# Supporting Research-Based Teaching in Your Department

Version 2024.1

Contributors and Reviewers

In this guide

This section provides guidance for department chairs and leaders to create departmental and cultural structures to support instructional staff in implementing research-based teaching in your department. Physics education research (PER) has produced many principles and strategies that can dramatically improve student learning of physics. We use the term *research-based teaching* broadly to refer to teaching that applies the principles of PER and/or uses strategies, tools, and/or materials developed through PER. Research-based teaching is structured around insights from research about students' physics ideas. It helps students build on these ideas through *active learning* or *interactive engagement*, in which students collaboratively think through physics rather than passively listen to lectures, as well as through peer interaction and formative assessment to support students in actively constructing their own understanding of physics. This section builds on research in departmental change, which demonstrates that the effective implementation of research-based teaching requires structural support at the departmental level. The section on Implementing Research-Based Teaching in Your Classroom provides guidance for classroom instructional staff on how to understand and implement research-based teaching in their physics classes. For general guidance on departmental change, which can be applied to changing the culture of teaching in your department, see the section on How to Create and Sustain Effective Change.

## Benefits

Effective implementation of the principles and strategies of research-based teaching has been demonstrated to improve student learning, satisfaction, and/or retention for all kinds of students, including students from marginalized groups, first-generation college students, introductory and advanced physics students majoring in physics and in other disciplines, and students who are underprepared. Supporting research-based teaching at a department level can help ensure that these practices become a part of the culture and structure of the department, rather than relying on isolated instructional staff to effect change while working against structures that don't support them in research-based teaching. Using these practices throughout your program can create a culture of scholarship around teaching and learning, enabling departmental instructional staff to apply their critical scientific skills to their teaching while helping them be more productive, collaborative, and effective in their teaching. These practices can improve student learning and student success, which is likely to enhance enrollment and thereby lead to departmental recognition and success.

### The Cycle of Reflection and Action

Read this first

### EP3 Glossary

## Effective Practices

Collapse all implementation strategies

1.

A. **Involve your department in discussions of teaching**

i. Have regular department-wide discussions to establish shared goals for student learning and success, discuss readings and teaching innovations, and celebrate successes. Discuss the role that research-based teaching can have in improving instruction and how this can impact student learning and success, which is likely to enhance enrollment and thereby lead to departmental recognition and success.

ii. Work to develop broad agreement about the need to use teaching practices that align with emerging effective practices and that support a changing student population. Identify and discuss the differences in underlying values and norms that may make it difficult for department members to agree. Provide multiple venues for the discussion and sharing of ideas and strategies.

iii. Encourage faculty and staff, collectively and individually, to think creatively and ambitiously about your department's teaching goals and the practices that can support those goals. For example, sponsor periodic brainstorming sessions at faculty meetings and departmental retreats. Additionally, consider involving students in these discussions.

B. **Develop a departmental commitment to research-based teaching**

i. Establish and publicize departmental values and goals around teaching. For example, include teaching in your mission statement. See the section on How to Create and Use Foundational Documents for details.

ii. Identify structural factors in your department and/or institution that support or undermine research-based teaching, for example, the departmental culture around teaching; criteria for hiring, annual performance reviews, promotion and tenure reviews, and other evaluation processes; how teaching evaluations are performed and used; teaching loads, compensation, and professional development for instructional staff; and the availability of instructional support staff. Work to align these departmental structures and practices with research-based teaching, recognizing that structural factors have a much bigger impact on the quality of teaching in a department than the enthusiasm and skills of individual instructional staff members.

iii. Ensure that the use of research-based teaching is a part of the culture of your department as a whole, so that students become familiar with these practices and see them as a normal part of physics classes, rather than as an isolated activity that happens in one class. See the section on Implementing Research-Based Teaching in Your Classroom for guidance on how to support students in understanding, buying into, and engaging in research-based teaching.

iv. Discuss and showcase the use of research-based teaching. For example, discuss such teaching at department meetings, in promotional materials, and in conversations with and reports to the dean and provost; nominate instructional staff for and/or give teaching awards; and hold colloquia and seminars on teaching.

v. Promote and facilitate the use of research-based teaching by instructional staff at all levels. See below for guidance on how to support all instructional staff in research-based teaching.

