Principles of Teaching and Learning that this session attends to?
- How does this session attend to that principle?
- (In a classroom setting, we might collect these papers on your way out the door).

**First principle:**

**Second principle:**

## Journal prompt 8 (ONLINE): Reflecting on a teaching challenge

Teaching journal: **pause and reflect**



We want you to do this teaching reflection ONLINE in your FTI folder because it is a longer piece of writing. Note that this is a similar reflection prompt as was discussed in annual teaching reflections on Day 1 ("Career: Understanding your role.")
You will have 15 minutes to do this reflection. This is just for you. You will not be asked to share the results of this reflection, so feel free to be honest.

**Reflect on a teaching challenge you have encountered in the last year.** Think of a challenge or question you have faced in teaching in the last year. This might be a general challenge (e.g., student complaints about exams) or a particular situation that took you by surprise.

- **Describe the challenge.** What happened?
- **How did you feel?** What were you thinking or feeling at the time?
- **What might have been going on?** Why do you think that this happened as it did? Do you have any insight from student responses or other data? What might have been the students' experience in this situation, if applicable?
- **Next steps.** What might you do next time to avoid or reduce this challenge, or simply to gather more information?

See also the *Constellation of teaching reflection strategies* sheet (p131) for more ideas on teaching reflection.

## One-minute paper: Like & Learn

Reflect on today's workshop activities.

| What did you like? |
| --- |
| |

| What do you want to learn more about? |
| --- |
| |

# Start - Stop - Continue

## "Midterm" feedback survey

*Please let us know how the workshop is going for you so far! We will collect these anonymous sheets to allow us to make adjustments as needed.*

## START

What is something that isn't being done but that you want us to start doing?

## STOP

What is something you don't like about the workshop so far that should be discontinued?

## CONTINUE

What is something you like about the workshop so far that we should be sure to keep?

*This activity is adapted from* Stop-Start-Continue surveys *(see https://online.uga.edu/news/start-stop-continue-survey-offers-mid-semester-snapshot-student-experience) and* Stop-Go-Change classroom evaluations*, developed by E. Sayre, available at PhysPort.org at https://www.physport.org/recommendations/files/Stop-Go-Change-Evals.pdf and part of the recommendation* How can I set the stage for student engagement? *https://www.physport.org/recommendations/Entry.cfm?ID=101223*.

This page intentionally left blank

# Day 3

## Faculty Teaching Institute (FTI)

**Teaching: Tutorials and other worksheets**

**Teaching: Common questions and sticky situations about group work**

**First day and student engagement**

**Teaching inclusively**

**Summative assessment**

**Teaching: Labs**

**Discussion in pod groups and your questions**

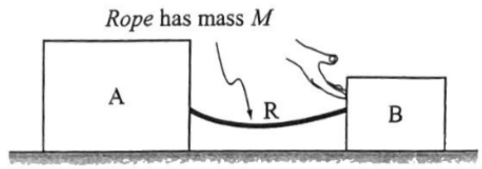
**Individual action planning session #1**

This page intentionally left blank

# Worksheet Exemplar: Tension Tutorial

## I. Blocks connected by a rope

Two blocks, A and B, are tied together with a rope of mass *M*. Block B is being pushed with a constant horizontal force as shown at right. Assume that there is no friction between the blocks and the table and that the blocks have already been moving for a while at the instant shown.




A. Describe the motions of block A, block B, and the rope.

B. On a large sheet of paper, draw a separate free-body diagram for each block and for the rope. Clearly label the forces.

*Copy your free-body diagrams below after discussion.*

| Free-body diagram for block A | Free-body diagram for rope | Free-body diagram for block B |
|---|---|---|
| | | |

C. Identify all the *Newton's third law (action-reaction)* force pairs in your diagrams by placing one or more small "×" symbols through each member of the pair (*i.e.*, mark each member of the first pair as →×→, each member of the second pair as →××→, *etc.*).

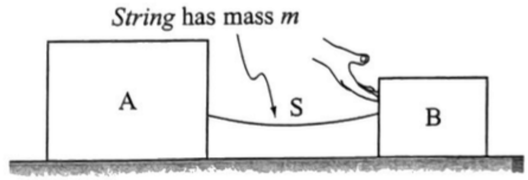
D. Rank, from largest to smallest, the magnitudes of the *horizontal components* of the forces on your diagrams. Explain your reasoning.

E. Consider the horizontal components of the forces exerted *on the rope* by blocks A and B. Is your answer above for the relative magnitudes of these components consistent with your knowledge of the net force on the rope?

➪ Check your reasoning with a tutorial instructor before proceeding.

## II. Blocks connected by a very light string

The blocks in section I are now connected with a very light, flexible, and inextensible string of mass $m$ ($m < M$).




A. If the motion of the blocks is the same as in section I, how does the net force on the *string* compare to the net force on the *rope?*

1. Determine whether the net force on each of the following is *greater than, less than,* or *equal to* the net force on the corresponding object or system in section I. Explain.

   - block A

   - block B

   - the system composed of the blocks and the connecting string

2. Compare the horizontal components of the following pairs of forces:

   - the force on the string by block A and the force on the rope by block A. Explain.

   - the force on the string by block B and the force on the rope by block B. Explain.

B. Suppose the mass of the string that connects blocks A and B becomes smaller and smaller, but the motion remains the same as in section I. What happens to:

- the magnitude of the net force on that connecting string?

- the magnitudes of the forces exerted on that connecting string by blocks A and B?

C. A string exerts a force on each of the two objects to which it is attached. For a massless string, the magnitude of both forces is often referred to as "the tension in the string."

Justify the use of this approach, in which a *single value* is assumed for the magnitude of both forces.

# Handout: Periscope lesson

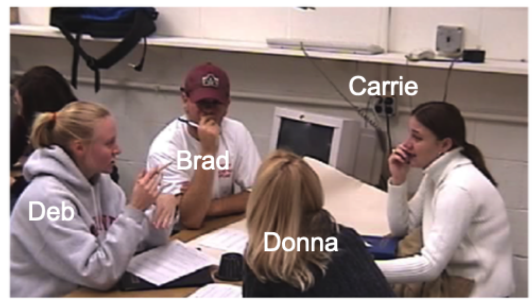
*HANDOUT*

## *What ideas do students have about mechanical energy?*

### Introduction

Research suggests that students have many productive ideas about mechanical energy, and with appropriate support can build a sophisticated model. Some common ideas that come naturally to many students include that energy transfers from one object to another and transforms from one form to another. What other ideas do students have about mechanical energy?

This episode shows a group of students in a tutorial who are considering the energy dynamics of an active person. Sample discussion prompts are about students' model of energy.




*Episode 106: "Potholes"*

### Task for students

*(from Maryland Open Source Tutorials in Physics Sensemaking)*

When you say something like "the jogger just burned 100 calories" of energy, what does that mean? Where exactly do those 100 calories come from? In other words, what form of energy is depleted by 100 calories? *Hint:* This is as much a biology or chemistry question as it is a physics question.

### Sample discussion prompts

1. **What struck you** about this episode? Talk to the person next to you about what got your attention.
2. Carrie, in trying to come up with where the jogger's energy went, says, "Did he perspire it?" A few lines later she cracks up at the idea that the jogger's energy might have dripped onto the road (suggested by her gesture). **How does she seem to be thinking of energy** (perhaps partly in jest)?
3. Deb decides that the jogger's **energy must go to the road.** Why does she think so?
4. Why do the students think that giving energy to the road would result in **potholes?** Do you think so?
5. Where do *you* think the jogger's energy goes?
6. What **student ideas about mechanical energy** are suggested by this episode?

*This page and the next are courtesy of Periscope: Looking into Learning, developed by R. Scherr. See [https://www.physport.org/periscope/](https://www.physport.org/periscope/). Based upon work supported by the National Science Foundation under Grant No. 1323699.*

### Transcript

1 Deb: Jogger used 100 calories, where did it transfer the 100 calories to?

2 Donna: Where'd it transfer to?

3 Carrie: Where'd it transfer to? Where are you reading that?

4 Deb: Well, I'm asking... it's... I'm not reading it. Like, because if energy is conserved and he burned 100 calories, that means he got rid of 100 calories.

5 Donna: Yeah, where did it go to?

6 Deb: But where did it go?

7 Brad: The environment.

8 Deb: You're like “uh huh.”

9 Carrie: Did he perspire it?

10 Deb: No, like, it left his body, it's not like “how did it leave his body?” it's like “where did it go?” Like, into the road?

11 Donna: Yeah, the force on the road? I guess.

12 Deb: Giving your energy to the street?

13 Carrie: The force on the r... I don't think you can answer that question in this case. That would be hard.

14 Donna: Probably goes to a bunch of different places.

15 Carrie: Mmmhmm.

16 Deb: Oh, it does go to the road.

17 Donna: It'd have to!

18 Deb: Cause he's pushing off the road.

19 Donna: That's the only force, yeah, that's the only force that he's exerting is on the road, I mean, think about it...

20 Carrie: Or on a sidewalk if he's walking on the sidewalk.

21 Donna: If you run enough you will eventually wear down the road.

22 Carrie: You will?

23 Donna: That's why there are potholes.

24 Deb: From runners. It's the joggers that create the potholes.

25 Donna: They're just running for a very long time.


*Filmed at the University of Maryland – College Park*

See the following practices sheets for ideas discussed in **Tutorials and other worksheets**, and **Common questions and sticky situations about group work** (p146-149).

PRACTICES SHEET Facilitating group activities

PRACTICES SHEET Planning group activities

## Journal prompt 9: Student engagement

Teaching journal: **pause and reflect**

Think about a moment from last term where student engagement was a challenge for you.

- **What happened?**
- **What was going on for you at that moment?**
- **What might have been going on for your students?**

## Handout: Categories and strategies for student engagement

**Engagement** means that students **participate,** are **interested,** and **value** the activity. You can increase student engagement and motivation by

1. What you say
2. What you do
3. Classroom policies and structures

### Five categories of productive engagement

| **What do students need?** | **What can instructors do?** How? |
|---|---|
| To know what is expected of them and how to succeed. | **Set and communicate clear expectations**: Set clear norms, and give clear expectations for behavior and grading. |
| To believe that engaging will help them learn and succeed | **Show the value of active engagement:** Explain teaching choices; support students' metacognition; use formative assessment. |
| To feel motivated to engage | **Motivate students to engage:** Provide accountability; support student ownership, help students feel capable; give work that is motivating. |
| To know how to engage | **Provide guidance and scaffolding** on how to engage: Actively facilitate activities; scaffold (structure) student engagement; give students time to process. |
| To experience a supportive class environment where they trust the instructor and feel cared for. | **Create a supportive environment:** Show respectful interest in student ideas, cultivate positive relationships; show caring; help students feel they are not anonymous. |

One minute paper:

- **What are you currently doing to support any one of these 5 student needs on the first day of class? What area(s) do you think you could do better?**

## Strategies for the first day and beyond

| **What can instructors do?** | **First-day strategies**<br>We did all these in the FTI, can you identify them? | **Beyond the first day**<br>We did all these in the FTI, can you identify them? Did they help you? |
|---|---|---|
| **Set and communicate clear expectations** | • Give a first-day framing speech explaining how class and grading are structured.<br>• Start with active learning.<br>• Use an interactive syllabus quiz | • Share SLOs with students.<br>• Give clear instructions per activity. |
| **Show the value of active engagement** | • Explain why you are using active learning.<br>• Ask them to reflect on what helped them learn in the past. | • Explain the purpose of each activity.<br>• Assign metacognitive writing.<br>• Use frequent formative assessment. |
| **Motivate students to engage** | • Give a first-day framing speech explaining that the class is hard but all can succeed.<br>• Bring up students' career goals. | • Give small incentives for participation in active learning.<br>• Let students choose topics or formats of projects. |
| **Provide guidance and scaffolding on how to engage** | • Do a first-day active learning activity, with clear indications of how to engage (e.g., facilitation, group structure). | • Structure group activities with worksheets, time checks, etc.<br>• Circulate and facilitate.<br>• Create group structures that support engagement. |
| **Create a supportive environment** | • Set a positive tone from the first email.<br>• Talk about yourself.*<br>• Share your pronouns and name pronunciation.<br>• Use an icebreaker.<br>• Learn names.<br>• Create Community Agreements. | • Use a midterm feedback survey.<br>• Use warm and supportive language.<br>• Hear from multiple students.<br>• Thank students for their contributions.<br>• Invite questions. |

*Those not belonging to dominant social groups in academia may wish to think carefully about self-disclosure, due to the potential for bias in terms of perceived professionalism and credibility.

Neighbor discussion notes

- **What are some strategies you particularly appreciate (from what we did in the FTI, from this sheet, or from these stories)**
- **What do you want to use in your own class?**

More tips on student engagement and motivation at these tip and practices sheets (p163, p150):



***For much more**, including example slide decks and downloadable activities, see the PhysPort article on student engagement by S. Chasteen,* How can I set clear expectations, and motivate students, so that they engage in active learning?
[*https://www.physport.org/recommendations/Entry.cfm?ID=101200#JXggBe695*](https://www.physport.org/recommendations/Entry.cfm?ID=101200#JXggBe695)

*This material is adapted from the above resource.*

## Worksheet: Who might feel disconnected?

| Teaching method or instructional choice | Who might feel disconnected? | What might help them feel more connected? |
|---|---|---|
| Participation points are only given to those who speak out to the whole class. | | |
| Lecture slides are dense with information. Notes are not available to students. | | |
| Historical examples always involve white men. | | |
| Examples always involve American people and situations. | | |
| Exams are long and there is a strict time limit. | | |
| The textbook costs $120. | | |
| The class meets at 7:30AM. | | |
| Students are required to meet in assigned groups weekly outside of class. | | |
| The instructor solves problems on the board quickly and cleanly. | | |
| Students are expected to debate each other in class. | | |
| Many students in the class have other classes together and are friends. | | |

*Credit: J. Handelsman, S. Miller, and C. Pfund (2007).* Scientific Teaching. *W.H. Freeman and Co..*

## Summative assessment case studies

### Part A: Exam crash and burn

You gave an exam that focused on solving several problems in electricity and magnetism. Many students didn't finish on time. Student answers show that they were confused by the question statements, and their work was scattered and disorganized. The average is 42% and you're freaking out. You're embarrassed to go into the class on Thursday.

1. How do you think students experienced this situation?
2. Who might be left behind as a result of what happened?
3. What might you do now?
4. What might you do next time?

### Part B: Grading the exam

You learned from your experience the first time and wrote an excellent, comprehensible exam. But because the exam is worth 25% of the grade, you want to make sure students understand their mistakes and where points were removed. So, you (or your TAs) are spending hours writing feedback to the students and assigning points to problem solutions. And there is a line of students out your door trying to get points back because they disagree with your grading. One who failed the exam breaks down crying in your office.

1. Put yourself in your students' shoes: What might be going on for them here?
2. Who might be left behind as a result of these practices? How might they be better supported?
3. What might you do now?
4. What might you do next time?

