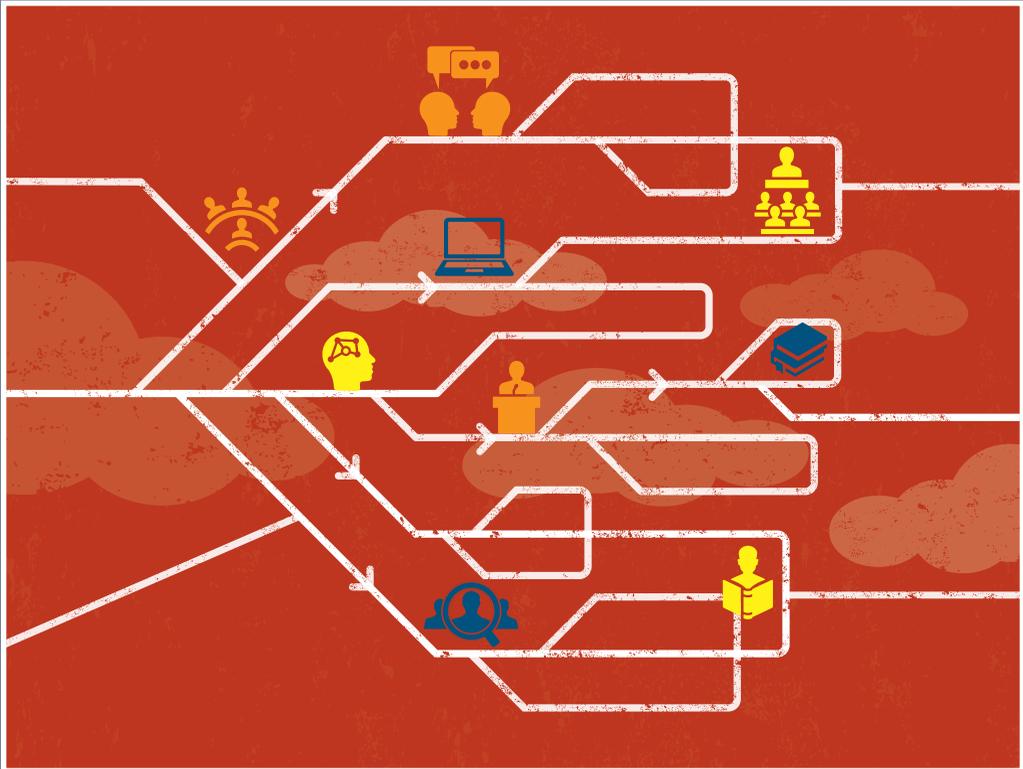


Policies and Practices to Support Undergraduate Teaching Improvement



Aaron M. Pallas, Anna Neumann,
and Corbin M. Campbell

AMERICAN ACADEMY OF ARTS & SCIENCES

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to Support Undergraduate
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Please direct inquiries to:
American Academy of Arts & Sciences
136 Irving Street
Cambridge, MA 02138
Telephone: 617-576-5000
Fax: 617-576-5050
Email: aaas@amacad.org
Web: www.amacad.org

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Executive Summary

In this paper, we focus our attention on undergraduate teaching and on policies and practices that support undergraduate teaching improvement. We begin by laying out the current institutional context of higher education, and the ways in which the social, economic, and political forces external to institutions have diverted attention away from undergraduate teaching improvement. Competition among institutions of higher education for scarce and valuable resources, such as prestige, dollars, and students, generally takes place on playing fields far from the college classroom, and institutional rankings are based on criteria removed from the quality of undergraduate teaching.

Public accountability systems for institutions receiving public funds are another force shaping institutional behavior. But accountability, in the form of outcomes-based accreditation processes, focuses the attention of policy-makers and institutional leaders on outcomes as markers of institutional success, with much less attention to the educating processes that produce these outcomes. Colleges and universities are definitely under pressure, but not to improve undergraduate teaching.

Accompanying these trends has been an effort to redefine scholarship in the academy, and encouraging active consideration of teaching as a form of scholarship to be cultivated and rewarded in faculty reward systems. There is, however, little evidence that the symbolic elevation of teaching as a form of faculty work has been accompanied by fundamental changes in the valuing of good college teaching.

We develop a view of good college teaching that emphasizes three forms of professional knowledge: subject-matter knowledge, general pedagogical knowledge, and pedagogical content knowledge. Subject-matter knowledge is a *sine qua non*; we assume that good college teachers must have deep knowledge of the subjects they teach. General pedagogical knowledge is knowledge that is broadly applicable to all teachers in all subjects—about approaches to managing class time, involving students equitably in class discussions, developing clear and inviting course syllabi, gaining and holding students' attention, managing student group work, and using varied instructional technologies.