vi. Align hiring procedures with your departmental values and goals around teaching. For example, ensure that these values and goals are included in position announcements, application materials, and criteria for evaluating candidates. See the section on How to Be an Effective Chair for guidance on how to hire strong and diverse faculty and staff.

vii. Promote and facilitate the use of research-based teaching during the hiring and orientation of new faculty and other instructional staff. For example, ensure that the application and interview process and hiring criteria include a demonstration of your department's commitment to research-based teaching, and provide professional development around research-based teaching for new hires.

viii. Consider seeking funding to support initiatives to improve teaching in your department through, e.g., grants from your institution for course improvement or curriculum development, NSF grants, or Reichert

C. **Ensure that your department's approach to teaching includes attention to equity**

i. Develop a shared understanding in your department that student experiences and success in the classroom are inseparable from social contexts and, as a result, that transforming departmental teaching effectiveness must consider the systemic structures that shape students' diverse identities and experiences. See the section on Equity, Diversity, and Inclusion for details.

D. **Develop and use a departmental structure to support high-quality, consistent, and efficient instruction**

i. Promote the idea that courses and the curriculum belong to the department, so instructional staff need to work together to determine what students should learn in each course. Establish a process for doing this that works in your context, recognizing that the process will look different in large versus small departments. For example, in a small department the curriculum is likely to be more dependent on the expertise of individual instructional staff members.

ii. Establish an expectation that all courses will use research-based teaching and inclusive pedagogy.

iii. Provide a framework for instructional staff to regularly review and discuss program- and course-level student learning outcomes, so that they are aware of the progression of content and concepts covered throughout the curriculum.

iv. Develop a course assignment policy that balances allowing for continuity and innovation against avoiding burnout. For example, instructors should teach the same course no more than X and no fewer than Y continuous years, and/or course assignments will be determined by a designated committee.

v. If appropriate, establish a committee to oversee the undergraduate curriculum; set standards for content, instructional practices, and assessment; check to ensure that the content in course sequences is properly aligned; and regularly engage all instructional staff in planning the courses they are or will soon be teaching.

vi. If appropriate (e.g., for large-enrollment classes), employ support staff to assist with administrative tasks (e.g., drops and adds, accommodations for

disabilities and missed classes and exams, and equipment maintenance

E. **Expect to commit substantial time and resources to establish successful change**

i. Identify a series of small changes to teaching practices in your department that can be implemented incrementally rather than trying to change everything at once.

ii. Establish a culture and incentive structure that allow sufficient time and resources to provide new implementations and the instructional staff who lead them with a fair chance to succeed. See Support all instructional staff in research-based teaching below for details.

iii. Allow time for instructional staff to fully develop the needed expertise, as well as to develop a departmental culture in which students expect, understand, and value research-based teaching. Be prepared for a long, slow road to the successful implementation of research-based teaching that will likely extend over several semesters or even years.

F. **Establish a department-approved plan to improve teaching and to develop and revise the curriculum**

i. See the section on How to Create and Sustain Effective Change for guidance on how to develop and act upon a shared vision and plan for departmental change.

ii. Assemble a diverse and representative team of department members to develop an action plan for instructional change. Include department members who are, e.g., pre-tenure faculty, tenured faculty, non-tenure-track instructional staff, other staff, students, and/or members of marginalized groups. At the same time, avoid overburdening new faculty or people from marginalized groups. Establish desired outcomes for the team's work and its norms for discussions, e.g., the STEP-UP Guidelines for Conduct During Discussions.

iii. Involve all members of your department in providing input, feedback, and support for the action plan at regular intervals as the plan is developed. This builds awareness of and agreement on the contents of the plan and identifies points of contention and possible resolutions before the final plan is presented.

iv. Identify institutional partners who can support this work, e.g., in your teaching and learning center and/or your student success center.

v. Consider collaborating with other departments where there might be overlapping interests or opportunities to expand curricular options through developing new, cross-listed courses, e.g., a computational physics or electronics course cross-listed with a computer science department or a materials science course cross-listed with a chemistry department.

vi. Establish a timeline for introducing research-based teaching into different courses and for obtaining and/or developing any needed infrastructure such as new classroom equipment or changes to teaching evaluation processes.

vii. Develop achievable but ambitious short-, mid-, and long-term goals for implementing research-based teaching in your department.