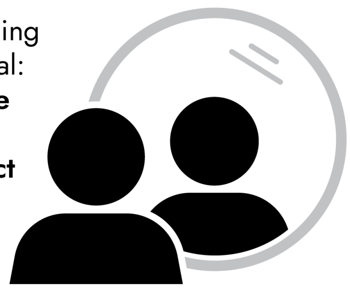
### Part C: Helping students learn from the exam

You learned from the above experience and used an excellent exam, which is preceded by multiple low-stakes quizzes and practice problem sets on HW. You post solutions and give students a chance for "oops" tokens. However, on the next exam, you see many students make the same mistakes in problem-solving strategies as the first exam.

1. Put yourself in your students' shoes: Why are many students making the same mistakes?
2. Who might be left behind as a result of these practices? How might they be better supported?
3. What might you do now? What might you do next time?

## Journal prompt 10: Summative assessment of your SLO

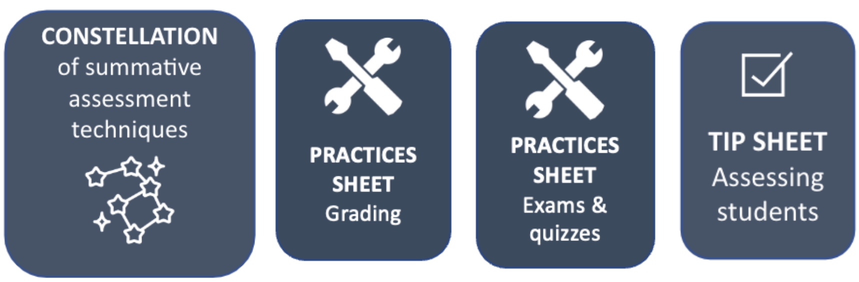
Teaching journal: **pause and reflect**



Review the Student Learning Outcome (SLO) you wrote down two days ago in the session *Foundations: Lesson Design* and how you said you might formatively assess it, during the session *Formative Assessment*.

- **How might you summatively assess that SLO?**
- **Are there ideas on summative assessment you want to capture for your action plan?**

Much more on summative assessment at these tips and practices sheets (p133, p156, p154, p165).



## Lab embellishments (without redesigning the lab)

**PRACTICES SHEET**
Labs & investigations

Labs are great for developing…

- **Scientific practices** (data analysis, experimental design, presenting results, etc)
- **Scientific habits of mind** (troubleshooting, curiosity, creating knowledge)
- **Scientific attitudes** (self-confidence, enjoying experimentation, belonging as a scientist)
- **Collaboration** (working as a group)

**Here are our "big 4" of lab embellishments to better support those outcomes:**

| **Embellishment** | **Notes:** What are tweaks to lab instructions or structure that can help achieve these? |
|---|---|
| Focus labs on process rather than product | |
| Give students more time to achieve process goals | |
| Give students agency and choice | |
| Fade structure over time (reduce scaffolding) | |

*Material for the handout and session on Labs is courtesy N. Holmes (Cornell University) and B. Zwickl (Rochester Institute of Technology).*

## One-minute paper: Like & Learn

Reflect on today's workshop activities.

| What did you like? |
|---|
| |

| What do you want to learn more about? |
|---|
| |

# Day 4

## Faculty Teaching Institute (FTI)

**Your career: Doing your role well**
**Pulling it all together: Course and unit design**
**Individual action planning session #2**
**Collective action planning session**
**Final words**

This page intentionally left blank

## Case studies: Choose-your-challenge

### Professor A: Brain is full

Every day, you are frantically busy with things that feel both urgent and important. Every morning your email is an impossible mix of mandatory time-sensitive tasks and pointless notices. You're often preparing your classes in a last-minute scramble; you miss lunch rushing from one meeting to the next; you come out of every meeting with new tasks on your to-do list and no idea when you will do them. You quit early to pick up the kids from school and make dinner, and you do your best to spend dinnertime focused on your family and try to catch up on work in the evening. And as you drag yourself to bed, head buzzing with unfinished business, you wonder where the time went. Are you ever going to get time for your research? You resolve to dedicate your upcoming break to writing multiple papers. Meanwhile, the emails keep coming in.

1. Although we hope this doesn't sound familiar to you, the reality is that many new faculty have experiences like this. Do you relate?
2. Does the above description suggest any potentially problematic behaviors?
3. Do you *really* think you'll spend your break writing multiple papers?
4. This kind of overwhelm is not likely to be addressed with quick tips. What are some big-picture strategies that might support a healthier and more satisfying work life?

### Professor B: Too much on my plate

It's Monday, you're near the end of the Fall semester, and planning your next several months of work and realizing that you have gotten yourself into an impossible situation. You will be teaching in a new course in the spring; you will be traveling to give an invited presentation at an important conference; you are giving the department colloquium at the start of the term; and you've been tasked with leading a department committee you really care about. Your graduate student is falling behind on their research, and you also have to prepare your tenure review dossier. That same afternoon you receive an email from a colleague inviting you to participate in a cool research effort, with a proposal due in March. You want to protect time for an annual hiking and camping event over spring break that you love. You are also trying to decide whether to serve on an NSF review panel that spring, and whether to accept a review request from an important journal in your field.

1. Although we hope this doesn't sound familiar to you, the reality is that many new faculty have experiences like this. Do you relate?
2. Does the above description suggest any potentially problematic behaviors?
3. How can you deal with this situation now that you're in it?
4. How might you avoid getting into situations like this in the future? (Hint: How can you strategically and tactfully say 'no'?)

**TIP SHEET**
Starting your career

# Handout: Features of "quick starter" faculty members

Robert Boice found that 5% of faculty met or exceeded expectations in the first 1-2 years of their appointment. What were the features of those "quick starters?"

**Quick starters...**

1. Have clear goals and plans - and say no to things that don't align with those plans.
2. Find balance and rhythm. Don't work nonstop, and find a rhythm that works.
3. Limit class preparation time to a set number of hours.
4. Schedule brief daily writing sessions (or time for other non-urgent but important tasks).
5. Connect with colleagues at least 2 hours/week.

## Have clear goals and plans

- Think periodically about what you care about; articulate your purpose and meaning.
- Make an annual plan with goals and milestones and get feedback on it (examples online).
- Strategically limit service to things that connect you to colleagues and help you feel good, especially before tenure (if applicable).
- Learn to say no! Here are some polite ways to decline requests:
  - That sounds interesting, but can I call you back tomorrow? I need a little time to think about it.
  - I'm sorry, but I've just got too many other commitments right now.
  - I'd love to help, but I really don't have time for a formal commitment. Maybe we could just talk once or twice.
  - I'm afraid I'm not the best person to help you with this. Have you thought about asking ____?
- Make sure there is time every week for important, but non-urgent tasks.
- Track and log your time to see where you are spending your time.

**Task prioritization matrix**

| | **Urgent** | **Not urgent** |
|---|---|---|
| **Important** | Crises, deadline-driven items, projects, meetings. It's easy to spend all your time here! **Avoid the urgency addiction.** | Scholarly writing, relationship building, planning. **Strategize so you spend regular time here!** |
| **Not important** | Phone calls, emails, reports, or some meetings. **Minimize your time here** and do these tasks when you are not at your best. | Nooooooo |

## Find balance and rhythm. Don't work nonstop!

- Strive for balance. Find out what energizes you and make time for YOU.
- Don't just work more and more and faster and faster; plan for intensive and calm times.
- This also means limiting class prep, scheduling regular time for non-urgent tasks like writing, and connecting with colleagues; see below.

## Limit class preparation time to a set number of hours

- New course: 18 hours/week (3-4 hours per hour of class time)
- Existing course: 9 hours/week (1-2 hours per hour of class time)
- More time if developing a course from scratch, rather than from somebody's materials, but this should not be the case in your first years.
- If you don't make this target that's OK, but don't overshoot it by a wide margin.

## Schedule brief daily writing sessions

- Work in brief regular writing sessions.
- Freewrite first, and critique and revise separately.
- Make notes of what you will work on in the next session.
- Hold yourself accountable (e.g., timer, timed playlist, writing partner).

## Connect with colleagues at least two hours/week

- Take the initiative and don't wait for colleagues to come to you with offers of help. Tradition discourages peers from seeming intrusive.
- Go to lunch, have coffee, discuss research and teaching, ask for feedback on a problem.
- Quick starters averaged 6 hours/week of networking!
- Engage with your national community as well (e.g., APS, AAPT, AAS) to find collaboration and support and further your career. National collaborators can be especially valuable in areas where you lack local colleagues.

| **What do you want to do differently going forward?** |
|---|
| |

*Credit for this material: R. Felder and R. Brent (workshops on faculty careers shared directly with the FTI); R. Boice (1991). Quick Starters: New faculty who succeed,* New Directions for Teaching and Learning, *48, 111; R. Boice (2000).* Advice for new faculty members: Nihil Nimus. *Allyn and Bacon; R. Reis (1997).* Tomorrow's Professor: Preparing for academic careers in science and engineering. *IEEE Press; L. D. Fink (2013).* Creating significant learning experiences. *Jossey-Bass.*

TIP SHEET
Course or class design

TIP SHEET
Teaching large classes

## Handout: Course planning

Many steps will already be done when teaching from a pre-designed course, but you will likely wish to adapt their approach.

### First planning phase: Identify the main components of the course

1. **Identify the context.** How many students are in the class, how long are class meetings, who are the students, and what is the classroom layout?
2. **Identify course-level learning outcomes.** About 5-10 big-picture takeaways you want your students to gain from the course. Broader than topic-level SLOs.
3. **Identify appropriate feedback and assessment procedures.** What formative and summative assessments will be used (e.g., JiTT, minute papers, exams, essays)? How frequently? How will students get feedback on their learning?
4. **Select the teaching and learning techniques.** What will be the textbook or other resources? How will the class sessions be organized? What types of learning activities will be offered? What technology will you use?
5. **Make sure these items are all integrated and aligned.** Is the structure of the course consistent with what you value about teaching? Are assessments, learning activities, and learning outcomes aligned?

### Intermediate planning phase: Assemble course units

1. **Identify the main themes (units) of the course.** What are the main concepts or topics? Arrange these into a meaningful sequence.
2. **Organize the course structure as a whole.** Outline the timeline of the course with a schedule of units, major activities, and assessments, including how the course begins and ends. See sample week-by-week schedule.
3. **Develop the first unit or two.** Before the term begins, develop one or two units. Further than that makes it hard to adjust if you get off schedule.

### Final planning phase: Remaining tasks

1. **Develop the grading system.** How will each assessment be weighted? What is the policy for missed assignments? Will students have a chance to revise and resubmit?
2. **Write the course syllabus.** What information do students need to know, including policies and ground rules, and SLOs? How can you strike a welcoming tone?
3. **Plan an evaluation of the course and of your teaching.** How will you collect feedback from students during and at the end of the course? How will you reflect on your teaching?

## Handout: Unit design

After you finish course planning, you are ready to design the course units. As the course progresses, develop one or two units at a time.

1. **Identify SLOs.**
2. **Select learning activitie**s. Which activities happen in class, and which are out of class? How do they build toward the SLOs?
3. **Develop feedback and assessments.**
4. **Put these together into daily lessons** that walk students through the unit in a clear narrative structure.

**Unit Design template**

| |
|---|
| **Title** |
| **Student learning outcomes**<br>What will students know, understand, and be able to do? |
| **Assessment**<br>How will students gauge their learning? How will instructors gauge student learning? |
| **Activities**<br>What will students do to achieve the SLOs? What is a rough schedule of events? What will happen inside the class vs outside the class? What instructional resources can I draw on? |
| **Alignment**<br>How does the teachable unit align with the principles of teaching and learning? With the SLOs?] |

**Sample week by week schedule**

| Week | Class session | Between classes | Class session | Between classes | Class session | Between classes |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | | | | | | |
| … | | | | | | |

*Credit: L. D. Fink (2013).* Creating significant learning experiences. *Jossey-Bass; W. McKeachie & M. Svinicki (2014).* McKeachie's Teaching Tips *(14th ed.). Wadsworth; G. Wiggins & J. McTighe (2005).* Understanding by Design. *Association for Supervision and Curriculum Development. The FTI online resources include the Appendix of D. Fink's course planning guide.*

# Handout: Lesson design

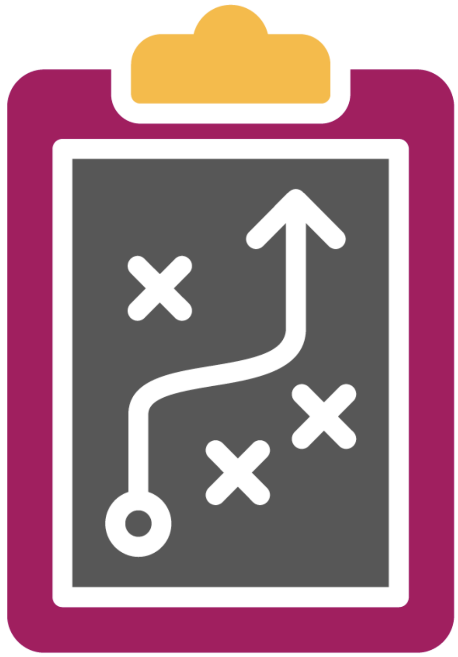
**The Engage-Construct-Evaluate (ECE) model of lesson design:**

| | |
|---|---|
| **Engage** | Hook students in, elicit prior knowledge, capture student interest, and let them express what they know. |
| **Construct** | Get them involved in a way that develops the skills and knowledge you want. |
| **Evaluate** | Use formative and summative assessments to determine what they learned. |

**Other tips:**

- Focus time on developing or adapting active learning activities, not writing lectures. Lectures can lead students in and out of the activities.
- Add active learning in existing lectures by finding a few places to ask students a question or have them do some of the steps before you do.
- Identify 3-4 key points per lecture and allot 10-15 minutes per point.
- Use an active learning activity within each of those key points.
- Plan how you will prepare students to engage with that activity, and how you will introduce the activity.
- Plan logistics such as timing and transitions.
- *See "Active Learning Cheat Sheet" in online resources for more.*

**What questions or strategies are you taking from this session on course, unit, or lesson design?**



# My Action Plan (MAP)

You will create an action plan online during the workshop. We suggest this be created online for easier writing, editing, and archiving. We suggest you **print** this plan and place it in the binder here for easy reference.

What follows is the content of the online action plan for reference but without necessarily adequate space for writing. If you need a physical copy of the MAP document, please ask an FTI staff member.