The distinctive contribution of our paper is that we center good college teaching on pedagogical content knowledge. Pedagogical content knowledge refers to knowledge that teachers have of how students go about learning a particular subject—for example, knowing all students bring distinctive prior knowledge to their classrooms, and that this knowledge shapes student learning in powerful ways; being aware of the common mistakes that students make in engaging with discipline-specific ideas; and understanding the distinctive ways of thinking through a particular discipline's ideas. Pedagogical content knowl-

edge also includes teachers' facility with bridging students' prior knowledge and the core disciplinary ideas that a student is expected to learn. We present two examples of the use of pedagogical content knowledge in the undergraduate classroom.

We then describe six examples of teaching improvement initiatives in the United States, attending to whether and how they cultivate general pedagogical knowledge and pedagogical content knowledge. Four of these cases are internal to the modern American campus: namely, teaching centers, mentoring programs, guided reflection programs, and the Science Education Initiative (SEI), a recent effort to systematically improve the teaching of science at two North American research universities. We find that teaching centers and faculty mentoring programs may address features of the faculty role that are decoupled from teaching; and their attention to teaching is overwhelmingly rooted in general pedagogical knowledge, and indifferent to specific disciplines and subjects and their distinctive concepts and ideas. In contrast, the SEI and, to a lesser extent, guided reflection programs emphasize and are situated in the teaching of specific disciplines. They are, therefore, much more attentive to pedagogical content knowledge than are most campus teaching centers and faculty mentoring programs.

The remaining two initiatives we consider are external to a particular campus: the Carnegie Academy for the Scholarship of Teaching and Learning (CASTL) and the Discipline-Based Education Research (DBER) community. CASTL's attention to disciplinary knowledge in cultivating changes in participants' teaching orientations and practices demonstrated that a pedagogical content knowledge of higher education was possible. DBER draws on the learning sciences to inform the teaching and learning of the science disciplines.

We conclude our review by noting that if institutions are to cultivate their faculty's pedagogical knowledge as the key to undergraduate teaching improvement, certain stakeholders, including institutional leaders, must share a conception of good undergraduate teaching, and the role of pedagogical content knowledge in that conception. We also find that whether an undergraduate teaching improvement initiative is internal or external to an institution, teaching improvement is most likely when there is coordinated activity at multiple levels of the academic enterprise.

Policy Recommendations

We differentiate our policy recommendations by the policy actors involved: campus and system leaders, academic department leaders, disciplinary associations, and government and philanthropic foundations.

Policy Recommendations for Campus and System Leaders

- Assess the role of undergraduate teaching in the institutional culture;
- Analyze and realign the formal faculty incentive system;

- Fund and fill tenure-track faculty positions that emphasize undergraduate teaching;
- Create teaching improvement efforts oriented to the entire campus, to academic departments, and to individual faculty;
- Put someone in charge of undergraduate teaching improvement at the campus level, and give that person authority and resources.

Policy Recommendations for Academic Departments

- Prepare graduate students to teach;
- Provide academic departments with management and organizational support for teaching improvement;
- Balance the academic department and individual faculty members as the key units of change;
- Build teaching expertise and promise into the faculty recruitment cycle;
- Invigorate department-level curriculum and teaching committees;
- Cover important material more deeply, and reduce the amount of material presented in each course.

Policy Recommendations for Disciplinary Associations

- Develop discipline-specific undergraduate teaching resources to support the teaching of core disciplinary ideas;
- Develop discipline-specific banks of formative and summative assessments of student learning to support research on effective pedagogical practices;
- Develop protocols for college classroom observations in particular fields of study.

Policy Recommendations for Government and Philanthropic Foundations

- Develop a DBER approach for the humanities and for the social sciences;
- Develop resources for eliciting students' prior academic and cultural knowledge;
- Create cross-institutional, annotated "galleries" of the good teaching of core disciplinary concepts;
- Conduct basic research on college students' learning of subject matter, and effective approaches for teaching to support that learning;
- Educate the public on what good college teaching looks like.

Introduction

In this paper, we focus our attention on undergraduate teaching, and how to improve it. We concentrate on the college classroom because it is the setting in which students, instructors, and curriculum come together. Co-curricular experiences matter, but the content of what is taught and the quality of classroom teaching are the primary determinants of what and how much students learn. Unfortunately, U.S. higher education, which is both autonomous and decentralized, has not developed a systematic array of policies and practices that support improved teaching and learning.¹ This is a description of the past; we offer a more optimistic prescription for the future.

We begin by laying out the current institutional context of higher education. We then present a conception of good college teaching, emphasizing *pedagogical content knowledge*—the ways in which skilled teachers orchestrate how diverse groups of students engage with the subject matter of a class, drawing on the students’ prior knowledge. We offer six extant examples of undergraduate teaching improvement, exploring how these cases address the distinctive features of undergraduate teaching. We conclude with recommendations for policy and practice.