viii. Create a plan with strategies for achieving your goals. Ensure that your plan has clear timelines, identified priorities, and indicators of success. For

example, consider using a SMART goals framework. Ensure that the plan lays out who has the responsibility and authority to carry out the plan.

ix. Plan teaching assignments that will support this plan, ensuring that research-based materials can be used and built upon by subsequent instructors. Often, this can require planning teaching assignments a year or more in advance.

x. Expect your plan to change as you learn more. Be flexible in adapting it as needed.

xi. Ensure that your plan for improving teaching in your department is connected to your department's process for establishing and assessing program-level and course-level student learning outcomes. See the section on How to Assess Student Learning at the Program Level for details.

xii. Consider either formalizing your plan into a strategic plan or incorporating it into an existing departmental strategic plan. See the section on How to Create and Use a Strategic Plan for guidance.

xiii. Ask for an outside analysis of your program, curriculum, and plan during your program review process or when updating the plan. Use this outside analysis as a lever for change. See the section on How to Undertake an Undergraduate Program Review for details.

G. **Design physical spaces that promote active learning**

i. Consider how physical spaces enable or hinder research-based teaching. Identify small changes you can make to these spaces, such as buying portable whiteboards and moving tables and chairs around to support group work, or if funds permit, explore larger changes such as remodeling or building classrooms. See the section on The Physical Environment: Encouraging Collaboration and Learning for guidance on how to use current and future instructional spaces to promote active learning.

2.

A. **Reward teaching and the scholarship of teaching and learning**

i. Learn about, support, and publicize the practices that instructional staff in your department are already doing that are aligned with research-based teaching.

ii. Use meaningful, actionable, and research-based measures for evaluation of teaching. See the section on How to Select and Use Various

## Develop, promote, and institutionalize a departmental culture of scholarly and effective teaching

teaching, for developing course curricula, and for supporting other instructors in implementation. For example, provide release time to develop new materials; take these contributions into account in tenure, promotion, merit, and annual reviews; and nominate instructional staff members for local, regional, and national teaching awards.

iv. Consider providing course buyout, professional development, and other support to instructional staff when they are investing substantial time in a major change in their teaching.

v. Identify and address ways that implementing research-based teaching can have negative impacts on teaching evaluations from students. For example, students might complain that instructional staff are not "teaching" them. Three possible ways to avoid such negative impacts are: (1) See the section on Implementing Research-Based Teaching in Your Classroom for guidance on how to support students in understanding and buying into research-based teaching. (2) Create and publicize policies to ensure that instructional staff are not penalized for attempting reforms that may not work well the first time, and give them several opportunities to teach a course and improve over time. (3) Improve the quality of teaching evaluations and use a wider variety of methods to assess teaching. See ii above.

vi. Recognize and take into account when making tenure, promotion, and other evaluation decisions for instructional staff that members of marginalized groups are more likely to receive negative student evaluations. For example, students are more likely to rate women and feminine-presenting instructional staff as less competent than male colleagues, comment on their clothing, or make sexually harassing comments. Students also give lower ratings, on average, to instructional staff who are people of color, have accents, and/or have Asian last names. See Evidence in the section on Equity, Diversity, and Inclusion for details.

vii. Ensure that your departmental culture allows instructional staff to make choices about research-based teaching that are a good fit for them (while still being effective for student learning), recognizing that instructors who embody authority and expertise (based on, e.g., race, gender, and/or age) have different instructional choices than instructors who do not. For example, when an instructor responds to questions by asking students to figure out the answers for themselves, students are less likely to recognize this as a pedagogical tactic, and more likely to assume the instructor doesn't know the answers, if the instructor is feminine-presenting, non-white, and/or young. Therefore, it is important for your department to support such instructors in embodying authority in the way they enact this practice.

viii. Evaluate multi-term trajectories of instructors' teaching rather than outcomes of single terms, to create a lower-risk environment that encourages instructional staff to engage in iterative curricular development, implementation, and refinement.

ix. Value and promote the externalization of the scholarship of teaching and learning, e.g., publication and presentations about physics teaching, local seminars, and participation in Scholarship of Teaching and Learning (SoTL)

B. **Offer opportunities and resources for instructional staff to learn about and discuss physics teaching and learning**

i. Encourage instructional staff to become familiar with online resources for teaching materials and ideas. See Resources in the section on Implementing Research-Based Teaching in Your Classroom.