This page intentionally left blank

The My Action Plan document has several pieces, we'll walk you through them during our four days together. They are

- **Part I: Your ideas (Days 1-3).** You will have time each workshop day to capture key ideas from those sessions, to inform your thinking at the end of the workshop.
- **Part II: Your goals (Day 3).** On day 3, you will write out some broad goals for your teaching.
- **Part III: This year's action plan (Day 4).** On day 4, you will write out a plan for a "mini teaching experiment" this next year.
- **Part IV: Other plans (optional).** If you can't keep yourself to one mini-experiment, this is where you can write other things you plan to do.
- **Part V: Your reflection one year later**. Next year we will prompt you to write down how the experiment went. The American Association of Physics Teachers (AAPT), the American Physical Society (APS), and the American Astronomical Society (AAS) can provide you with a personalized letter for your reappointment, promotion, or tenure portfolio! Just submit a reflection on what you did on your Action Plan to us at info-fti@aps.org using the format in the MAP, approximately 2-3 pages.

*Credit for the My Action Plan material:*

- *The University of Georgia* Project DeLTA. *DeLTA is supported by the NSF IUSE award 1821023.* *https://seercenter.uga.edu/delta-project/*.
- Change at the Core *(C-CORE) project at Western Washington University.* *https://smate.wwu.edu/c-core-website*.
- *National Association of Geoscience Teachers. On the Cutting Edge: Early Career Geoscience Faculty Workshop* *https://nagt.org/nagt/profdev/twp/cau/program.html*, Considering your goals *worksheet* *https://serc.carleton.edu/NAGTWorkshops/earlycareer/pastworkshops/index.html*.

This page intentionally left blank

# The universe of teaching and assessment strategies

## The universe of student-centered instructional techniques
## The universe of formative assessment techniques
## The constellation of instructional technologies
## The constellation of teaching reflection strategies
## The constellation of summative assessment techniques

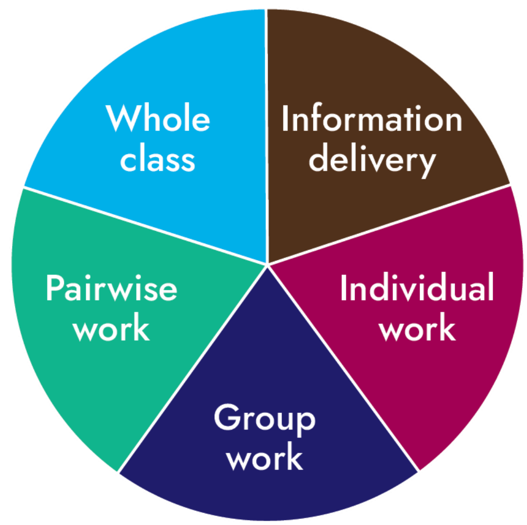
# The universe of student-centered instructional techniques

**Student-centered instruction** places the focus on the learner (rather than the instructor), emphasizing student ideas and thinking; it includes but is not limited to **active learning.**

Student-centered instruction includes a range of practices such as the use of student learning outcomes, scaffolding to help build mastery, the use of active learning, and opportunities for useful feedback. Our Principles of Teaching and Learning are essentially principles of effective student-centered instruction. *Also known as student-centered learning, learner-centered education*

## How can I help students learn?

Five core strategies in the FTI



# Student-centered instructional techniques

## Information delivery

- Demonstrations
- Lecture
- Reading / textbooks
- Screencasts
- Simulation / animation
- Video
- Worked problems

## Individual work

- Brainstorming
- Commented reading
- Concept mapping
- Demonstrations
- Handouts with gaps
- Just in Time Teaching
- Note-taking
- One-minute paper
- Pause for reflection
- Problem solving
- Reading assessment
- Revise and resubmit
- Self-assessment
- Simulation / animation
- Student-generated test questions
- Writing assignment

## Whole class discussion

- "Any questions?"
- Choral response
- Demonstrations
- Discussion
- Online discussion platform
- Polling
- Random call and cold calling
- Simulation / animation
- Vetted questions

## Pairwise or group work

- Brainstorming
- Case studies
- Collaborative note-taking
- Demonstrations
- Discussion
- Flipped classroom*
- Group exams / two-stage exams
- Group presentations
- Guided peer questioning
- Inquiry-based learning
- Interactive demonstrations
- Jigsaw discussion
- Kinesthetic activities
- Labs and other investigations
- Pause for clarification
- Peer review/ group evaluation
- Problem solving in pairs or groups
- Problem-based learning
- Ranking / sorting tasks
- Reading assessment
- Role play
- Simulation / animation
- Statement correction
- Studio / SCALE-UP*
- Think-pair-share (TPS) & variations
    - Polling TPS / Peer Instruction
    - Whiteboard TPS
- Whiteboard
- Worksheet

* Flipped class and Studio/SCALE-UP are overall course structures, not an individual technique

## Student-centered instructional approaches (in alphabetical order)

| | |
|---|---|
| **"Any questions?"** | The instructor pauses regularly to solicit questions. More substantive prompts will typically generate more discussion. |
| **Brainstorming** | The instructor asks students (individually or in groups) to generate a list of ideas on a topic or question. Ideas are recorded. |
| **Case studies** | Students discuss real-life stories about a community, family, school, industry, or individual, to integrate their classroom knowledge with their knowledge of real-world situations, actions, and consequences. |
| **Choral response** | All students give a verbal response at the teacher's signal. Choral responses are used when answers are short and the same. The instructor might pose an incomplete fill-in-the-blank sentence (often with two opposite options: e.g., redshift or blueshift). |
| **Collaborative note-taking** | Students collaborate on shared notes, either in pairs or as a whole class. Students may contribute to a shared set of notes (e.g., in a Google Doc), or work in pairs or small groups to develop or review each others' notes. |
| **Commented reading** | Students take notes on an article or text. This can be done in a structured way so that the instructor and/or other students can read and reply to comments. Perusall™ is a platform for group-based commented reading. |
| **Concept mapping** | Students are asked to make a visual representation of information or ideas in charts, tables, flowcharts, Venn Diagrams, or mind maps. |
| **Demonstrations** | The instructor performs a physical experiment while students observe. These work best when done actively; see "interactive demonstrations." |
| **Discussion: Whole class or group** | Students discuss a topic in class either as a whole class or in pairs or groups. Students might discuss the reading, a video, a problem solution, a question posed by the instructor, work out the next step of a problem, predict an outcome, brainstorm a list, summarize a topic, or observe and interpret features of an image, graph, simulation, or demonstration. |
| **Flipped classroom** | Students read a textbook section or watch a video on their own before a class session, then spend class time on active-learning activities. |
| **Group or two-stage exam** | Students first complete and turn in the exam individually and then, working in small groups, answer the exam questions again. This makes the exam a more valuable learning experience. |

| | |
|---|---|
| **Group presentations** | Students work together to create a presentation for their classmates about a particular topic, showing a problem they solved, a discovery they made, etc. Can be done via slides, a poster, whiteboard, or video. |
| **Guided peer questioning** | Students write down questions to ask one another about the content, using question stems provided by the instructor (e.g., What causes ___? What would happen if ____?). Then students take turns asking one another their questions and discussing the answers. |
| **Guided or skeleton notes** | The instructor provides a written outline of the material, including diagrams and equations, but with gaps for students to fill in key information based on that day's lecture or activities. |
| **Inquiry learning** | Inquiry activities often involve students developing their own questions to investigate based on intriguing observed phenomena, working in groups to plan and carry out an investigation to answer their questions, and communicating their results with classmates. |
| **Interactive demonstrations** | Students actively engage in lecture demonstrations. For example, the instructor can ask students to predict what will happen and then check their predictions, invite students to direct what to do (change X variable, move this piece), or ask students to make measurements. See PhysPort for Interactive Lecture Demonstrations materials. |
| **Jigsaw discussion** | Each group of students learns about a different piece of a topic. Then new groups are formed composed of one member from each of the first groups, and students teach each other about their piece. |
| **Just-in-Time Teaching (JiTT)** | Students complete a pre-class assignment and answer questions on the concept covered before coming to class (often called "warmup exercises," "preflight checks," or "checkpoints"). Instructors review the responses before class and address student difficulties in class. |
| **Kinesthetic activities** | Students act out phenomena, physical processes, etc., sometimes in a group; e.g., acting as an electron in a circuit. Other students can observe and give feedback. |
| **Labs and other investigations** | Hands-on experimental opportunities for students to learn the skills of doing physics, and experience phenomena that demonstrate a theory. Labs usually use physical equipment but may also use virtual labs (e.g., PhET simulations, RealTime Physics, Tools for Scientific Thinking). |
| **Lecture** | The instructor introduces students to key ideas, concepts, terminology, and problem-solving methods using both words and visuals. |

| | |
|---|---|
| **Note-taking** | Students take notes while reading or listening to a lecture or video. Students may need guidance on the best strategies. See also "collaborative note-taking" and "guided notes." |
| **One-minute paper** | Students write in response to a topic or question from the instructor. Common prompts are the main point, or the muddiest point, from today's lecture. The instructor may wish to collect responses and use them to identify common confusions to be addressed in the next class. |
| **Online discussion platform** | Students discuss concepts or seek help in an online asynchronous forum. Many Classroom Management Systems (CSM) have such an online forum, or Piazza™ and Slack™ are often used. |
| **Pause for reflection or clarification** | The instructor pauses regularly during class and asks students to reflect on the content on their own and/or clarify their notes with a partner. The instructor gives space for students to ask questions. |
| **Peer review / group evaluation** | Students are asked to complete an individual homework assignment, short paper, or give a presentation. Students submit one copy to the instructor to be graded and one copy to their partner, who gives critical feedback. One format for peer review is "two stars and a wish," stating two things that were good about the work and a suggestion. |
| **Polling** | Students respond to multiple-choice questions from the instructor. This is best done with challenging conceptual questions where distractors reflect common student thinking, but polling can be used for other purposes. See *Think-pair-share practices (p142)* and the *Constellation of educational technologies* (p129). Also called "ConcepTests" or "Peer Instruction" when done in association with Think-Pair-Share. |
| **Problem-solving in pairs or groups** | Students practice solving problems or derivations on their own or in a group. Group problem-solving can be done in a structured way, with one problem-solver and one listener or questioner, preferably working together on a whiteboard. Cooperative Group Problem-Solving and Context-Rich Problems are published techniques with many examples. |
| **Problem-based learning (PBL)** | Students learn the content by working in groups to solve a complex, real-world problem; the source of the learning is the work required to solve the problem. See Context-Rich Problems on PhysPort. |
| **Random call and cold calling** | The instructor randomly calls on students or groups to answer or ask questions during class, in order to encourage all students to be engaged and contribute. Random call can create anxiety for students so must be used carefully; see Whole Class Discussion practices. |

**Ranking / sorting task**

Students place items (e.g., concepts, quantities) in a logical order, or sort them into categories. This can be done on a worksheet or with cards. Ranking Tasks in astronomy is an example of this.

**Revise and resubmit**

After an assignment, homework, or exam is graded, students are given an opportunity to revise and resubmit for partial credit. This can work best when the returned papers do not give detailed explanations of the error, and when the student is required to explain their error.

**Reading / textbooks**

Students are assigned a reading to complete, usually before class. It is best to choose a selection that is not too long, and indicate what students should focus on. See "commented reading" for a structured method of student collaboration and see "Just-in-Time Teaching".

**Reading assessment**

Students complete an assessment related to the reading, possibly in groups in class, or possibly turned in for credit. Assessments could include writing questions or responding to a question about the reading, listing two things you learned, summarizing the main points, etc.

**Role-playing**

The instructor asks students to "act out" a part or a position to get a better idea of the concepts and theories being discussed.

**Screencast**

A video where the instructor records their own writing on their screen with narration, e.g., while they solve an example problem.

**Self-assessment**

Students assess their own learning through quizzing themselves, taking a quiz and grading it themselves, or using a checklist or rubric to self-determine their level of performance or understanding.

**Simulations or animations**

Simulations or animations are computer-based depictions of a physical phenomenon. See also "simulations and demonstrations practices." Sets of online simulations include PhET Interactive Simulations, Physlets, and Open Source Physics.

**Statement correction**

Students determine what is wrong with a statement, and propose an alternative correct statement. Can be done individually or in groups.

**Student-generated test questions**

Students write their own questions that they feel capture the key concepts from a topic they recently learned, either individually or in groups. The instructor uses those questions for exam review, or on the exam.

**Studio or SCALE-UP**

Labs, tutorials, and lectures are all integrated into one course, and most of the "lectures" are class-wide discussions. The learning space is designed to facilitate interactions between small groups.

| | |
|---|---|
| **Think-pair-share (TPS) and variations** | Students first think about a question individually, then discuss it in pairs. Then, they share their answers with the rest of the class. Can be combined with polling to collect individual and/or joint responses, also called Peer Instruction or ConcepTests. TPS can be used productively with whiteboards. See "polling" and "whiteboards." |
| **Vetted questions** | Vetted questions are questions that are "upvoted" by students in some way, and so represent the most popular or pressing questions. Questions can be upvoted using technology or small groups can discuss. |
| **Video** | Students watch a video on content usually before class. The video can be professional or amateur (e.g., YouTube™, or created by the instructor). Use "Just-in-Time Teaching" to ask students questions about the video. |
| **Worked problems** | An instructor demonstrates how they solve an example problem in real time in class or with a screencast (see above). |
| **Whiteboard** | Students work on a whiteboard, usually on solving a problem. This can be on small individual whiteboards, or large shared whiteboards around the room, and students can work alone or in groups. Whiteboards make it easier for students to collaborate, and for the instructor to view student work. Virtual whiteboards (e.g., Jamboard) can also be used. |
| **Worksheet** | Students work in class or recitation on written problems or questions, usually in small groups. Worksheets that provide guided inquiry may be called "tutorials." The instructor acts as a facilitator and walks around helping groups. There are many examples of published worksheet-based curricula available on PhysPort.org; e.g., Lecture Tutorials and Ranking Tasks in astronomy, Physics by Inquiry, Tutorials in Introductory Physics, Workshop Physics, Tasks Inspired by Physics Education Research, Open Source Tutorials, Physics by Inquiry, Physics and Everyday Thinking, etc. The instructor can also design their own. |
| **Writing assignment** | Students write in response to a prompt, in class, out of class, or in a lab. For example, students could be asked to write what they already know about a topic, generate a list of applications, summarize a topic or their lab results, connect lab activities to lecture material, or summarize a reading. For example, "what about the enterprise of sciences makes it different from business?" |

*Credit for this material:*

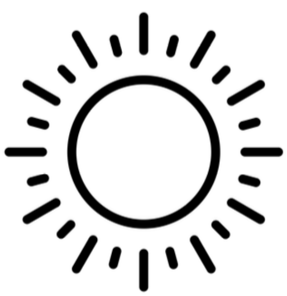

- *PhysPort.org*
- *C. O'Neal & T. Pinder-Grover.* How can you incorporate active learning into your classroom? *Center for Research on Teaching and Learning, University of Michigan.* *https://crlt.umich.edu/sites/default/files/resource_files/Active%20Learning%20Continuum.pdf*.
- *D. Wiliam (2018).* Embedded formative assessment. *Solution Tree Press.*

# The universe of formative assessment techniques

**Formative assessment** is low-stakes, ongoing assessment to monitor students' learning and give them feedback during instruction. **Classroom assessment techniques** (CATs) are classroom activities to quickly gauge student understanding.