To foreshadow our argument, we find that current undergraduate teaching improvement practices in the United States are overly broad and vague, taking up a small amount of space in the developmental arc of the early faculty career. Further, most teaching improvement efforts emphasize general pedagogical skills to the exclusion of those that are tied to the subject matter being taught. Most institutions of higher education haven’t cracked the code on student learning, good teaching that promotes learning, and the policies and practices that encourage both.

But there is great potential. Advances in the learning sciences are providing new insights into how students learn, and the ways in which teaching can support that learning. The main challenges are putting that knowledge in the hands of the faculty who teach undergraduates, and providing them with the incentives and necessary support to use it. Although the faculty who teach are the key actors in this effort, there is much that campus and system leaders, department chairs, disciplinary associations, and philanthropic foundations can do to support undergraduate teaching improvement.

1. David F. Labaree, *A Perfect Mess: The Unlikely Ascendancy of American Higher Education* (Chicago: University of Chicago Press, 2017).

The Current Institutional Context

The social, economic, and political forces framing contemporary higher education in the United States have largely discouraged undergraduate teaching improvement, rather than supported it. We note three trends: institutional competition for resources; the rise of public accountability systems; and changing definitions of scholarship in the academy.

First, institutions of higher education compete with one another for goods that have little bearing on the quality of teaching and learning: namely, prestige, legitimacy, dollars, and students.² The pattern is rampant and deeply engrained in the American higher education system. Even the neutral Carnegie institutional classifications can detract from attention to teaching, as institutions strive to position themselves with increasingly prestigious (i.e., research-intensive) peers, or to “move up” in the rankings in their own classification. Efforts to respond to the institutional rankings criteria, or to appeal to a mass public, may draw time, attention, and resources away from faculty teaching.³ When faculty reward structures and professional development opportunities emphasize securing external grants, many faculty will follow suit; and since time is not infinitely expandable, the more time that faculty spend on research activities will likely result in less time spent thinking about teaching.

Further, rankings and other public measures of institutional effectiveness are sites for institutional competition and “gaming the system.” Years of research have demonstrated that college rankings (such as *U.S. News & World Report*) privilege the incoming characteristics of students over education practices or student outcomes.⁴ Higher education scholars and foundations hypothesized that changing the bases for the rankings and/or providing additional information about teaching and learning to the public might incentivize institutions to focus more on teaching and learning than on the incoming characteristics

2. Mitchell Stevens, *Creating a Class: College Admissions and the Education of Elites* (Cambridge, MA: Harvard University Press, 2009).

3. Kerry Ann O’Meara, “Striving for What? Exploring the Pursuit of Prestige,” in *Higher Education: Handbook of Theory and Research*, ed. John C. Smart, 22nd ed. (New York: Springer International Publishing, 2007), 241–306; Christopher Morphew and Bruce Baker, “The Cost of Prestige: Do New Research Universities Incur Higher Administrative Costs?” *The Review of Higher Education* 27 (3) (2004): 365–384.

4. Morphew and Baker, “The Cost of Prestige: Do New Research Universities Incur Higher Administrative Costs?”; Gary Pike, “Measuring Quality: A Comparison of US News Rankings and NSSE Benchmarks,” *Research in Higher Education* 45 (2) (2004): 193–208; O’Meara, “Striving for What? Exploring the Pursuit of Prestige.”

of students. But there is little evidence to date that changes in the data made available to the public—admittedly primitive and difficult to make sense of—have had this effect.

Higher education scholars and sociologists have noted the ways in which rankings and other accountability measures evoke changes in institutional behavior, often unintended, in response to being rated or evaluated.⁵ For example, institutions of higher education that strive to move up in the rankings have focused on recruiting more applicants each year while admitting the same number, on increasing research expenditures and spending on administration, and on hiring faculty who are experts and promoting them based on their research prowess.⁶ Conversely, such institutions also decrease behaviors that do not garner status or count toward the ratings to which they attend, such as admitting a broad spectrum of students, emphasizing teaching in the campus reward structure, and increasing instructional expenditures. Institutions mimic behaviors that are rewarded in the prestige hierarchy (i.e., admissions selectivity, research productivity), and dissociate from behaviors that are unrewarded (e.g., teaching quality).⁷ Since the current generation of college ratings does not address teaching quality or student learning outcomes, it is not surprising that the ratings do not drive institutions to attend to undergraduate teaching improvement.

Second, government has taken a more active role in developing public accountability systems for institutions receiving public funds, even in the form of student loans. But accountability focuses the attention of policy-makers and institutional leaders on outcomes as markers of institutional success, with much less attention to the educating processes that produce these outcomes.