ii. Value and promote professional development around teaching for all course instructional staff and instructional support staff.

iii. Identify programs at your institution that provide professional development for teaching, e.g., your teaching and learning center. Determine how these programs might be able to support your instructional staff and instructional support staff, e.g., through providing consultations or conducting mid-semester formative assessments of courses.

iv. Encourage and provide support for faculty and staff (including yourself) to attend conferences, workshops, and trainings focused on teaching, e.g., national and regional AAPT meetings, AAPT workshops and short courses, and the Physics and Astronomy Faculty Teaching Institute (FTI). Provide departmental funds and/or help identify external funds for this support.

v. Encourage discussions of teaching and learning in your department that include learning about students' ideas and reasoning processes, as well as teaching innovations.

vi. Host seminars, colloquia, workshops, and informal discussions about physics teaching and learning and research-based teaching.

vii. Organize, encourage, and lead meetings and discussions about teaching with instructional staff in other departments that are using research-based teaching.

viii. Provide robust mechanisms for course instructional staff and instructional support staff to obtain feedback on their teaching throughout the term and as appropriate to the needs of the course. See the section on How to Select and Use Various Assessment Methods in Your Program for guidance on how to use classroom observations and student feedback

C. **Establish shared syllabi and course materials**

## Support all instructional staff in research-based teaching

assignments, rubrics, and exam questions) to support the sharing and continued use of materials that work well in your department, minimize preparation time, and promote long-term sustainability. Ensure there is a person or group responsible for curating and maintaining this resource.

ii. Encourage continuous refinement and improvement of shared course materials as new instructional staff bring fresh perspectives.

iii. Promote the use of freely available course materials (e.g., open source education resources) to minimize costs for students. See Resources in the section on Implementing Research-Based Teaching in Your Classroom.

**Effective Practices** Practices

express their expertise and identities, to the extent possible, while still maintaining course consistency, meeting course-level student learning outcomes, and using practices consistent with research in physics education.

v. Encourage, incentivize, and reward faculty and staff who maintain and organize resource repositories. Recognize that someone will need to dedicate a significant amount of time and effort to ensure that these repositories are functional and beneficial, and that dedicating faculty and/or staff time to this work will pay off by reducing redundant development and improving instructional quality and alignment.

D. **Provide opportunities for instructional staff to mentor each other in teaching**

i. Create a culture and structure that supports instructional staff to easily and comfortably observe each other's teaching as a safe way to both learn about and get informal feedback on teaching. See the section on How to

Select and Use Various Assessment Methods in Your Program for guidance on classroom observations.

ii. Assign experienced mentors to new instructional staff to provide coaching and support around teaching.

iii. If your department is too small for sufficient mentorship and observation within the department, consider partnering with other departments to assign mentors and observers across departments.

iv. Consider using co-teaching as a mechanism for instructional staff to learn from each other.

v. See the section on How to Be an Effective Chair for guidance on how to

E. **Support and value instructional staff in a variety of roles**

i. Provide adequate resources and rewards to ensure that everyone in your department who is implementing and supporting research-based teaching has the time and energy needed to do so effectively.

ii. Identify and/or advocate for positions for full-time staff or student workers to serve as instructional support staff, to enable instructional staff to receive support and spend more time on research-based teaching. See below for guidance on how to engage students as instructional support staff to support research-based teaching.

iii. Consider hiring an embedded teaching expert with dedicated time and resources to support departmental teaching efforts, as well as to connect to, translate, and adapt the wealth of scholarship in physics/STEM education for your department and instructional staff. An embedded teaching expert might be a faculty member, postdoc, or staff member, and their roles might include facilitating the development of learning goals, developing curricular materials, collecting and analyzing data on student learning, facilitating faculty discussions, serving as a departmental resource, conducting research, and/or disseminating results within and outside the department. Ensure that this person's expertise and role are valued. If possible, connect this person to institution-wide networks that include others in similar roles in other STEM departments and/or in education departments. See Reference 3 in Evidence below for details.

iv. If you have differentiated teaching and teaching support positions in your department, ensure that people in these positions are valued and treated as equal members of the department, e.g., by evaluating them appropriately and giving them appropriate workloads, distributions of responsibilities, voting rights, job security, and leadership roles within your department. Examples of such positions are full-time teaching instructors, lecturers, teaching professors, and/or embedded teaching experts.