## Classroom Assessment Techniques (CATs)

- 3-2-1
- "Any questions?"*
- Background knowledge probe
- Brainstorming / listing*
- Color cards
- Concept mapping*
- Defining features matrix
- Entrance ticket / exit ticket
- Fish Bowl
- Group work assessment
- Instructor circulates during group discussion
- Muddiest point paper
- One-minute paper*, possibly with a reflective prompt
- One-sentence summary
- Pause for reflection*
- Peer review / group evaluation*
- Polling*
- Quiz - also outside class
- Ranking/sorting task*
- Red light / green light or thumbs up/ thumbs down
- Scratch-off quiz
- Statement correction*
- Think Pair Share and variations*
- "What's the principle?"
- Whiteboard*
- Worksheet*
- Writing assignment*



## Out-of-class formative assessments

- Exam wrapper
- Homework
- Just in Time Teaching*
- Learning log / weekly report
- Online discussion platform*
- Practice exam
- Pre-test
- Quiz - also CAT
- Revise and resubmit*, possibly with a reflective prompt
- Self-assessment
- Student-generated test questions*
- Student self-assessment of learning gains (SALG)
- Summary sheets
- Writing assignment*

* Items with a * are repeated from the *Universe of Student-Centered Learning Techniques.* Most student-centered learning techniques are also formative assessments; here we have listed some of the key ones.

**Reflection** entails considering past or present experiences, learning from the outcomes observed, and planning how to better approach similar situations in the future. Reflection supports **metacognition**; being aware and able to monitor your own learning.

## Reflective prompts for students

These can be used as prompts within many of the formative assessment techniques listed on the first page, either for students to reflect individually or in small groups.

**Writing starters:**

- Today I learned…
- What helped me learn those things was…
- What I liked most about this lesson was…
- I might have gotten more from this lesson if….
- The most useful thing I will take from this lesson are…
- I was surprised by…
- One thing I'm not sure about is…
- My favorite part of class today was…
- The main thing I want to find out more about is…
- After this lesson I feel….

**Questions on specific content or learning strategies:**

- What are the learning strategies I am using in this course? How might they be adapted for more effective learning?
- What do I wish I had known before we covered topic X in class?
- What do I wish my instructor had known about me before we covered topic X in class?
- How did what I learned in class today connect with what I already knew?
- How comfortable did I feel in sharing my thinking in the group/class today?
- How did sharing my thinking help with my learning today?
- Did listening to other students in my group help my learning today? How?
- What is a mistake I made on this assignment? How do I want to think differently about it next time I encounter a similar problem?
- What were the main ideas from X?
- How does what I'm learning connect with my personal values?
- What questions do I have about X?
- What was most interesting about X? What would I like to learn more about?
- How have my ideas changed about X?
- What learning strategies am I currently using? What's working well for me? What's a new strategy I might like to try?
- What is advice I want to give my future self, e.g. when preparing for my next exam?

## Classroom assessment techniques (in alphabetical order)

| | |
|---|---|
| **3-2-1** | At the end of class, ask students to write down: (a) Three ideas/concepts reinforced; (b) Two new ideas or concepts; (c) One question they have. |
| **Background knowledge probe** | The instructor gives students a short online or in-person quiz to evaluate what students already know about material that is about to be covered. This can occur at the start of the term, or the start of a new topic. |
| **Color cards** | Provide each student with a set of three color-coded cards. Red means *Stop, I need help*; Green means *Keep going, I understand*; Yellow means *Slow down, I'm a little confused*. |
| **Defining features matrix** | Prepare a handout with a matrix of three columns and several rows. In two columns two distinct concepts with potentially confusing similarities (e.g. force and momentum), and in the third list the important characteristics of both concepts in no particular order. Students use the matrix to identify which characteristics belong to each concept. |
| **Entrance ticket / exit ticket** | Entrance ticket: The instructor asks a question at the start of a lesson, students write responses on index cards and hand them in. Exit ticket: Same as an entrance ticket, but at the end of the lesson. Example exit ticket, "What is the difference between mass and weight?" The instructor uses the responses to address student difficulties. |
| **Fishbowl** | Ask each student to write one issue or concept they want to be clarified on a card and drop it in a bowl as they enter class. During class, select cards from the bowl and clarify any issues or concepts from the card. |
| **Group work self-assessment** | After working in small groups, group members assess the outcome of that group work. One format is the "I-You-We" checklist; each student records something about their own contribution, the other group members' contribution, and the quality of the work of the whole group. |
| **Instructor circulates during groups** | The instructor sets up students to have discussions on a topic in small groups and then moves around the room listening in to student conversations, to gauge students' level of understanding and progress. |
| **Muddiest point paper** | Ask students to jot down a quick response to one question: "What was the muddiest point in [the lecture, discussion, homework assignment, film, etc.]?" The term "muddiest" means "most unclear." |
| **One-sentence summary** | This activity asks students to synthesize information into a single sentence. Ask students to identify the who-what-when-where-why of something they read or did in preparation for class. |

| | |
|---|---|
| **Quiz** | A short set of questions to test students on material. Frequent, low-stakes quizzes support consistent student effort and give feedback on their learning. Quizzes can be in or outside class, individually or in groups. |
| **Red light / green light or thumbs up/down** | Provide students with a red and green index card for the semester. Students can then show the card before or during class sessions to indicate they are unprepared/prepared, confused/not confused, etc. For thumbs up/down, students give a thumbs up or thumbs down. |
| **Scratch-off quiz (individual or group)** | A form of in-class quiz where students scratch off their response to a multiple choice question on a scratch card. The correct answer is revealed on the card. Students score themselves based on how many times it takes them to get the correct answer. |
| **"What's the principle?"** | This is useful in courses requiring problem-solving. After students figure out what type of problem they are dealing with, they often must decide what principle(s) to apply in order to solve the problem. This CAT provides students with a few problems and asks them to state the principle that best applies to each problem. |

## Out-of-class formative assessments (in alphabetical order)

| | |
|---|---|
| **Exam wrapper** | After an exam, a student completes a short handout about their exam performance, including addressing instructor feedback and how they might adapt their future study strategies. Many examples online. |
| **Homework** | An assignment that students do outside of class to help students practice concepts, go deeper, or demonstrate their understanding. Homework is often done individually but can also be done in groups. Homework assignments should include problems similar to "Typical Test Questions," and identify these problems as such. |
| **Learning log / weekly reports** | Each student is asked to submit a short summary of their educational activities over the course of a week. These can include specific prompts for students to reflect on and/or summarize what they learned or accomplished each week during synchronous and/or asynchronous learning time, and questions or feedback to share with the instructor. See "student reflective prompts" for questions to use in learning logs. |
| **Practice exam** | This is a set of questions similar in type, length and format to an exam that students will take later. |

| | |
|---|---|
| **Pre-test** | The instructor gives students a short online or in-person quiz to evaluate what students already know about the material that is about to be covered. This can occur at the start of the term, or the start of a new topic. |
| **Student self-assessment of learning gains (SALG)** | The SALG is an instrument that asks students to assess and report on their own learning, and on the degree to which specific aspects of the course have contributed to that learning. See SALG on Physport for information and a sample set of questions. |

*Credit for this material:*


- [PhysPort.org](PhysPort.org)
- *D. Wiliam (2018).* Embedded formative assessment. *Solution Tree Press.*
- *The Learning Accelerator.* Weekly Learning Logs. https://practices.learningaccelerator.org/strategies/weekly-learning-logs
- Student Assessment of Learning Gains*:* https://salgsite.net/about
- *Classroom Assessment Techniques: University of Colorado Boulder* https://www.colorado.edu/center/teaching-learning/teaching-resources/assessment/assessing-student-learning/classroom-assessment-techniques; Iowa State University https://www.celt.iastate.edu/instructional-strategies/evaluating-teaching/classroom-assessment-techniques-quick-strategies-to-check-student-learning-in-class/; *Vanderbilt University* https://cft.vanderbilt.edu/guides-sub-pages/cats/
- *Typical Test Questions and continuously open feedback surveys from K. Hogan & V. Sathy (2022).* Inclusive Teaching: Strategies for promoting equity in the classroom. *West Virginia University Press.*
- *Start-Stop-Continue surveys: University of Georgia* https://online.uga.edu/news/start-stop-continue-survey-offers-mid-semester-snapshot-student-experience
- *Summary sheets: P. C. Brown et al. (2014).* Make it Stick. *Belknap Press.*
- *L. Strubbe (2023). Reflecting on our teaching with gratitude and compassion, Teaching Made Visible,* https://teachingmadevisible.com/2023/06/reflecting-on-our-teaching-with-gratitude-and-compassion/

This page intentionally left blank

## The constellation of educational technologies

**Educational technology** is the use of computer software and hardware for learning purposes.

- Audio or video, podcasts
- Blogs
- Classroom response systems (e.g., clickers, Polleverywhere™, Slido™)
- Collaborative whiteboard software (e.g., Jamboard™)
- Collaborative writing (e.g. Google Docs™, Padlet™)
- Course management system (CMS)
- Discussion platform
- Email
- Listservs
- Presentation software (e.g. Powerpoint™, Keynote™, Google Slides™).

- Simulations or animations
- Social annotation software (e.g. Google Docs™, Perusall™)
- Web conferencing software
- Websites
- Wiki

### Educational technologies (in alphabetical order)

| | |
|---|---|
| **Audio or video, podcasts** | Short pieces of audio or video about a particular topic. The instructor could ask students to listen or watch as a homework assignment or show them in class. Students could be assigned to create a podcast or video. |
| **Blogs** | A regularly updated website or web page, usually written in an informal or conversational style. The instructor could ask students to write blog posts about their learning journey or a topic. |
| **Classroom response systems** | A system that can be used in a classroom to anonymously collect an answer to a question from every student. This allows rapid reliable feedback to both the instructor and the students plus individual accountability. Polling can be done through physical devices (clickers), colored cards, holding up fingers, or a web interface through students' phones or laptops (e.g., Polleverywhere™, Slido™). |
| **Collaborative writing** | Students co-create or contribute to a written document. For example, the instructor could write a question prompt or discussion topic in a document, and ask students to work together to write their ideas in response. In Google Docs™, multiple students can add text, links, graphics, equations, and comments to a word-processed document, at the same time. With Padlet™, the instructor can create the layout for an |

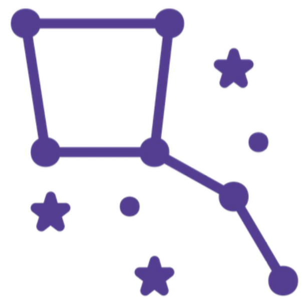
| | |
|---|---|
| | online wall; students can respond by posting notes (with text and/or media) and "liking" others' notes. |
| **Course management system (CMS)** | An online environment for course interactions such as posting material and submitting assignments. The CMS is usually provided or mandated by the university. Sometimes called a learning management system; LMS. |
| **Discussion platform** | Students discuss concepts or seek help in an online asynchronous forum. Many CMS have online forums, or consider Piazza™ and Slack™. |
| **Email** | Electronic mail. A convenient way for the instructor and students to correspond outside of class. The instructor can send class-wide email messages, and correspond with individual students. |
| **Listservs** | A platform for sending emails to a (large) group of people at the same time, often included in the CMS. |
| **Presentation software** | Software such as Powerpoint™, Keynote™ or Google Slides™, that allows the instructor to display slides with text, equations, graphics, etc. |
| **Simulations or animations** | Computer-based depictions of a physical phenomenon. Sets of online simulations include PhET Interactive Simulations, Physlets, and Open Source Physics. |
| **Social annotation software** | Group-based commented reading of a text. Students use the software to take notes, and then the instructor and other students can read and reply to their notes and comments (e.g., Google Docs™, Perusall™). |
| **Web conferencing software** | A communications platform that allows groups of users to connect with video, audio, and chat over the internet. The instructor can hold full class sessions on Zoom™ or hold office hours, one-on-one conversations, etc. |
| **Websites** | Pages on the Internet. The instructor could ask students to read or find pages about a particular topic, then write reactions or answer questions about the topic. The instructor can also point to websites as resources for more information for students. |
| **Wiki** | A wiki is a collaborative website where multiple users can add and edit information on internal pages. An instructor could create a wiki for their course, where students and instructors can post resources or ideas. |

*Credit for this material: W. McKeachie & M. Svinicki (2014).* McKeachie's Teaching Tips *(14th ed.). Wadsworth;* Clickers / personal response systems. *https://cwsei.ubc.ca/resources/instructor/prs*.

# The constellation of teaching reflection strategies

**Teaching reflection**: Considering your teaching experiences, learning from the outcome, and planning how to better approach similar situations in the future. See also the "multiple measures of teaching" handout from Day 1 of the workshop.

- Write brief memos after each class
- Take notes in lecture notes or slides
- Journal about your teaching
- Write an annual reflection in a standard template
- Use reflection prompts to guide periodic reflection
- Discuss with critical friends and colleagues
- Use paired teaching



Times to self-reflect:

- Before a class session
- After a class session
- Before a course starts
- After a course finishes
- Once/year
- At promotion and tenure review

## Reflection prompts for instructors

- How did I feel during this activity/class?
- What went well, and what didn't go well in today's activity/class? How do I know?
- How might I gather feedback from others about today's activity/class?
- How was the pace of this class?
- What felt surprising to me?
- What challenges did I face (in teaching methods, class management, etc.)?
- What aspects would I like to pay attention to next time?
- Who might be left behind as a result of each of my practices today? How can I invite those students in?
- How did I create multiple ways for students to grow and demonstrate their understanding?
- Which of the Principles of Teaching and Learning were in this lesson? Which weren't?
- What actions might I take next class? Next week? Next semester?
- What resources do I need to support those actions?