The increase in accountability practices has largely been driven by calls for transparency, efficiency, and return on investment. One clear example of this practice, and its application to teaching and learning in higher education, was the Spellings Commission on the Future of Higher Education, so named for Margaret Spellings, Secretary of Education under President George W. Bush. The Commission's 2006 report called for institutions of higher education to document the "value-added" to students in the form of learning outcomes in a

5. Ibid.

6. Ronald G. Ehrenberg, "Reaching for the Brass Ring: the *U.S. News and World Report* Rankings and Competition," *The Review of Higher Education* 26 (2) (2003): 145–162; Susan K. Gardner, "Keeping Up with the Joneses: Socialization and Culture in Doctoral Education at One Striving Institution," *The Journal of Higher Education* 81 (6) (2010); Tatiana Melguizo and Myrah Strober, "Faculty Salaries and the Maximization of Prestige," *Research in Higher Education* 48 (6) (2007): 633–668; Marc Meredith, "Why Do Universities Compete in the Ratings Game? An Empirical Analysis of the Effects of the *U.S. News and World Report* College Rankings," *Research in Higher Education* 45 (5) (2004): 443–461.

7. Jerome Barkow et al., "Prestige and Culture: A Biosocial Interpretation," *Current Anthropology* 16 (4) (1975): 553–572; Paul DiMaggio and Walter Powell, "The Iron Cage Revisited: Collective Rationality and Institutional Isomorphism in Organizational Fields," *American Sociological Review* 48 (2) (1983): 147–160.

“consumer-friendly” way.⁸ Coming on the recent passage of the No Child Left Behind Act in 2002, which mandated virtually universal testing of students in grades three through eight in English and mathematics, institutions of higher education were very concerned about a broad federal mandate for parallel testing in postsecondary institutions.⁹

Although no such mandate emerged from the Spellings Commission’s recommendations, the consequences of the emphasis on value and transparency rippled across higher education institutions and trickled down into faculty life. The regional accreditors charged by the U.S. Department of Education accelerated a shift in their philosophy and standards toward what became known as “outcomes-based accreditation,” a model that obliged institutions to define desired student and organizational outcomes (such as student learning outcomes) and to demonstrate a continuous quality improvement mechanism in which measured outcomes would drive changes in institutional policies and practices.¹⁰ The accountability movement led to an increase in standardized institutional assessments of student engagement and learning, such as the National Survey of Student Engagement (NSSE), the Collegiate Learning Assessment (CLA), and the American Association of Colleges and Universities’ (AAC&U) Valid Assessment of Learning in Undergraduate Education (VALUE) rubrics.

Generalized assessments such as these appear to shift institutional attention toward student engagement and learning. However, little is known about whether student learning does actually improve at the institution level in response to these accountability efforts. Institutions that adopt such assessments report increased faculty understanding of assessment,¹¹ but there is little evidence that *student learning* increases or improves as a result. Likewise, there is little attention to college teaching in these assessments and improvement mechanisms.

Undergirding the student learning assessment movement and its counterpart, outcomes-based accountability, is the assumption that a focus on the student experience and student learning will reinforce and improve the educational practices at the institution. Assessment has been used in strategic planning, increasing student engagement, developing databases to inform institutional

8. “A Test of Leadership: Charting the Future of U.S. Higher Education” (Washington, D.C.: U.S. Department of Education, September 22, 2006), <https://www2.ed.gov/about/bdscomm/list/hiedfuture/reports/final-report.pdf>.

9. Corbin M. Campbell, “Serving a Different Master: Assessing College Educational Quality for the Public,” in *Higher Education: Handbook of Theory and Research*, vol. 30, ed. Michael Paulsen (New York: Springer International Publishing, 2015), 525–579; Peter Ewell, “Assessment and Accountability in America Today: Background and Context,” in *New Directions for Institutional Research* (San Francisco, CA: Jossey-Bass, 2008), 7–17.

10. *Balancing Competing Goods: Accreditation and Information to the Public About Quality* (Washington, D.C.: Council for Higher Education Accreditation, 2004), https://www.chea.org/userfiles/Letters%20from%20the%20President/PresLtr_InformPublic_0304.pdf.

11. Esther Hong Delaney, “The Professoriate in an Age of Assessment and Accountability: Understanding Faculty Response to Student Learning Outcomes Assessment and the Collegiate Learning Assessment,” Ph.D. diss., Columbia University, 2015.

decision-making, enhancing faculty collaboration, and aligning curricula. Yet outcomes-based accountability has not sought to understand teaching in classrooms or the connections between teaching and the desired learning outcomes. Rather, there is a broad but generic notion that data on student learning outcomes might be examined via a feedback process that redirects faculty and administrators' attention to curriculum and teaching practice, but with little guidance on how specifically to improve teaching.

The accountability movement has, we believe, encouraged data-based decision-making in higher education, what is sometimes referred to as a "culture of evidence" in organizational decision-making.¹² A culture of evidence is a culture "in which colleagues from varied disciplinary contexts and roles (including student affairs) share information and judgments about what is and isn't working and commit as a community to ongoing improvement."¹³ What is particularly notable about this definition is that the focus is on the process of assessing—without much regard for the *content* of what is being assessed (e.g., teaching, learning, etc.). In recent years, the culture of evidence has been associated with student learning assessment, but the attention is on the institutional commitment to the assessment process (collecting and using data as evidence to guide practices) rather than on undergraduate teaching and teaching improvement.