v. Pay particular attention to the needs of adjunct faculty and staff, whose contributions are often overlooked, resulting in low morale and high turnover rates. Ensure that they are treated and compensated well, that they receive the professional development they need to implement research-based teaching, that their jobs are clearly defined and reasonable, and that they understand their opportunities for advancement.

vi. Avoid assuming that faculty whose research specialty is physics education research will necessarily support departmental teaching efforts to a greater extent than any other faculty member. While it may be appropriate for a physics education researcher to support departmental teaching efforts, ensure that doing so is an explicitly recognized and compensated part of

this person's job, rather than an implicit assumption due to their research

F. **Engage students as instructional support staff to support research-based teaching**

i. Consider creating a Learning Assistant program or other program for undergraduate instructional assistants to support the use of research-based teaching. See the section on Undergraduate Instructional Assistants for guidance (much of which is also applicable to graduate teaching assistants) on how to:
   - Integrate instructional assistants into your courses,
   - Integrate instructional assistants into student support outside of class, and
   - Train and support instructional assistants.

ii. Establish a process for the selection and training of instructional support staff such as graduate teaching assistants and undergraduate instructional assistants. Ensure that their training teaches them how to support research-based teaching and integrates them into the course teaching team. For example, teach them about research-based pedagogy and why it is valuable, how to facilitate students working together effectively in small groups, and how to guide students to discover the solutions to physics problems without telling them the answer.

iii. Encourage instructional staff to engage instructional support staff in ways that support research-based teaching, e.g., by facilitating small group work.

iv. Consider how to effectively engage different types of instructional support staff, such as undergraduate instructional assistants and graduate teaching assistants, to take advantage of each group's unique strengths. For example, as near peers, undergraduate instructional assistants are generally more relatable to other undergraduate students, and are typically better able to understand their institutional context and help students feel comfortable asking questions that they might be hesitant to ask their instructor or even a graduate student. If undergraduate instructional assistants are part of a Learning Assistant program with a strong pedagogy component, they might know more than graduate students about research-based teaching practices. Graduate students, in contrast, typically know more about physics subject matter, as well as how the content of a particular course fits into the broader context of the physics discipline.

v. If applicable, consider training graduate teaching assistants and undergraduate instructional assistants together, and encourage each group to learn from each other.

## 3. Use a cyclic process to design, assess, and improve courses based on student learning outcomes

A. **Engage instructional staff in a cycle of assessment and improvement of teaching**

i. Ensure that the existing mechanisms for assessing teaching effectiveness support instructional staff in improving their teaching. Incorporate new mechanisms for formative assessment of teaching as needed. See the section on How to Select and Use Various Assessment Methods in Your Program for detailed guidance on how to assess teaching effectiveness

through peer review of teaching, teaching portfolios, teaching reflections, classroom observations, student feedback forms for formative assessment, student evaluations of teaching, and evidence of student learning.

B. **Consider what kinds of student learning outcomes are needed for your courses**

i. Consider the needs, interests, and goals of the students each course serves. See the sections on Introductory Courses for STEM Majors 1.A, Upper-Level Physics Curriculum 1.A, Introductory Courses for Life Sciences Majors 1.C, Courses for Non-STEM Majors 2.C, Instructional Laboratories and Experimental Skills 1.C, and Online Education 1.B for recommendations on how to do this for specific courses and types of courses.

ii. Understand the typical background and preparation of students at your institution and consider how your courses will provide all students the opportunity to succeed, refining your course design and student learning outcomes to include appropriate bridges to meet students where they are.

iii. If appropriate, include learning outcomes related to attitudes and beliefs about physics. See the section on Courses for Non-STEM Majors for guidance on how to build student trust by creating positive experiences in the study of physics.

iv. If appropriate, include learning outcomes related to the social context and impact of physics. See the section on Courses for Non-STEM Majors for guidance on how to engage students in understanding and evaluating the impact of physics on society and the practices of physics and the social context in which it is embedded.

v. If appropriate, include learning outcomes related to communication. See the section on Communication Skills for guidance.

vi. If appropriate, include learning outcomes related to computation. See the section on Computational Skills for guidance on how to develop technical computing skills and introduce computational physics skills in introductory courses for majors and non-majors.