## Teaching reflection strategies (not in alphabetical order)

| | |
|---|---|
| **Write brief memos after each class** | Take ~5-10 minutes after class to write quick notes to yourself, to look at before you teach the next class or course. These can be quick thoughts of whatever comes to you, and/or responses to some of the given reflection prompts. You may want to write memos after grading assignments, writing exam questions, etc., as well. |
| **Take notes in lecture notes/slides** | A great place to keep your brief memos is in your lecture notes or the "notes" part of your slides; that way you can point to exactly which line or slide your reflection is referring to. You can note the results of student assessments (e.g., clicker questions) here too. |
| **Journal about your teaching** | You can keep a physical or electronic journal about your teaching (like your FTI teaching journal) and spend time at a specific time each week free-writing and/or responding to reflection prompts. |
| **Use reflection prompts to guide periodic reflection** | Use reflection prompts (previous page) in written reflections. Consider writing in the third person (e.g., "Jasmine's main teaching strength is ____") to achieve some emotional distance. |
| **Write an annual reflection in a standard template** | It can be valuable to use a consistent formal for an annual teaching reflection, especially if this will be submitted to administrators. UGA Project DeLTA uses the following prompts: What teaching challenge did you consider this year? What evidence did you collect to understand this challenge more deeply? What did you learn by examining this evidence? What teaching decisions will you make next year? |
| **Discuss with critical friends and colleagues** | Find a colleague or two whose opinions about teaching you value and whom you trust. Set aside time for regular discussions about your teaching and explain what you want that critical friend to do (e.g., ask questions, give advice, observe your class). |
| **Paired teaching** | Two instructors teach a semester-long course together, jointly responsible for all aspects of the course. Paired teaching can be done between a novice and an experienced instructor (to provide teaching development for the new instructor) or between two experienced teachers. |

*Credit for this material:*


- *W. McKeachie & M. Svinicki (2014).* McKeachie's Teaching Tips *(14th ed.). Wadsworth*
- *Strubbe et al. (2019). Faculty adoption of active learning strategies via paired teaching.* J. Coll. Sci. Teach., *49(1), 31.*
- *L. Strubbe (2023). Reflecting on our teaching with gratitude and compassion, Teaching Made Visible,* *https://teachingmadevisible.com/2023/06/reflecting-on-our-teaching-with-gratitude-and-compassion/*
- *University of Georgia Project DeLTA.* UGA DeLTA Guide to Self Reflection for Faculty. *https://seercenter.uga.edu/delta-project/*.

# The constellation of summative assessment techniques

**Summative assessment**: Assessment to evaluate student learning at the end of instruction. Often high-stakes.

- Exams (in class, take-home, oral)
- Final project
- Group or two-stage exams
- Homework (see "formative")
- Lab report
- Multiple-choice test
- Oral exam
- Peer assessment
- Research-based inventory
- Rubric
- Self-assessment* - also formative
- Student portfolio
- Student presentation
- Writing assignment

## Summative assessment techniques (alphabetical order)

| | |
|---|---|
| **Exams: including take-home, and oral exams** | Sets of questions that assess students' knowledge and skills, usually for summative purposes. Exams can be written, oral, open-book, closed-book, individual or group. Oral exams typically are usually in-person with the instructor asking questions in real-time. |
| **Final project** | Students explore a topic in depth and create an artifact to demonstrate their learning; for example, a paper, poster, or presentation. Often involves synthesizing multiple sources or ideas to create something new. Can be done individually or in groups. |
| **Group or two-stage exam** | Students first complete and turn in the exam individually and then, working in small groups, answer the exam questions again. This makes the exam a more valuable learning experience. |
| **Group work assessment** | While not a specific method of assessment, we list group work assessments here to highlight that it is important to assess the outcomes of group work. Individual learning from group work can be measured through individual work after the activity, such as a poll or quiz question. The group can also submit a single report or worksheet for a grade. |

| | |
|---|---|
| **Lab report** | A formal summary of a lab experiment written by a student or lab group. Lab reports often contain sections on hypotheses, background, materials, experimental procedure, results and data analysis, and conclusions. |
| **Peer assessment** | Students in the class evaluate one another's work. This might be done by randomly distributing papers or problem sets with a rubric for grading. |
| **Research-based inventory** | A standardized assessment that has been rigorously developed and tested. These assessments are intended to measure the learning of the class as a whole (rather than individual students). Inventories can measure concepts, skills, student attitudes, or beliefs. See physport.org. |
| **Rubric** | A document that identifies criteria for performance and different levels of performance or understanding within each of those criteria, usually in a grid-like structure. Rubrics of student performance outline the levels of performance criteria (from novice to advanced) for different aspects of an assignment. Can be used with student peer- or self-assessment. |
| **Self-assessment** | Students assess their own learning and performance, possibly assigning themselves a grade prior to the instructor's grade assignment. |
| **Student portfolio** | A compilation of materials to provide evidence of student achievement of course or program-level student learning outcomes. Students can often choose what goes into a portfolio to highlight their best work or how their skill development progressed. |
| **Student presentation** | Students give short presentations to their peers, on a topic of their choice or assigned by the instructor, individually or in groups. |
| **Writing assignment** | Students write an essay on a particular topic, either assigned by the instructor or chosen by the student, to synthesize and demonstrate their understanding. These are usually written individually, although students can work on papers in groups as well. Papers can be used for metacognitive reflection when paired with reflective prompts. Low-stakes writing assignments will prepare students to do well on high-stakes assignments. High-stakes writing assignments might be paired with a grading rubric. Consider "middle stakes" writing assignments that give some credit for the work but not as much as the final essay or paper. |

*Credit for this material:*


- *W. McKeachie & M. Svinicki (2014).* McKeachie's Teaching Tips *(14th ed.). Wadsworth.*
- *EP3 Initiative (2021).* Assessment Instruments *(Version 2022.1), in A Guide to Effective Practices for Physics Programs (EP3), edited by S. B. McKagan, D. A. Craig, M. Jackson, and T. Hodapp, American Physical Society.* [https://ep3guide.org](https://ep3guide.org).

# Teaching practices

These sheets compile recommendations for the Teaching Practices in the FTI into one place. See also the next section on Tipsheets for more general suggestions for instruction, assessment, and careers.

1. **LECTURE and PRESENTATION practices**
2. **READING and Just-in-Time-Teaching (JiTT) practices**
3. **HOMEWORK practices**
4. **WHOLE CLASS DISCUSSION practices**
5. **THINK-PAIR-SHARE practices**
6. **QUANTITATIVE PROBLEM SOLVING practices**
7. **SIMULATIONS AND DEMONSTRATIONS practices**
8. **ENGAGEMENT and FIRST DAY practices**
9. **FACILITATING GROUP ACTIVITIES IN CLASS practices**
10. **PLANNING GROUP ACTIVITIES practices**
11. **INCLUSIVE TEACHING practices**
12. **EXAMS and QUIZZES practices**
13. **GRADING practices**
14. **LABS AND INVESTIGATIONS practices**

This page intentionally left blank

## LECTURE and PRESENTATION practices

Presentation has its place and is a valuable tool, when done sparingly and for the right type of content. The following practices support both more effective and more inclusive presentations.

**Keep it short and pause.** Lecture no more than ~10-15 minutes, and then turn to active learning. Pause frequently to give students a chance to think about what you've presented, identify questions, take notes, or draw connections. Start a problem and pause to have them think about the next step.

**Engage students** with the content you're telling them about through strategies like choral response, individual work like quick writes, or group work like neighbor discussions or think-pair-share.

**Provide guided or skeleton notes.** These notes provide some level of organization but lack details, which students fill in, helping them to become better note-takers and consumers of information. You might start with your full lecture notes or slides, and keep things like equations or charts, and leave out detailed discussion or answers. Or simply provide headings, equations and diagrams, leaving the rest blank. Cornell Notes are another option to offer students.

**Provide slides, recordings, and screencasts** so that students can review the presentation again. When solving problems, record a separate screencast that students can re-watch and pause.

**Use supportive and encouraging language** to establish a good class climate and boost student confidence. Emphasize hard work over ability so that students develop a growth mindset. Examples[3]:

- "Everyone can learn physics. Yes, it takes hard work and practice, and you can do it!"
- "You guys came up with some really cool answers. I love the way that everybody thinks about this a little bit differently."
- "I'm more curious about your approach to how you think about [this assignment], than I am whether you get the answer right or not."
- "Be a good colleague, help other people if you can. We don't grade on the curve. There is no reason not to help anybody else."

**Additional practices:**

- **Help students structure their knowledge.** Help students develop a coherent cognitive structure or mental model of the content. An organizational chart or graphic can help with this.
- **Use universal design strategies** to ensure lecture materials are accessible to those with auditory or visual impairments. Seek out your local disability resource center for strategies.
- **Use real world examples** to connect to students goals, values, and interests, and help them see alignment between the course and their lives.

[3] *Seidel et al. (2017). Beyond the biology: A systematic investigation of noncontent instructor talk in an introductory biology course.* CBE-Life Sciences Education, *14(4).* https://www.lifescied.org/doi/10.1187/cbe.15-03-0049

## READING and JUST-IN-TIME TEACHING (JiTT) practices

Reading is an important information-delivery tool, but most students do not read text effectively, simply re-reading or highlighting text. This results in an illusion of fluency through familiarity.

**Ask students questions about what they are reading.** Students' main study strategy is re-reading a text and highlighting, but it just results in an illusion of fluency. Give them questions they can respond to, or require that they self-test with study questions in the book.

**Teach students metacognitive strategies.** Helping students learn how to learn has large paybacks, and helps them read and engage in class content more effectively. Some strategies for students' reading skills include previewing what they will read, identifying questions they want to answer, and reading and paraphrasing. Relevant links and reading in the FTI online resources.

**Use Just-in-Time Teaching (JiTT).** Also called "preflights" or "warmups," Just-in-Time Teaching gets students ready for class by requiring them to answer questions online before class. Instructors use the responses to direct their presentation and share examples of student thinking in class. Types of JiTT questions:

- Open-ended conceptual questions.
- Metacognitive reflection prompts
- Questions related to the reading (e.g., summarize, compare and contrast, sketch, define).
- Connect reading to real-world or prior experience
- Solve a problem

**Tips for effective use of JiTT:**

- Explain the purpose of JiTT on the first day.
- Use JiTT routinely, throughout the term.
- You do not need to review all student responses, just enough to get a sense of student thinking and to give credit.
- Always say something positive in response to the student work you show in class.
- Consider changing a challenging open-ended JiTT question into a multiple-choice think-pair-share question during class to provide an opportunity to solidify learning.
- Give students an incentive (e.g., participation points).
- JiTT is just as good for upper-division courses as for lower-division courses. Upper-division students can make connections to pre-requisite courses and go deeper.
- Use a variety of online sources for good example questions (e.g., PhysPort's JiTT page).

*Credit: S. Y. McGuire (2015).* Teach students how to learn: Strategies you can incorporate into any course to improve student metacognition, study skills, and motivation. *Stylus; A. Gavrin "Just in Time Teaching" workshop materials.*

## HOMEWORK practices

Homework is a useful tool for students to practice new concepts and skills and get feedback.

**Align with student learning outcomes (SLOs).** Review SLOs when creating homework to ensure that it is helping students practice critical skills, and that nothing is left out.

**Make the purpose and goals of homework explicit, possibly with TILT.** The TILT framework (https://tilthighered.com/tiltexamplesandresources) helps you be more transparent and explicit.

**Include typical test questions** on homework sets, and consider labeling them as such.

**Have students generate test questions** as a homework assignment, and use some on the test. This is a very effective study strategy for students, as well as empowering.

**Give actionable feedback.** Focus on feedback that tells them what to do (not just whether it is correct). Don't just tell them to be more strategic in problem-solving, tell them exactly how.

**Use semi-automated feedback** to reduce your feedback load. One way is with "response categories"; pre-written feedback statements are applied to student work by copy-pasting, selecting from a list in an online system, or using numeric codes to identify the category to students. Many online systems allow the option to add standard sentences to grade statements.

**Use a variety of question types and assignments** such as problem-solving, conceptual questions, sketching, essays, discussion board posts, reflective journaling, summarizing reading, etc., to get at all your SLOs. PhET and other simulations are also great starting points.

**Additional practices:**

- **Include reasoning** in problem-solving sets; ask students to explain their choice of a solution method.
- **Give examples of success criteria** such as multiple examples of good problem solutions or a discussion of the strengths and weaknesses of work of different quality.
- **Have students start a problem on homework** that you then finish in the lecture. The challenge they encounter will set them up well for learning from the expert solution method.
- **Make students identify their own errors** rather than pointing them out for them. For example, "Five of these are wrong; find them and fix them." "There are 3 mistakes in this solution, find them" and allow them to revise and resubmit. Peer review is another strategy. This helps students learn from mistakes, especially in larger classes where individual feedback may be impractical.
- **Reduce hand-grading.** See "grading practices" for tips on grading.

*Credit: K. Hogan & V. Sathy (2022).* Inclusive Teaching: Strategies for promoting equity in the classroom. *West Virginia University Press; D. Wiliam (2018).* Embedded formative assessment. *Solution Tree Press.*

# WHOLE CLASS DISCUSSION practices

Whole class discussions are an opportunity for community dialogue. Below are practices to increase the number participating, give them time to think, and make it non-threatening and inclusive.

**Ask productive questions.** Don't rely on the generic "Are there any questions?" to generate good discussion. Some possible questions include:

- How does this look to you?
- What is the next step (in this solution/derivation)?
- What is wrong with what I just did?
- Why (is/is not) ___ an example of Y?
- What is an example of ____?
- How does ___ affect ____?
- How might ___ apply to real life?
- Why ____?
- What would you do next?

**Use a silent wait time** of at least 5-10 seconds (or more) after asking a question before soliciting responses. Students can be silent during this time, or write down their own answers. This gives them time to think and helps encourage reflection.

**Wait for multiple hands** and be explicit that you will not call on anyone until you see (for example) at least 5 hands in the air because that signals that enough people have had time to think.

**Ask for specific types of volunteers** such as those who haven't spoken, those with birthdays in this month, or some other attribute, to enhance accountability but not anxiety.

**Have students discuss first** in groups or pairs before you ask them to respond.

**Hear from multiple students** before weighing in on the correctness of a response, so you can respond to the idea as a whole rather than focusing on one student's answer.

**Let students know in advance that there will be a whole class discussion on a topic.** This can help anxious students prepare, especially members of marginalized groups.

**Maybe call on students at random ("random call")** to make sharing more equitable, using popsicle sticks or an app.... But beware that random call can create anxiety for students. Explain why you are using random call, allow an individual to pass on responding, and create a welcoming atmosphere where student responses are treated with respect. The practices which follow are ways to make random call less threatening.

**Ask certain members of small groups to speak up** after a group discussion, such as a designated group reporter. Group reporters can be assigned in non-biased ways, such as those with the most/least vowels in their full name or the person who woke up earliest/latest.

**Let students respond quietly or anonymously** using colored cards, written responses on cards, or polling software. A variation is thumbs up/down: Ask students if what you have written on the board is correct, and they give a thumbs up or down.

**Follow up with specific students who are anxious or not engaging.** Ask those students: "How is this going for you? Are you able to benefit from the whole-class discussion?" and learn from their responses. Affirm their experience, whether it is positive or negative: e.g., "I hear that this is an anxious experience for you." Tell them when they are doing well. This can be especially important for members of marginalized groups who may experience imposter feelings or stereotype threats in whole class discussions.

**Thank students for their response and respond positively**. Here are some productive responses:

- "That is such a good idea. Thank you. Who has another idea?"
- "I especially love the part where you said, ____"
- "I want to understand better what you meant by ___. Can you rephrase that another way?"
- "I followed all of it until... can you explain this part again?"
- ·"I like what you did and agree with it. I thought of it somewhat differently..."
- "I understand where you are coming from, but I am getting a different result/answer. Can I share my ideas and then we can compare?"