Third, over the past three decades, there has been a systematic effort to redefine scholarship in the academy, pushing it increasingly to encompass teaching. But this work has not reached deeply enough into teaching practice to make a lasting difference. Ernest Boyer's seminal work for the Carnegie Foundation for the Advancement of Teaching, *Scholarship Reconsidered: Priorities of the Professoriate*, sought to expand what counts as scholarship. Recalling Aristotle, Boyer remarked, "teaching is the highest form of understanding," as he attempted to elevate teaching from the lowest common denominator among faculty to a fundamental and revered form of scholarship. Boyer's report caused a significant ripple in the field, with faculty and administrators seeking to integrate these ideas into academic discussions in institutions across the nation.¹⁴ Many institutions revised their tenure, promotion, and merit reward structures to include forms of scholarship beyond basic research, such as the scholarship of teaching (i.e., the study of one's own teaching practice, and that of others).¹⁵

12. Catherine Millet et al., *A Culture of Evidence: An Evidence-Centered Approach to Accountability for Student Learning Outcomes* (Princeton, NJ: Educational Testing Service, 2008).

13. Pat Hutchings, Mary Taylor Huber, and Anthony Ciccone, *The Scholarship of Teaching and Learning Reconsidered* (San Francisco, CA: Jossey-Bass, 2011).

14. Charles E. Glassick, Mary Taylor Huber, and Gene I. Maeroff, *Scholarship Assessed: Evaluation of the Professoriate* (San Francisco, CA: Jossey-Bass, 1997); Adrianna Kezar, "Higher Education Research at the Millennium: Still Trees Without Fruit?" *The Review of Higher Education* 4 (2000): 443–468; KerryAnn O'Meara, "Encouraging Multiple Forms of Scholarship in Faculty Reward Systems: Does It Make a Difference?" *Research in Higher Education* 46 (5) (2005): 479–510, doi:10.1007/s11162-005-3362-6.

15. Glassick, Huber, and Maeroff, *Scholarship Assessed: Evaluation of the Professoriate*; O'Meara, "Encouraging Multiple Forms of Scholarship in Faculty Reward Systems."

Five years after Boyer’s report, almost half of faculty responding to a national survey stated that there was a greater emphasis on teaching in their institutions and roles than before the report.¹⁶

In spite of Boyer’s symbolic elevation of the importance of college teaching, there is little evidence of a fundamental restructuring of faculty reward systems in the wake of the movement he initiated. Although teaching frequently is institutionalized as a regular (and measurable) part of faculty workload, the campus values and assumptions supporting college teaching are often tacit.¹⁷ Virtually all full-time faculty can describe their work in terms of their teaching “load”—a term that by its nature connotes a burden—but not in terms of teaching’s qualities, or its value to the institution and its students. In many institutions, teaching remains a “second among equals”—overshadowed by research productivity, though typically of greater importance than service.¹⁸

There is one additional feature of contemporary higher education worthy of note: Technological change and its potential to transform college teaching and learning and the professional development of college teachers. Increasingly, technology can mediate the relationships among teachers, learners, and subject matter, in the form of online classes and “flipped” classrooms, to name but two increasingly salient innovations. Some observers are convinced that technological change will fundamentally disrupt and alter existing institutional arrangements;¹⁹ others, drawing on the history of technological change in K-12 schools, are more skeptical about that possibility.²⁰ We acknowledge the potential for technological change to reconstruct the college classroom, but it is not a central focus of our analysis.

This overview summarizes evidence that the external environments of colleges and universities shape their internal cultures, norms, and practices, which

16. Mary Taylor Huber, *Balancing Acts: The Scholarship of Teaching and Learning in Academic Careers* (Washington, D.C.: American Association for Higher Education, 2004).

17. John Braxton, William Luckey, and Patricia Helland, *Institutionalizing a Broader View of Scholarship Through Boyer’s Four Domains* (San Francisco, CA: Jossey-Bass, 2002).

18. We acknowledge that these hierarchies differ by institutional type, as a research-intensive university will have different values and reward structures than, say, an urban community college.

19. Kevin Carey, *The End of College: Creating the Future of Learning and the University of Everywhere* (New York: Riverhead Books, 2015); Ryan Craig, *College Disrupted: The Great Unbundling of Higher Education* (New York: St. Martin’s Press, 2015); Jeffrey J. Selinger, *College (Un)Bound: The Future of Higher Education and What It Means for Students* (Boston: New Harvest, 2013); Henry C. Lucas, *Technology and the Disruption of Higher Education* (Hackensack, NJ: World Scientific Publishing Company, 2016).