C. **Develop student learning outcomes and other goals for each course**

i. Create course-level student learning outcomes for each course that are appropriate to the needs, interests, goals, and preparation of students, as identified above.

ii. Ensure that each course-level student learning outcome is a statement describing what students should be able to do as a result of completing a particular course and is observable, measurable, and demonstrable. Emphasize the integration and application of knowledge rather than coverage of material. Use specific, active verbs (e.g., “solve,” “describe,” and “calculate”) rather than “understand.”

iii. Be realistic and flexible about what can be accomplished in a single course and consider the development of skills over a sequence of courses. For example, recognize that teaching critical thinking skills and/or deeper conceptual understanding may require teaching fewer topics.

iv. Ensure that your course-level student learning outcomes for courses in the major are aligned with your program-level student learning outcomes.

v. Ensure that your process of developing and using course-level student learning outcomes is consistent with the typical requirements of your institution and institutional accreditors, such as requirements that all required major courses have outcomes and that these outcomes are measurable, systematically assessed, and included in course syllabi. See the section of How to Assess Student Learning at the Program Level for details.

vi. Develop goals for your courses that go beyond student learning outcomes. For example, establish explicit goals for making your classroom more equitable and welcoming for all students, for developing students' identities as physicists and/or sense of belonging, for creating a culture where it is okay to be wrong, for ensuring students participate in class activities, and for reducing DFW rates.

vii. Discuss with stakeholders (e.g., faculty in your department and in departments that your courses serve and representatives from relevant employers and/or graduate programs) the course-level student learning outcomes and course goals, as well as how they are connected to the program-level student learning outcomes (e.g., curriculum map), to obtain consensus and understand concerns, particularly if material has been added or removed.

viii. Ensure that all course-level student learning outcomes and course goals

D. **Design assessments that align with your student learning outcomes and other course goals**

- i. For each student learning outcome or course goal, determine what evidence would show that students achieved the outcome or that the course met the goal, and design assessments to measure success.

- ii. Encourage instructional staff to measure course-level student learning outcomes through, e.g., pre- and post-tests; presentations; projects; and designated in-class conceptual questions, homework, and exam questions chosen for their relevance to particular outcomes. Consider both formative and summative assessments. Because course-level student learning outcomes are broad, you might need more than one assessment to be convinced that a student has achieved a particular outcome.

- iii. Measure course goals through, e.g., classroom observations, surveys of students, and tracking DFW rates. See the section on How to Select and Use Various Assessment Methods in Your Program for details.

- iv. See the section on Implementing Research-Based Teaching in Your Classroom for guidance on how instructional staff can align assessment practices with course goals.

- v. See Programmatic Assessments below.

E. **Design courses based on course-level student learning outcomes, assessments, and research into student learning**

- i. Encourage instructional staff to use course goals, course-level and program-level student learning outcomes, and the learning outcomes of other programs these courses serve to develop appropriate activities and pedagogy based on the recommendations in the section on Implementing Research-Based Teaching in Your Classroom.

ii. Encourage instructional staff to consider how each element of a course's design supports (or could undermine) course-level student learning outcomes. For example, an exam with no conceptual problems will undermine an outcome of developing conceptual understanding.

iii. Encourage instructional staff to use course-level student learning outcomes to guide instruction and assessment about specific topics, e.g., Newton's third law. Consider defining topic-level student learning outcomes to help design instruction and assessment at a finer-grained level.

iv. Encourage instructional staff to review outcomes each time they plan a day or unit and to choose instructional activities and homework that will help achieve the outcomes. See the Faculty Teaching Institute recommendation on What is "backwards design" and how can I use it in my physics classes? for an example of a lesson design template that uses student learning

F. **Establish procedures that integrate assessment into ongoing department activities**

i. Encourage instructional staff to reflect on and document the topics they taught and how students were engaged in the material (e.g., activities, handouts, assignments, problems) along with the perceived effectiveness of their lessons (e.g., what appeared to work, why something did not work, student feedback), and potential improvements.

ii. Encourage instructional staff to consult regularly with instructional support staff throughout the course to discuss how the course is going, what students are understanding and not understanding, what feedback they are hearing from students, and their recommendations for improving the course. Have a review meeting at the end of a course for all instructional staff and instructional support staff to reflect on all feedback and compile it into a document to be used for planning future courses.