**Additional practices:**

- **Ask students to come up with questions individually or in groups.** Ask students to write out answers to a question in advance of class, or to bring one question to class for discussion. Or during class, ask them to talk with a group to identify questions and then ask them to share any questions, or upvote questions for the instructor to answer.
- **Base discussions on a common experience.** Giving everybody a concrete, common experience such as a demonstration, film, or reading can be a great way to start a discussion (whole class, or between students. Then ask a question that builds on that experience (e.g., "What are the implications of what we just saw?")
- **Extend the discussion ("Stretch it.")** Avoid the rapid reward, where the discussion ends with the student stating the right answer. Follow up on the correct answer with further questioning to confirm their understanding and extend the class' mastery. Questions that "stretch it" include asking how or why, for another way of getting the same result, using a different word, evidence for their answer, or applying to a new situation.

*Credit: K. Hogan & V. Sathy (2022).* Inclusive Teaching: Strategies for promoting equity in the classroom. *West Virginia University Press; D. Wiliam (2018).* Embedded formative assessment. *Solution Tree Press.*

## THINK-PAIR-SHARE (TPS) practices

These practices can be used with think-pair-share (TPS), where students think on their own, pair to talk to a neighbor, and share with the whole class. Some practices are specific to TPS with polling.

**Explain to students why you are using think-pair-share.** Explain that the point is to help them learn by reasoning and discussion. Otherwise, they may assume that the goal is to test or track them.

**Offer credit for participation.** This may be based on observations of student behavior, and/or points through electronic clickers (e.g., 1 point for answering, extra credit for the correct answer).

**Use a variety of questions, including conceptual questions.** Many existing TPS questions focus on conceptual understanding, which is useful for student learning. You can also use TPS questions for surveys, interpreting graphs, learning reflections, predicting outcomes of demonstrations, or breaking down a problem into parts. See the TPS session handout for more and for examples.

**Use a mix of simple and complex questions.** Use a range of simple and complex questions to help students build confidence, and also engage with difficult ideas. Many people use questions that are too simple. If a student can answer the question on their own, then it's not a TPS question.

**Give students time to think about their answers on their own.** Let students read through the question and reason about it to arrive at their own answer; this avoids privileging students who are faster readers or thinkers. Ensure you give them enough time to do this by reading the question and answering it on your own. Then ask, "Does anyone need more time?" (*not* "Is everybody ready?")

**Have students vote anonymously** *(for TPS with polling).* If you are using ABCD voting cards, have students vote on the count of 3, and hold cards against their chest so other students can't see their votes. They can use the back side of the sheet for "none of the above" and all four colored squares for "I don't know." With electronic polling, do not show students the results of this initial vote.

**Decide whether to have students turn to their neighbors** *(for TPS with polling).* A common rule of thumb is that students may not need to discuss their answers if 80% or more vote correctly.

**Circulate and listen in while students discuss.** This is very valuable and lets you listen to their reasoning, and identify some ideas that can be brought out in the large group discussion.

**Have a signal for ending small group discussion** E.g., a bell, raising your hand, or telling "time!". Give them a 10-second warning. Then *(for TPS with polling)*, have them re-vote.

**Wait to reveal the answer.** If you reveal the correct answer as soon as students are done voting, it can short-circuit students' engagement and thinking and convey that the right answer is the only thing that matters. Hear reasons for all answer choices before confirming the correct answer.

**Hold an interactive debrief, discussing the reasoning behind right and wrong answers.**
Whether you have students discuss with one another or not, the debrief should always include a discussion of what the correct answer is, and why the incorrect answers are not correct. If no students volunteer to explain a particular answer, you might suggest some reasons. *Note: If students have not yet converged on the correct answer, there may be something confusing about the question.*

**Tips for writing TPS polling questions:**

- **Use existing questions.** See lists of question banks at https://cwsei.ubc.ca/resources/instructor/prs or in *Peer Instruction* (Mazur 1991).
- **Draw from your students for answer sources.** Some good sources of TPS questions are the questions students ask you, or common analogies you have found that help students.
- **Don't make them too easy.** This is a common mistake and misleads students as to your expectations. Use questions that emphasize reasoning and challenge student thinking.
- **Include tempting distractors.** Use distractors (the incorrect answer choices) that represent likely student answers or difficulties, so that students will actually vote for them. A good technique is to use students' wrong answers to open-ended questions as your distractors.
- **Get feedback from colleagues.** Or just try the question with students and revise next time.
- **Write or find questions that target student difficulties.** Identify an area that students struggle with, and use a question to help them wrestle with the idea. The best questions are those which only 30-70% of students answer correctly before discussion. Online sources have great questions you can use; past exams and homework are also good sources.

**Additional practices:**

- **Use questions to set up instruction, not just assess learning.** While TPS is great as an exit poll and to keep students on target, it can also be used to assess prior knowledge, provoke thinking, and elicit misconceptions. You can use TPS questions to lead into lectures too: Asking students to predict the outcome of a surprising demonstration can then create a "time for telling."
- **Just show students the question without a lengthy introduction.** Give students a prompt such as "I've got a question for you." Don't go into a lengthy introduction of the question, and avoid reading the question out loud. This allows students time to read and interpret the question.
- **Tell students to discuss with a phrase that tells them what you want them to do.** Some good phrases are "Turn to your neighbor and convince them you're right. Just because you both have the same answer does not mean that you're both correct. So make sure you explain your reasoning. You've got about a minute. Go!"

*Credit: G. Brissenden & E. Prather (2015).* Think-Pair-Share: A revised "How to" guide. *https://www.as.arizona.edu/cae/download/workshopfiles/Think-Pair-ShareHow-ToGuide.pdf; D. Duncan (2008).* Tips for successful 'clicker' use, https://bit.ly/3C4yVnH . *D. Bruff (2009).* Teaching with classroom response systems. *Jossey-Bass.*

## QUANTITATIVE PROBLEM-SOLVING practices

**Normalize the use of group work for problem-solving**, making it a regular part of your in-class instruction, so that students get used to supporting each other and articulating their ideas about how to solve problems.

**Emphasize that solving problems in groups helps students** — this helps them successfully solve problems that they might otherwise struggle to do on their own, boosting students' confidence and skills simultaneously.

**Have students work at the board** (or whiteboard) when possible so every group member can see and contribute, and you can see their progress. It also normalizes brainstorming, making mistakes, and trying again.

**Model good problem-solving.** When you solve problems in a lecture, be explicit about which strategies you are using. Demonstrate and normalize trying multiple approaches and representations. It can be helpful to show how some approaches may not lead to a solution and that making and detecting mistakes is a normal part of problem-solving.

**Scaffold problem-solving**. Break problems into "steps" that each correspond to a decision students must make while working toward a solution — such as sketching the situation or selecting an equation to use. Each decision highlights a particular conceptual, reasoning, or mathematical difficulty students commonly experience. It's best if this is done as a class activity, engaging students in discussion at each step and providing meaningful feedback on their progress.

**Reward problem-solving on homework and exams.** Give credit for a good problem-solving process even if a student doesn't get the "right" answer. Don't give credit if students give only their answers without explaining how they got there.

**Additional practices:**

- **Ask students to reflect on their problem-solving process**. To encourage reflection, ask students to write a narrative, indicating any strategies that they used, on submitted coursework. Students can also explain their process to another group.
- **Choose problems that have real-life contexts and applications.** This boosts students' interests, motivation, and perception of the relevance of physics.
- **Invite students to write their own problems.** This inspires students' curiosity, creativity, and engagement with the discipline of physics at a deep level.

*Credit: L. Strubbe (2018).* Problem-solving strategies for estimation in physics and astronomy. https://sites.google.com/site/lestrubbe/workshops-resources/problem-solving-strategies.

# SIMULATIONS AND DEMONSTRATIONS practices

These can allow students to observe real or virtual experiments of physical phenomena.

**Build on students' prior knowledge, and connect to the real world.** Elicit student ideas about a topic, and then use the demonstration or simulation to test their ideas. For example, before a simulation or demonstration on buoyancy, ask "What do you think affects whether something floats? Do you think it matters what liquid we place the object into?"

**Ask students to predict what will happen** before doing a demonstration or showing a simulation; for example, what will happen when a variable or parameter is changed, or what a graph might look like. Predictions can be multiple-choice or open-ended.

**Make it interactive with think-pair-share or Interactive Lecture Demonstrations.** You can ask students to make predictions in multiple steps: Ask students to make an individual prediction, then discuss the physical reasoning for their predictions in their group and update their predictions, and then ask for a few volunteers to do so for the whole class. Even when students agree on the predicted outcome, they may have differing reasons. You might collect predictions at each step through polling. See also *Interactive Lecture Demonstration (ILD)* on PhysPort.org.

**Conduct the experiment or simulation, and discuss comparisons to the predictions.** It can be a joyful, exciting moment when students see the result of a demonstration they've thought carefully about. Follow up with a whole-class discussion about the results.

**Additional practices for simulations:**

- **Create think-pair-share polling questions to support student learning.**
    - *Use images from the simulation.* Use images from the simulation in the question or answer choices to make use of the visual model that students are already familiar with.
    - *Use the simulation to verify the answer.* Rather than telling students the answer to the question, show them the answer – by closing the switch, displaying the graph, etc.
- **Stretch-it questioning.** You can use the simulation to generate further open-ended questioning and deeper learning. What will happen if I add a second bulb to the circuit? If I move the zero volts line?
- **Use simulations with activities and homework**. You can use simulations with lab, in-class, or homework activities. When doing these, it's best to start with open-exploration time, and use challenge prompts instead of explicit detailed instructions. For example:
    - What's the biggest... *orbit you can make?*
    - List all the essential items to...*make a circuit.*
    - What are two ways to...*increase the kinetic energy of the skater?*

*Credit: S. Chasteen and Y-y. Carpenter (2016).* PhET Interactive Simulations expert recommendations. https://www.physport.org/recommendations/Search.cfm?T=PhET%20Interactive%20Simulations.

# FACILITATING GROUP ACTIVITIES practices

## Introducing group activities

**Explain why you are asking students to work in groups**. For example, explain that it helps students learn content and collaboration skills through discussion.

**Give clear instructions and expectations for small group activities** to avoid confusion and communicate expectations about timing and participation. For example, how many people should work together, how long it will take, and what kinds of conversations you expect to happen. Hold a class-wide discussion about discussion norms for productive group work before group work starts.

**Have students introduce themselves.** Students work best together if they know or trust each other. Have students introduce themselves to their group members before attending to their tasks. For teams that will work together for a longer period of time, consider an icebreaker or an activity designed specifically to build a sense of teamwork.

## During group activities

**Circulate and listen quietly.** This is your golden opportunity to learn what your students do and don't understand, and what they need to do to learn what you've set out for them! Use the time well by eavesdropping - truly, there is nothing more precious to you than this. As you listen in, you may be tempted to jump in and help. WAIT. Give them a bit to figure things out, and give yourself time to figure out what they are thinking. It's usually okay if they are off track for a little bit - aren't we all?? Let it unfold. Also listen for trends that are emerging from the discussions, so that you can refer to them during the subsequent plenary discussion.

**Be slow to share what you know.** If you come upon a group that is experiencing uncertainty or disagreement, avoid the natural tendency to give the answers or resolve the disagreement. If necessary, clarify your instructions, but let students struggle — within reason — to accomplish the task.

**Nudge strategically – and leave.** If you do decide on a well-placed nudge, try to make just one brief suggestion or ask one juicy question, and leave within one minute. Ideally, this helps students understand that they are responsible for their own learning during this time, and helps you distribute your attention among the many groups in your class. Avoid interfering with group functioning — allow time for students to solve their own problems before getting involved.

**Monitor students' progress.** In addition to circulating, you can do occasional polling on key questions, glance at their worksheets, and ask students to indicate where they are in their progress through the activity.

**Coach students in expressing ideas.** Monitor student discussions so you can coach students in expressing their ideas. If you notice a student who did a particularly good job of planning a project, assign him the role of leading his group during the next planning phase of the project. Have the whole class brainstorm ideas, as you write them on the board, along with the pros and cons of each idea. Then, you can coach the class through deciding among the ideas as a group.

**Help groups collaborate effectively.** Students are likely to need some help in working together well. Use icebreakers and team-building exercises. Give explicit instruction on teamwork (e.g., "Listen to each other's ideas as well as sharing your own and try to reach consensus") and coach/model your instructions during collaboration.

## After group activities

**Provide closure through a whole-class discussion.** You can end with a "plenary" session in which students do group reporting. If you notice a group that did a particularly good job on a group task, call on them to share their thinking with the class.

**Solicit feedback from students on group activities.** Give students a way to give you feedback about how the group activities are going, and invite students to come to you if they are having problems. Listen carefully and take action if appropriate (with student permission).

**Ask students to reflect on their group work experience.** This reflection helps them identify what they learned and improve group function. For example, have students write down answers to questions such as "How are we doing as a group? What is working well? What is something we may need to change?" This can be done as an exit activity, essay, or survey. know that their contributions can be identified. You might also have students evaluate their group members' collaboration, to help the instructor identify problems.

**Additional practices:**

- **Express your confidence in students.** Assume that they do know, and can do, a great deal. Express your confidence in them as you circulate the room.
- **On longer group projects, scaffold time management.** Give dedicated time for students to exchange contact information, choose a time and place to meet outside of class, and how they will communicate. Assign intermediate goals and milestones.

*Credit: S. Chasteen (2017).* How can I help students work well in small groups, so they are more likely to engage? [https://www.physport.org/recommendations/Entry.cfm?ID=101224](https://www.physport.org/recommendations/Entry.cfm?ID=101224)

## PLANNING GROUP ACTIVITIES practices

The structure and quality of group tasks matters. Group structures and tasks should lead students to participate equitably and productively and connect with students' interests and the course SLOs.

### Group structure and process

**Use groups of 3-6 people.** Groups should be fewer than 8 people, and the best group size is 3-6. If the group is too small, there won't be enough diversity of student perspectives. If the group is too large, it will take longer to manage diverse tasks and it's harder for students to participate equally.

**Decide whether students should choose their groups.** Consider whether students should choose their groups or the instructor will create them; there are pros and cons for both. Student choice is easy but students can get left out. Random assignments can support equity and help students make connections but can be socially taxing. You might allow students to choose their own groups at the start, and then reassign them later (Rachel's way). Pay attention to equity in group composition: avoid having a single member of an underrepresented group.

**Decide whether students should change groups frequently.** Consider whether groups should be one-off or long-term; there are pros and cons to both. Long-term groups may be better for students learning to work together well, perhaps changing once or twice during the term.

**Decide whether to assign group roles.** Again, there are pros and cons to assigning roles. Roles can help students know what to do and promote equity. However, they can be difficult to enforce and feel overly managed. You might assign roles in some cases (like labs) but not others (like short think-pair-share discussions). Common roles are facilitator, scribe, reporter, data manager, materials manager, time manager, coach, encourager, question monitor, etc. Ensure that students rotate roles.