20. Larry Cuban, *Oversold and Underused: Computers in the Classroom* (Cambridge, MA: Harvard University Press, 2003); Karen J. Head, *Disrupt This! MOOCs and the Promise of Technology* (Lebanon, NH: University Press of New England, 2017); Susan M. Dynarski, “For Better Learning in College Lectures, Lay Down the Laptop and Pick Up a Pen” (Washington, D.C.: The Brookings Institution, August 10, 2017), <https://www.brookings.edu/research/for-better-learning-in-college-lectures-lay-down-the-laptop-and-pick-up-a-pen/>.

in turn influence faculty work priorities, experiences, and learning.²¹ But attention to high-quality teaching and learning is largely absent here. Changes to institutional decision-making and reward structures can, in some cases, turn faculty attention to teaching, motivating them to teach more, and altering their priorities among research, teaching, and service. What these processes cannot do, however, is alter the content and quality of undergraduate teaching. Only the faculty who are charged with teaching can do this.

We note as well that even for institutions with prominent undergraduate teaching missions, what counts as high-quality teaching is not at all clear. But we believe that these two aims—meaningful improvement in undergraduate teaching and making it an organizational goal—are attainable. We address these concerns in the next two sections of the paper, first by responding to the key question of “What is good teaching?” and then by examining six cases of attempts to improve classroom teaching.

21. Adrianna Kezar, *Understanding and Facilitating Organizational Change in the 21st Century* (San Francisco, CA: Jossey-Bass, 2011); Judith Gappa, Ann E. Austin, and Andrea G. Trice, *Rethinking Faculty Work* (San Francisco, CA: Jossey-Bass, 2007); KerryAnn O’Meara and Corbin M. Campbell, “Faculty Sense of Agency in Decisions About Work and Family,” *The Review of Higher Education* 34 (3) (2011): 447–476, doi:10.1353/rhe.2011.0000.

What Is Good College Teaching?

We take it for granted that college teachers, entering the classroom after years of study and the acquisition of advanced credentials, are knowledgeable about their subjects. They are subject-matter experts who are appointed to teach *something in particular*. It is hard to imagine good teachers who don't know their subjects; but subject-matter knowledge isn't enough. Good undergraduate teachers must have other forms of knowledge as well.

We have educational psychologist Lee Shulman to thank for articulating the forms of knowledge that undergird good college teaching.²² In addition to subject-matter knowledge, Shulman drew attention to two forms of knowledge about teaching practice. The first, *general pedagogical knowledge*, is knowledge that is broadly applicable to all teachers in all subjects—about approaches to managing class time, involving students equitably in class discussions, developing clear and inviting course syllabi, gaining and holding students' attention, managing student group work, and using varied instructional technologies.

The second, *pedagogical content knowledge*, refers to knowledge that teachers have of how students go about learning a particular subject—for example, knowing that all students bring distinctive prior knowledge to their classrooms, and that this knowledge shapes student learning in powerful ways; being aware of the common mistakes that students make in engaging with discipline-specific ideas; and understanding the distinctive ways of thinking through a particular discipline's ideas. Pedagogical content knowledge also includes teachers' facility with bridging students' prior knowledge and the core disciplinary ideas that a student is expected to learn. Thus, students learning mathematics will need to learn different ways of thinking than will students learning history, or biology, or another discipline. Each discipline involves unique modes of thought that must be learned. Unlike general pedagogical knowledge, pedagogical content knowledge is discipline-specific.

Historians, for example, have a distinctive way of thinking that has little to do with the memorization of historical facts such as names, events, and dates. Sam Wineburg has written extensively about how to think like a historian, and the value of relying on primary sources. He notes that historians think about a document's author and its creation, situate the document in time and place, read the document closely, draw on background knowledge to understand the document, determine what is left out or missing from a document and

22. Lee S. Shulman, "Those Who Understand: Knowledge Growth in Teaching," *Educational Researcher* 15 (2) (1986): 4–14, <http://www.jstor.org/stable/1175860>.

its account, and look across multiple sources to see points of agreement or disagreement.²³

Tony Acevedo,²⁴ teaching an introductory course on Western Civilization at Hudson County Community College in New Jersey, applied this knowledge about teaching history in his classroom. He was worried that many of his students were not reading the history texts that he assigned, and when they did, they often became inundated with historical facts, losing sight of any underpinning historical thought. Moreover, he worried that he himself was contributing to the problem through the frequent use of multiple-choice tests that rewarded the recall of names, dates, and events rather than the generation and analysis of cross-cutting historical themes and concepts.

Drawing on the work of David Voelker,²⁵ Tony developed a way to help his students learn some of the basic “thinking moves” in which expert historians engage. Each week, Tony would give students two claims pertaining to the historical topic his class was studying. Two examples are:

- Agriculture was the worst mistake in human history.
- Hitler and the Nazis were mostly to blame for the start of World War II.