iii. Conduct regular assessments of courses, focusing on a limited set of student learning outcomes in each cycle. Align assessments with institutional assessment activities (e.g., assessing program-level student learning outcomes, assessing general education requirements, and/or satisfying external accreditation requirements) and the information your department needs to improve courses. See the section of How to Assess Student Learning at the Program Level for details.

iv. Encourage and support course instructors' regular and systematic administration of research-based assessment instruments developed to evaluate conceptual skills, content mastery, and attitudes. Use these to better understand and monitor student performance, and to track pre- and post-instruction student performance in multiple courses over extended time periods. See the section on How to Select and Use Various Assessment Methods in Your Program for guidance on how to use research-based assessments of concepts or skills and research-based assessments of student attitudes or beliefs.

v. Develop a dashboard or data tracking system for assessment results. Identify who (e.g., a course lead, introductory physics course committee, and/or individual instructors) is responsible for conducting assessments in various courses and tracking results.

vi. Budget the necessary time and resources for assessment.

viii. Provide recognition to faculty and staff who carry out assessment

G. **Use data and assessment results to make, sustain, or enhance course improvements**

i. Document information gathered through assessments and discussions, and use that documentation to make adjustments and improvements to course design, course-level student learning outcomes, program-level student learning outcomes, and the sequence of physics content through multiple courses.

ii. Assess the degree to which courses are supporting program-level learning outcomes. Periodically review course-level student learning outcomes for their alignment to program-level student learning outcomes and then recommend revisions.

iii. Engage in a cyclic process of revision and improvement of course practices.

iv. Communicate assessment results and planned improvements to course stakeholders (e.g., faculty in physics, engineering, chemistry, or life sciences) and your administration.

v. Dedicate specific time(s) in department meetings to discuss the assessment and improvement of courses.

**Programmatic Assessments**

Assessments

## Programmatic Assessments

Expand all assessments

1. **What are the mechanisms through which your program currently implements research-based teaching? What are the additional mechanisms through which it could do so?**

2. **Is there a supportive culture in your program for implementing research-based teaching? How do students and instructional staff perceive and understand the use of research-based teaching in your program?**

3. **How successful is your program at implementing research-based teaching? How has its success changed over time?**

**Resources**

See Resources in the section on Implementing Research-Based Teaching in Your Classroom for resources about transforming classroom practice. The following resources are guides to particular models for transforming teaching in STEM departments.

- S. V. Chasteen and W. J. Code, *The Science Education Initiative Handbook* (2018).
- C. Ngai, J. C. Corbo, K. L. Falkenberg, C. Geanious, A. Pawlak, M. E. Pilgrim, G. M. Quan, D. L. Reinholz, C. Smith, and S. B. Wise, *Facilitating Change in Higher Education: The Departmental Action Team Model*, Glitter Cannon Press (2020).

## Evidence

References 1–3 provide overviews of research on models for the transformation of teaching in STEM departments. Reference 4 provides a summary of the extent to which research-based teaching practices have been taken up in higher education in the U.S.. See Evidence in the section on Implementing Research-Based Teaching in Your Classroom for an overview of research on the effectiveness of research-based teaching. See Evidence in the section on How to Create and Sustain Effective Change for an overview of research on change models in higher education.

1. C. Henderson, A. Beach, and N. Finkelstein, "Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature," *Journal of research in science teaching* **48**(8), 952-984 (2011).
2. M. Borrego and C. Henderson, "Increasing the use of evidence-based teaching in STEM higher education: A comparison of eight change strategies," *Journal of Engineering Education* **103**(2), 220-252 (2014).
3. K. White, A. Beach, N. Finkelstein, C. Henderson, S. Simkins, L. Slakey, M. Stains, G. Weaver, and L. Whitehead (editors), *Transforming Institutions: Accelerating Systemic Change in Higher Education*, Pressbooks (2020): A collection of articles on different models for departmental transformation of STEM teaching. The last two articles discuss embedded experts.
4. M. Dancy, C. Henderson, N. Apkarian, E. Johnson, M. Stains, J. R. Raker, and A. Lau, "Physics instructors' knowledge and use of active learning has increased over the last decade but most still lecture too much," *Physical Review Physics Education Research* **20**, 010119 (2024).

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