**Allow sufficient time for group work.** You won't be able to cover as much material as you could if you lectured for the whole class period. Cut back on the content you want to present in order to give groups time to work.

**Hold both groups and individuals accountable through assessment.** Reward both individual and group outcomes. Rewards might include polls or quizzes (where members must respond to a physics question they worked on in a group), shared grades (final individual grades rely on team member scores), certificates of recognition (for teams with average scores on quizzes meet a benchmark), two-stage exams (where students complete the exam individually and then collectively), group assignments (where the group turns in a single assignment for a common grade), and group self-assessments (where members rate their group's process and outcomes).

## Group tasks

**Use group activities for the most challenging student learning outcomes.** Group activities take time; use them for the aspects that are most challenging for students.

**Design group activities that students can't do on their own.** Make the task stimulating and challenging with ill-structured problems or high-complexity tasks, where students will benefit from collaboration. Tasks that involve recall, definitions, or looking up information shouldn't be group tasks. Resources on PhysPort at "Where can I find good activities for small group discussions?"

**Increase the complexity of group activities over the semester** (scaffolding). You might give relatively easy tasks early in the term, with a clear structure, to encourage their progress and help them develop good working habits. Then "fade" that structure over the term.

**Use multiple forms of collaborative work throughout the term.** The *Universe of student-centered instructional techniques* handout provides a range of options. A diversity of learning activities maintains student interest and helps students with various skill sets engage and succeed.

**Consider scaffolding student work with tables.** Tables in a worksheet help focus students without needing many directions or overwhelming students with detail. Plus, it is easy for facilitating instructors or TAs to see student progress at a glance. Use minimal wording and lots of space.

**Additional practices:**

- **Create or secure a physical space that facilitates group work** if you can, such as round tables, rather than rows of seats, with a space where all can see and contribute to common writing on a worksheet or whiteboard, while addressing accessibility needs.
- **Find other ways for students to participate.** Some students may have social anxiety or may be neurodivergent in ways that make group work additionally challenging. You may decide not to require every student to participate in group work, and find ways for students to learn similar content and skills on their own.
- **Give students some freedom and choice** over how they engage in the work and the outcomes of the group activity. People are more interested in a task when they feel they have some level of control. That control could be related to how students will accomplish something, or which topic they choose to explore. You might choose tasks with multiple pathways to the solution.

*Credit: S. Chasteen (2017).* How can I help students work well in small groups, so they are more likely to engage? https://www.physport.org/recommendations/Entry.cfm?ID=101224; Group Work teaching guides, *CBE-Life Sciences Education*, https://lse.ascb.org/evidence-based-teaching-guides/group-work/; Guide to Group Work, https://www.student.unsw.edu.au/groupwork. Implementing group work in the classroom, https://uwaterloo.ca/centre-for-teaching-excellence/catalogs/tip-sheets/implementing-group-work-classroom; *L. E. Gin et al. (2020). Is active learning accessible? Exploring the process of providing accommodations to students with disabilities.* CBE-Life Sciences Education, *19(4)*.

# ENGAGEMENT and FIRST DAY practices

Setting the stage for student engagement occurs at many levels in the class, including what you say and do in class and the way you set up grading and assessment structures. *There are many more examples of how to accomplish the following things in the articles in PhysPort, "How can I set clear expectations and motivate students...?" and "What are some strategies for the first day of class...?"*

## First day

**Set the right tone from the start** from the initial email, to generate enthusiasm and establish rapport. Establish yourself as a caring and fair person.

**Share a little bit about yourself** on the first day and throughout so that students can connect to you as a person; invite them to share their stories with you. Share your pronouns and how to pronounce your name.

**Do an icebreaker** on the first day so students get to know each other and establish a community.

**Explain your pedagogical choices** to let students know why you're using the approaches you are using, see the value in them, and develop trust. For example, explain that you'll ask students to work in groups because we learn more when we talk to other people about our ideas, or reflect with students about the shortcomings of traditional lecture approaches.

**Jump into activities from day 1** to set the tone for the course early, and give students a chance to reflect on how a collaborative approach helps their learning. Icebreakers can be useful for this too.

**Learn some students' names** so that students feel you are an ally. Table tents or index cards can be useful strategies; these can include names and pronouns. When a student asks a question, ask for their name. Call on students by name and ask them if you have pronounced it correctly. Remember, you only need to know a few names for students to perceive that you know their own name!

**Discuss the course goals and approach.** How is the course relevant to students' lives or careers? Perhaps ask them to write a one-minute paper ("What is mechanics? Why study it?") What are the course outcomes? Make the relevance and excitement of the course come through.

**Explain how to be successful** by discussing effective learning strategies, and sharing advice from past students. Make it clear that physics and astronomy are hard, and it is expected that all students will be challenged at some point – active learning and other engagement opportunities are valuable for all.

## Throughout the term…

**<u>Use warm verbal and non-verbal cues</u>** to establish mutual respect and connection with your students. Smile, don't rush, listen to students, encourage them, and praise their insights. Set high expectations but use praise generously while the culture is being established.

**<u>Share your student learning outcomes</u>** so that students understand what is expected of them, reducing anxiety. Make it clear how these relate to students' lives and career interests.

**<u>Let students choose topics or assignments</u>** so that students feel ownership over their own learning. Be flexible and give students choice where possible.

**<u>Have students reflect on their own learning</u>** and then tie their reflections back to the strategies you are using in the course to help them learn.

**<u>Actively facilitate activities</u>** so that you can coach students as they work together, and provide feedback or guidance. Circulate and approach students to hear their thinking or help them out.

**<u>Don't rush students through active learning.</u>** This sends the message that you don't actually value active learning and doesn't give them adequate time to benefit from it.

**<u>Use frequent formative assessments</u>** so that students can monitor their learning, encouraging them to take advantage of the active engagement opportunities to improve their performance.

**<u>Use assessment practices that reward engagement and participation</u>** such as points for participation, peer ratings of group effort, achievement awards for group work, and group exams.

**<u>Listen to student feedback</u>** so that students feel you are on their side. Solicit feedback, and acknowledge and respond to suggestions or questions. Mid-term surveys are one way to do this.

**<u>Additional practices:</u>**

- **Use supportive whole-class discussion practices;** see *Whole Class Discussion Practices.*
- **Establish a routine** so that students know what is expected of them and feel more comfortable.
- **Keep your cool and listen if students have trouble.** You might face students who argue, are unprepared, dominate discussions, or are discouraged. Rather than reacting, listen to students and try to understand their perspectives. You don't have to respond immediately. For students who need emotional support, listen and then refer them to the appropriate campus resource.

*Credit: S. Chasteen (2023).* How can I set clear expectations and motivate students, so that they engage in active learning? https://www.physport.org/recommendations/Entry.cfm?ID=101200; *S. Chasteen (2023).* What are some strategies for the first day of class, to set the stage for student engagement? https://www.physport.org/recommendations/Entry.cfm?ID=101223

## INCLUSIVE TEACHING practices

**Use students' names** by learning names or using a class roster so that students feel like they belong and are cared for. Consider sharing your pronouns, and inviting students to share theirs. Ask if you have pronounced their name correctly, and tell them how to pronounce yours.

**Create ground rules** such as sharing discussion time and engaging in respectful discourse. Revisit these over the semester. The STEP UP Guidelines poster is a valuable resource.

**Cultivate a positive tone** in syllabi, emails, assignments, feedback, and lecture. The way you communicate with students has a large impact on their feeling of inclusion and comfort.

**Connect with your students.** Chat with them before or after class, use icebreakers, and encourage students to come to office hours ("free help sessions!").

**Use Universal Design for Learning,** such as multiple representations of the material, clear organization of the content, and digital accessibility options. Connect with the campus Accessibility Office or visit http://udloncampus.cast.org/home.

**Explicitly say that all students can succeed in your class.** Let them know "you all belong here," that you believe all students can succeed, and you are committed to helping them succeed.

**Explicitly indicate that you promote equity and inclusion in the class.** Tell students you care about equity and inclusion and let them know what you are doing to help all students succeed. The Underrepresentation Curriculum Project and STEP-UP projects have relevant materials.

**Use diverse examples of scientists,** who have contributed to our knowledge of physics and astronomy, including highlighting those from marginalized identities. The Underrepresentation Curriculum Project and STEP-UP projects have relevant materials.

**Give assurance along with criticism.** Hold all students to high standards, but to mitigate challenges faced by students with historically marginalized identities, tell why you're giving that feedback and that you have faith in them. For example, "I see you've taken this task seriously, so I'm going to honor your effort by giving some comments to help you improve. Remember, I wouldn't go to the trouble of giving you this feedback if I didn't think you were capable."

**Connect students to one another.** Group work creates student networks and knowing, increasing both belonging and peer support. On the first day you might ask students to exchange contact information with students sitting near them.

**Additional practices:**

- **Consider a "belonging intervention."** A short in-class task (like essay writing) can have an outsized impact on students' sense of belonging. Many such interventions are available online.
- **Discuss your own journey.** You can share setbacks and challenges that you overcame in your own work to show that success doesn't always come easily. Note however that vulnerability can backfire for women and minoritized faculty who must work harder than their counterparts to demonstrate credibility.
- **Give students choice in assignments.** This gives them the chance to show what they know in a way that works best for them. For example, they might choose the topic or format of a paper.
- **Use other productive classroom practices from the FTI** such as frequent formative feedback, equitable grading strategies, supportive whole-class discussion, positive first-day practices, and opportunities for students to give you anonymous feedback. These effective strategies are all also aligned with inclusive teaching.

*Credit: K. Hogan & V. Sathy (2022).* Inclusive Teaching: Strategies for promoting equity in the classroom. *West Virginia University Press; M. Lovett, M. Bridges, M. DiPietro, S. Ambrose & M. Norman (2023).* How Learning Works: 8 Research-Based Principles for Smart Teaching *(2nd ed.). Jossey-Bass.*

## EXAMS and QUIZZES practices

Below are practices for using exams and quizzes in ways that will assess what you value in student learning while being compassionate, clear, and fair. Practices for GRADING are on the next sheet.

**Align with student learning outcomes (SLOs) and homework.** Review SLOs when creating quizzes and exams to ensure that exams are targeting what you value. Make sure the homework questions are similar to exam questions so that students are prepared to do well and feel the exam is fair. Typical test questions can be valuable to include on homework.

**Don't make it too long.** Make sure the slowest student will have time to finish. Some instructors make exams take-home to eliminate the time limits. If it is in class, one rule of thumb is one minute per multiple-choice item, two minutes per short answer, and 15-30 minutes for a problem or essay.

**Do your exam yourself, and show it to a colleague** to make sure it's clear, reasonable, and readable. Review for jargon, ensure sentences are short, use clear prompts, and highlight key parts in bold.

**Tell students the content and format of exam questions** in advance so that they can prepare well and reduce anxiety. Provide old exams and (possibly) practice exams.

**Consider alternative forms of summative assessment.** While exams and quizzes are common mainstays of summative assessment, review the "universe of summative assessments" for more creative approaches such as projects and presentations.

**Consider two-stage or group exams** where students complete the exam individually, and then again in a group. The group score adds incrementally to their individual score, providing an incentive to work productively. This technique provides built-in accountability and learning from the exam results. Many sources online describe this in detail.

**Use a mix of questions.** Different questions will assess different learning outcomes, such as conceptual understanding, problem-solving, or other skills. Make sure the exam is testing what you want them to know. Higher-level learning outcomes will require some essay questions or problem-solving, which will take more time to grade. Some common exam question types:

- Problems
- Short answer
- Essays
- True false (paired with explanation)
- Multiple choice
- Matching
- Sketching
- Graphing

Most physics exams include some problem-solving. Since these can be time-consuming to complete and to grade, consider having students set up the problem but not complete it. Good multiple-choice questions are hard to write; review online sources on how to write good questions.

**Debrief with students after the exam** so that they understand how their performance relates to that of other students and make sure that a low score on the exam does not discourage certain people (especially from historically marginalized groups). This is also a time to transparently share any mistakes you made in designing the exam and how you will manage that error.

**Give students some feedback, including encouragement.** Giving students feedback is important, but that feedback should be actionable and brief (see "homework practices"), especially since students will pay less attention to that feedback when it is accompanied by a grade. The most important thing to do on the quiz or exam is to add the personal touch of encouragement or praise since this is often one of the few times an instructor has the opportunity to add a personal touch.

**Have students complete an "exam wrapper,"** as an assignment after the exam. An exam wrapper asks students to reflect on their performance on the exam, possibly identify where their solution went wrong, and identify changes they might make to their study strategy in the future. There are many examples online.

**Additional practices:**

- **Post solutions.** Post solutions and hold students accountable for reviewing where their work did or didn't follow the solution, and allow them to submit a revision.
- **Make notes for yourself** in your teaching journal or other reflective notes so you improve your exams over time.

*Credit: W. McKeachie & M. Svinicki (2014).* McKeachie's Teaching Tips *(14th ed.). Wadsworth; R. Felder & R. Brent (2016).* Teaching and learning STEM. *Jossey-Bass.*

## GRADING practices

Below are practices for grading policies that hold students to high standards while helping all students succeed. Note that many of these have the additional benefit of reducing students' stress and desperation, thus reducing cheating.

**Use frequent low-stakes quizzes, not small N high-stakes exams.** Don't rely on just a few exams to determine a grade; high-stakes exams disadvantage students. Instead, multiple quizzes (e.g., weekly or biweekly) ensure students put in consistent effort and give them low-consequences chances to practice before demonstrating their final level of mastery. Increasing the frequency of assessments automatically reduces the stakes for each one. Fewer high-stakes exams also puts heavy pressure on students which can increase the temptation to cheat.

**Use 3-2-1 or another coarse-grain grading scheme.** When your grading scheme is too fine-grained (e.g. one point for each part of a problem), it takes you longer and provides less useful feedback for students. On homework and quizzes especially, consider a 0-1-2 scale (0 = does not meet the standard, 1 = meets the standard, 2 = exceeds the standard). Another approach is "meets standard" and "not yet."

**Allow students to revise and resubmit.** Especially on homework or formative assessments, this "mastery approach" allows students to continue to improve their work until they meet the desired standard. This will set them up well for success on exams and hold them accountable for paying attention to corrective feedback.

**Allow "oops" tokens** for late work or to redo an assignment. For example, each student might be given 3 "oops'' tokens to use during the term. Importantly, students do not need to disclose the reason behind their use of the "oops" token, allowing them privacy.

**Use a regrade form** for students to request a re-grading of a high-stakes assessment. A re-grade sheet gives a standardized way for students to make this request for you to manage on your own time (not in office hours). Examples are online, and the Gradescope site also includes such options.