Tony asked his students to prepare for class by reading the assigned texts in ways that would position them to take two very different stances on each claim: A stance *for* the claim, and a stance *against* it. For both positions, students were to present accurate and specific evidence; their reasoning, for or against, was to be clear and sound. When students arrived in class, they faced the possibility of being asked to write two paragraphs: one arguing for and the other arguing against one of the pre-specified claims.

To carry out this task, students could not simply memorize and repeat facts. Rather, they had to marshal historical evidence, analyze it, explore emergent historical ideas, and explain those ideas in ways that made sense. Tony described this new assignment, which replaced his multiple-choice tests, as positioning students to think like historians. He found that more students read the assigned texts, and read them more carefully. Students liked the new assessments, finding them more interesting than the earlier multiple-choice approach, and they often wrote paragraphs that wove in content from prior weeks in the term, making larger connections across the course topics.

Tony’s approach fundamentally transformed how many of his students learned history, and strengthened their abilities to think historically. He planned

23. Sam Wineburg, *Historical Thinking and Other Unnatural Acts: Charting the Future of Teaching the Past* (Philadelphia, PA: Temple University Press, 2001).

24. Tony Acevedo was a participant in the Metropolitan Colleges Institute for Teaching Improvement (MetroCITI), a cross-institution initiative to improve teaching in general education courses in high-diversity institutions in the New York City metro area. MetroCITI was directed by Anna Neumann of Teachers College, Columbia University.

25. David Voelker, “Assessing Student Understanding in Introductory Courses: A Sample Strategy,” *History Teacher* 41 (4) (2008): 505–518.

to extend his approach by asking students to write *their own* for and against claims, and to rely more heavily on primary source documents, rather than the more distanced treatments typically available in textbooks.

We use Tony Acevedo to illuminate the importance of discipline-based thinking in undergraduate teaching. But good undergraduate teaching is more than this. Students bring different values, assumptions, experiences, and real-life examples to school that shape their understandings of math, history, biology, and other disciplines. Some of this prior knowledge is helpful to their learning of the disciplinary ideas that teachers present, and teachers can use examples drawn from students' experiences to advance their learning. But prior knowledge that is poorly aligned with the new concepts that students read, study, or hear about in class may impede their learning. Students may ignore new disciplinary ideas, learn them superficially, mislearn them, or outright resist them.

Good college teachers are able to combine the presentation of distinctive disciplinary ideas with knowledge of what students already know and believe. They are likely to know who among their students holds knowledge bearing on the core ideas of the course, and they may leverage this knowledge in their teaching. They may also know what kinds of misconceptions about the topic might hold students back in their learning.

To illustrate this point, we turn to Eryn Klosko, Professor of Geosciences and Chair of the Department of Physical Sciences at Westchester Community College, part of the SUNY system.²⁶ Eryn teaches a course in Earth Science that is the only science course that many of her students will take. She worried that her students didn't really grasp the distinctiveness of the scientific method, and weren't able to apply it to adjudicate competing theories, which would in turn limit their learning in the more advanced portions of the course. She gave students a prelecture questionnaire to ascertain their understanding of scientific beliefs and of pseudoscience, including such things as magic, spirits, aliens, psychic powers, and astrology. In a class of thirty-three students, at least five students, and perhaps more, will embrace pseudoscience or supernatural phenomena, believing pretty much anything they see on television and social media.

Eryn described the difference between a natural, scientific system and a supernatural, belief-based system by using a scientific "checklist" that emphasized the features of the scientific method. She emphasized that science focuses on the natural world; aims to explain the natural world; uses testable ideas; relies on evidence; involves the scientific community; leads to ongoing research; and benefits from scientific behavior.

She gave her students a homework assignment to watch two short video clips from the Animal Planet TV series, "Mermaids Revealed." She asked her students to write a brief essay about the clips and to discuss if the footage was from a documentary or a "mockumentary," using the features of scientific evidence to guide their opinions. (The footage was, of course, from a mockumentary.) Back in the classroom, students discussed the distinction between

26. Eryn Klosko also was a participant in MetroCITI.

empirical evidence and belief. Eryn asked them to think about what sort of evidence would be most convincing to prove the existence of mermaids. All of the students came to understand the features of scientific claims and the experiments to support those claims.

Because Eryn was confident that the scientific method and the ability to distinguish science from pseudoscience are central to the lives of her students and to the mastery of Earth Science, she was willing to devote extended time to its explication, even though that left less time to spend on the rest of her course content.