**Additional practices:**

- **Use minimum grading scales** to avoid overly penalizing low scores. In a "minimum grading scale" the instructor does not give percentage grades that are below 50%. Any grade below 65% is still considered a failing grade, but by capping the minimum grade at 50%, students are more likely to be able to recover from a single very low score in the term. Poor performance on exams (including leaving blanks) are affected by individual characteristics such as race, gender, and first-generation college student status; thus minimum grading scales are more equitable.

- **Review troublesome items.** When grading an exam, do a quick look to see what percentage of students missed each item and if there was a consistent reason for a large fraction of the class missing an item. Then adjust the score for any poorly worded questions and let students know that this was done. This establishes greater trust between instructor and student.
- **Use rubrics to reduce grading bias**. A rubric identifies different levels of performance criteria. A rubric can be useful for grading problems, essays, projects, presentations, or other types of open-ended work. These can be useful to provide to students in advance, but research suggests it's most useful to show the top (exemplary) level of the rubric.
- **Use comments or comment codes**. Write feedback on papers or problem sets as possible. You might develop a code for common comments to save writing them down.
- **Communicate clearly about success criteria** by outlining what the criteria are, giving multiple examples of exemplary work, and spending class time discussing pieces of work that do and don't meet those standards. Again, showing the top level of the rubric can be beneficial.
- **Avoid grading homework by hand.** Use other mechanisms to give students feedback on their work such as posting solutions, allowing students to revise and resubmit, having students review one another's work (peer review), or auto-grading. Research shows that students ignore written feedback when it's accompanied by a grade. If you are writing feedback for students, consider not assigning a letter grade on that assignment.

*Credit: W. McKeachie & M. Svinicki (2014).* McKeachie's Teaching Tips *(14th ed.). Wadsworth; K. Hogan & V. Sathy (2022).* Inclusive Teaching: Strategies for promoting equity in the classroom. *West Virginia University Press. C. Paul & D. J. Webb (2022). Percent grade scale amplifies racial or ethnic inequities in introductory physics.* Phys. Rev. Phys. Educ. Res.*, 18, 020103.*

## LABS AND INVESTIGATIONS practices

**Focus student learning outcomes (SLOs) on process and practice** such as scientific practices and collaboration, rather than content: e.g., "select the appropriate analysis method." Allow more time to achieve these goals; stretch a single lab over multiple weeks.

**Let students make decisions** to achieve those process goals. For example, Let students make choices such as what equipment to test. Turn statements into questions such as, "How could you improve your measurements?" instead of "list your sources of error."

**Have students reflect on their results and use them for improvement** such as, "What did or didn't go as expected? How did you respond? How would you improve the experiment next time?"

**Make space for students to ask their own research questions.** This supports students' investigative skills; e.g., have students brainstorm questions after their first explorations.

**Build real-world connections.** For example, indicate that these methods are used to measure climate change. Or ask them to test different stretchy objects at home (instead of providing a spring).

**Support positive group dynamics.** Remind students to share equipment; encourage and ask questions to students who are participating less. You might use early team-building exercises, assign rotating lab roles to students (e.g., experimenter, writer, reviewer), have group and team self-evaluations, and require students to document group contributions in the lab notebook.

**Build in more structure early.** As the term continues, reduce the structure (fade scaffolding), to support students in developing autonomy. For example, in early labs, you might suggest the analysis methods that they use, and in later labs let them design their own plans.

**Additional practices:**

- **Build in accessibility.** Make sure labs work for students with a variety of accessibility needs.
- **Listen to student group conversations as they work** to understand their level of understanding, without interrupting their own learning process. After a while, ask open-ended questions.
- **Give opportunities for students to communicate their findings** in multiple ways; e.g., discussions, posters, presentations, end-of-lab mini-conference.
- **Reconsider lab reports.** Traditional lab reports may not achieve your goals. Options include writing a section of the report, allowing rewrites, doing peer review of lab reports, or using lab notebooks.

*Credit: Kozminski et al. (2014).* AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum*; N. G. Holmes & H. J. Lewandowski (2020). Investigating the landscape of physics laboratory instruction across North America.* Phys. Rev. Phys. Educ. Res.*, 16, 020162; E. M. Smith & N. G. Holmes (2021). Best practice for instructional labs.* Nature Physics*, 17, 662; N. G. Holmes workshop slides (personal communication).*

# Tipsheets

Starting your career

Teaching large classes

Inclusive teaching

Boosting student motivation and learning

Assessing students

Course or class design

This page intentionally left blank

## Tipsheet : Starting your career

☑ **1 Identify your evaluation criteria**
so that you can align your effort and collect appropriate data to support career success.
*Am I doing more than 10% service?*

☑ **2 Develop a plan**
of targets and goals to define your aspirations and support strategic efforts. Keep a list of future work ideas.
*I plan to submit 5 proposals & serve on a panel*

☑ **3 Learn about your department culture**
to navigate decisions about teaching and service.
*Are other instructors using active learning?*

☑ **4 Find a trusted colleague or two**
to serve as a mentor, help you navigate requests, and understand the department culture.
*What do you think about X committee – is it worth my time?*

☑ **5 Regularly decline requests**
especially to serve on committees, to protect your time and focus on things that are important to you.
*"Thank you for asking, but I have too many other commitments right now"*

☑ **6 Schedule regular writing sessions**
to maintain publication productivity (if applicable).
*I write from 1-2 pm every Monday & Thursday.*

☑ **7 Track your time**
to see if your time is being spent wisely.
*I spent 5 hours grading this week.*

☑ **8 Spend 2 hours/week with colleagues**
to integrate into the department, build a network of support, cultivate allies, and get advice.
*"Dr. ___, do you want to go out for coffee Monday?"*

☑ **9 Manage distractions and urgent items**
by allocating time to urgent items and reducing interruptions when needed.
*I spend 1 hour every morning with my door and email closed*

☑ **10 Set aside time for self-care**
to allow for activities that fill you up. Protect that time by making it a regular event in your calendar.
*On Tuesdays and Fridays at 3 pm, I meditate.*

*Credit: R. Boice (1991). Quick Starters: New faculty who succeed.* New Directions for Teaching and Learning*, 48, 111; R. Boice (2000).* Advice for new faculty members: Nihil Nimus*, Allyn and Bacon; R. Reis (1997).* Tomorrow's Professor: Preparing for academic careers in science and engineering. *IEEE Press.*

## Tipsheet : Inclusive teaching

See also the "inclusive teaching practices" sheet for specific practices.

- ☑ **1 Reflect on your own identity** and positionality, and how this might impact your teaching. Educate yourself about other identities. — *I identify as ___.*

- ☑ **2 Make expectations explicit** so that all students know how to succeed, including SLOs, grading criteria, and expectations for participation. — *"Here is an example of an exemplary student paper."*

- ☑ **3 Help students feel they belong** so they feel that they "fit in" to the class or discipline. — *"You all belong here."*

- ☑ **4 Encourage active participation** to ensure all students have an opportunity to engage, even if they need additional time or are shy. — *"I'm going to wait until I have at least three hands."*

- ☑ **5 Create group activities** to give them time to process and practice in a supportive environment (especially before whole-class discussion.) — *"Discuss in your group for 5 minutes."*

- ☑ **6 Embrace structure** Don't assume your students know how to succeed in your course; be transparent to mitigate unfairness and ensure all students can engage and are accountable. — *"If you have something to share, please raise your hand."*

- ☑ **7 Support a positive class climate** to create a conducive learning environment. Explicitly welcome varied perspectives and address problems. — *"All ideas shared in class will be treated respectfully."*

- ☑ **8 Take an asset-based approach to students** by remembering that individual differences are important and helpful. Assume all students are capable. — *"That is a great way to look at it."*

- ☑ **9 Review your pedagogical choices for impact** on students. Are you assuming a certain background or context with your examples or assignments? — *"Who is being left behind? How can I invite them in?"*

Credit: *K. Hogan & V. Sathy (2022).* Inclusive Teaching: Strategies for promoting equity in the classroom. *West Virginia University Press; K. D. Tanner (2013). Structure Matters: Twenty-one teaching strategies to promote student engagement and cultivate classroom equity.* CBE-Life Sciences Education*, 12, 322.*

## Tipsheet : Boosting student motivation and learning

☑ **1 Enhance student autonomy**

- Allow students to choose paper, project, or discussion topics
- Do a weekly goal-setting exercise with your students
- Discuss attribution with your students (i.e., whether they feel that their success or failure are in their control)

☑ **2 Enhance students' competence**

- Give clear expectations, with your syllabus and assignments
- Provide early opportunities for success
- Test early and often
- Use one class session to present metacognitive learning strategies
- Do a 1-2 minute interactive activity for every 10-15 minutes of class
- Provide targeted feedback, rubrics and exemplars

☑ **3 Enhance students' belongingness**

- Use metacognitive get-acquainted activities
- Assign authentic, real-world projects
- Promote cooperative (group) learning

☑ **4 Enhance students' self-esteem**

- Discuss fixed vs. growth mindset and emotions with students
- Let your students know you are human; reveal your struggles in your journey.
- Provide early opportunities for success
- Do a reflection activity with students; ask them to reflect on how they have previously achieved mastery

☑ **5 Enhance students' involvement and enjoyment**

- Connect to students' interests
- Introduce "switch days" when students have the opportunity to teach and evaluate another student's teaching
- Play learning games
- Give students a question or task at the beginning of class that they will be required to answer or execute by the end of class.

*Credit: S. Y. McGuire (2015).* Teach students how to learn: Strategies you can incorporate into any course to improve student metacognition, study skills, and motivation. *Stylus.*

## Tipsheet : Teaching large classes

☑ **1 Use active learning strategies**
Most of these still apply, such as TPS, whole class discussions, and pausing during lectures.

*Let's pause for a neighbor discussion.*

☑ **2 Use technology**
Much educational technology will help you see where a large number of students are at (e.g. clickers).

*Submit your vote with your clicker.*

☑ **3 Use pairwise work**
Since you'll have less time to give individualized feedback, break students into pairs or groups for students to discuss their papers or problem sets.

*Swap your paper with your neighbor.*

☑ **4 Rely on giving summary feedback**
You can skim student contributions to get a sense of their ideas or confusions, then share that with the class.

*I see that many of you are confusing force and impulse.*

☑ **5 Encourage study groups**
These can give feedback and create connections.

*Swap contact info with a neighbor.*

☑ **6 Organize things well**
Plan tests well in advance, have clear central communication on the website or CMS, and use email.

*The full schedule is on the website.*

☑ **7 Reduce students' feeling of anonymity**
This can boost morale. Learn some names, encourage students to come to office hours, and chat with them.

*Drop into the free help sessions every Thursday!*

☑ **8 Train TAs and supervise them**
You might have a TA responsibility checklist, hold weekly meetings, review student work, have them collect student feedback, and observe and facilitate classes.

*Please come to Wednesday's lecture to help student groups.*

*Credit: W. McKeachie & M. Svinicki (2014).* McKeachie's Teaching Tips *(14th ed.). Wadsworth.*

## Tipsheet : Assessing students

See also the "exams and quizzes practices" and "grading practices" sheets for specific practices.

| | | | |
|---|---|---|---|
| ☑ | 1 | **Let SLOs guide assessment**<br>so that you're assessing what you value, including concepts, problem-solving, higher-order thinking, etc. | *Have I assessed all my SLOs?* |
| ☑ | 2 | **Communicate expectations**<br>to support a positive class climate and norms, reduce student anxiety and support success. | *"We expect group members to share the talk time."* |
| ☑ | 3 | **Discuss the role of assessment**<br>so that students see assessment as beneficial to their learning by giving feedback to them, and to you. | *"Why do you think our university / department has assessments?"* |
| ☑ | 4 | **Use clear, compassionate grading policies**<br>so the standards are clear; grade formative assessment for participation only, and explain your reasons. | *"Your assignment will be graded with this rubric to be more fair."* |
| ☑ | 5 | **Use frequent formative assessments**<br>to assess students' learning along the way and give students practice for high-stakes summative assessment. | *"Complete this one-minute paper"* |
| ☑ | 6 | **Use a variety of assessments and questions**<br>to assess a variety of outcomes and give opportunities for every student to shine. Assessment ≠ testing! | *Multiple choice, problem-solving, writing, ranking, self-reflection, two-stage exams, scratch cards, etc.* |
| ☑ | 7 | **Solicit student feedback**<br>to learn their perspective and establish trust. | *"Please complete this feedback survey."* |
| ☑ | 8 | **Empower students to self-assess**<br>to help them to develop metacognition skills. | *"Where did you get stuck in this exam?"* |
| ☑ | 9 | **Facilitate student learning with assessment**<br>Tests should facilitate learning for you and your students. | *"Complete this exam wrapper to reflect on your learning."* |

*Credit: W. McKeachie & M. Svinicki (2014).* McKeachie's Teaching Tips *(14th ed.). Wadsworth; K. Hogan & V. Sathy (2022).* Inclusive Teaching: Strategies for promoting equity in the classroom. *West Virginia University Press; S. Chasteen (2023).* How can I set clear expectations and motivate students, so that they engage in active learning? *Physport.org.*

## Tipsheet : Course or Class Design

| | | | |
|---|---|---|---|
| ☑ | 1 | **Develop student learning outcomes (SLOs)** to focus the course or unit. Include scientific content, scientific practices, and affective goals. | *"Students should be able to..."* |
| ☑ | 2 | **Ensure SLOs are clear & suitable** so that it is clear the SLO can be assessed, and SLOs are at the appropriate level (e.g., higher/lower order). | *Do my verbs have a clear meaning? Is this what I want students to do?* |
| ☑ | 3 | **Use backward design** to align SLOs, instruction, and assessment. | *Is my course aligned?* |
| ☑ | 4 | **Use Principles of Teaching and Learning** as a guide, to maximize student learning and inclusion. | *Have I included opportunities for feedback?* |
| ☑ | 5 | **Select active learning techniques** to support student learning, especially around the most difficult topics. Use a variety of techniques. | *Which of the menu of teaching options seems best here?* |
| ☑ | 6 | **Structure collaboration** to ensure that students are not left out. | *"Your assigned partner today is ____."* |
| ☑ | 7 | **Create structure and organization** so students have clear direction and to be fairer. | *"Each day will begin with a warm-up...."* |
| ☑ | 8 | **Aim for 3 hours of preparation** for each hour of teaching, so that you teach well, but do not over-prepare. | *I should spend about 6 hours on lecture preparation this week.* |
| ☑ | 9 | **Assess and reflect on the course or class** to learn and refine over time. Reflect and take notes after every class, and give opportunities for student feedback. | *How did that go? What did students think?* |
| ☑ | 10 | **Discuss with colleagues** and solicit feedback on your design, especially colleagues with different backgrounds from yours. | *"What do you think about X course element?"* |

*Credit: L. D. Fink (2013).* Creating significant learning experiences. *Jossey-Bass; W. McKeachie & M. Svinicki (2014).* McKeachie's Teaching Tips *(14th ed.). Wadsworth; G. Wiggins & J. McTighe (2005).* Understanding by Design. *Association for Supervision and Curriculum Development.*