Since pedagogical content knowledge is rooted in the teaching and learning of particular subject matter, it is the province of faculty such as Eryn, who are experts in their subjects, to evaluate which portions of a discipline's knowledge base students enrolling in a class should master before others; which core disciplinary ideas to focus on in a given semester-long class; how best to represent core ideas (e.g., through relevant images, examples, or metaphors) so that students will grasp them easily; and how to assess students' evolving thinking about subject-matter ideas as they are learning them. Although both Tony Accvedo and Eryn Klosko are skilled undergraduate teachers, Tony's approach to historical thinking, and the learning of history, might not work in Eryn's Earth Science classroom, and in fact might backfire.²⁷

A key feature of Tony's and Eryn's teaching is their ability to spot and correct the errors that students are prone to make in learning their particular discipline. For Tony, such errors include an over-reliance on facts like dates, places, and events rather than concepts such as nation or conflict that are central to understanding history. Similarly, students in Eryn's class hold to prior beliefs in pseudoscience and the supernatural for which no confirming evidence exists, even though their learning about the scientific method requires them to speak to the value of evidence-based ideas. Without Eryn pushing her students to question the underlayer of their prior knowledge and deliberate its validity, the students would gain little insight and skill in scientific thinking. Both of these examples highlight one way in which teachers' acquaintance with students' prior knowledge is valuable: It positions them effectively to correct flaws in their students' prior knowledge, especially when such flaws threaten to misdirect their disciplinary learning or render it superficial.

This view, common in the writing on pedagogical content knowledge, portrays prior knowledge as a *deficit*—something to be unlearned or overcome. In response, some scholars have sought to position prior knowledge, especially the knowledge rooted in cultural practices and beliefs, as a potential *asset* on

27. This by no means precludes the possibility that Tony and Eryn might learn from one another's practice, as the MetroCITI project demonstrated.

which teachers can capitalize.²⁸ Not all prior knowledge is flawed, and some of the prior knowledge that students bring to class can serve as scaffolds for the learning of subject matter.

A classic example of the asset-based approach is Robert Moses' account of teaching the mathematics of subway trips in the Algebra Project.²⁹ Moses saw that young students in Boston sometimes struggled in moving from arithmetic to algebra because they did not join questions about magnitude (e.g., "how many?") to questions about direction (e.g., "which way?"). He had the insight that students could use their knowledge about how to navigate the stations on Boston's subway system, referred to as the T, to reason about Cartesian coordinates and vectors. The relative position of one station to another could be expressed as a displacement from a fixed starting point. For example, students constructed diagrams showing that Park Street Station was three stops inbound from Central Square, whereas Harvard Square was four stops outbound from the Park Street Station. Moses drew on the knowledge of the T and its stations that his students had constructed from daily life in Boston to teach them concepts fundamental to algebra and more advanced mathematics. But this method could work only because the Boston students shared a set of cultural practices about navigating the subway. For a different population of students—say, rural youth in Pennsylvania—a teacher would need to look to different cultural practices and beliefs as forms of prior knowledge on which to build.

All the forms of knowledge we consider here—subject-matter knowledge, general pedagogical knowledge, and pedagogical content knowledge—are on display in good college teaching. Higher education has been slow to acknowledge the promise of the varying forms of knowledge for college teaching. A much more robust knowledge base about how people learn, and how teachers support that learning, infuses K-12 education research, teaching practice, and policy in comparison to postsecondary education.³⁰ We believe that many concepts and research findings derived from K-12 schooling studies can serve as

28. Examples include Gloria Ladson-Billings on culturally relevant pedagogy, Carol Lee on cultural modeling, and Norma Gonzalez, Luis Moll, and Cathy Amanti on cultural funds of knowledge. See, e.g., Gloria Ladson-Billings, "Toward a Theory of Culturally Relevant Pedagogy," *American Educational Research Journal* 32 (3) (1995): 465–491; Gloria Ladson-Billings, "'Yes, But How Do We Do It?': Practicing Culturally Relevant Pedagogy," in *White Teachers/Diverse Classrooms: A Guide to Building Inclusive Schools, Promoting High Expectations, and Eliminating Racism*, ed. Julie Landsman and Chance W. Lewis (Sterling, VA: Stylus, 2006), 29–41; Carol Lee, *Culture, Literacy, and Learning: Taking Bloom in the Midst of the Whirlwind* (New York: Teachers College Press, 2007); and Norma Gonzalez, Luis C. Moll, and Cathy Amanti, eds., *Funds of Knowledge: Theorizing Practices in Households, Communities, and Classrooms* (New York: Routledge, 2005).

29. Robert P. Moses and Charles E. Cobb, Jr., *Radical Equations: Civil Rights from Mississippi to the Algebra Project* (Boston: Beacon Press, 2001).

30. See, e.g., the work of K-12 disciplinary teaching organizations such as the National Council of Teachers of Mathematics; National Council of Teachers of English; National Council for the Social Studies; National Association for Research in Science Teaching; Society for History Education; and the International Group for the Psychology of Mathematics Education, to name but a few.

useful starting points for research on college teaching improvement. But we also acknowledge that because postsecondary settings configure interactions among teachers, learners, subject matter, and contexts in distinctive ways, there may need to be some translation and adaptation.³¹

We would be remiss if we ignored the link between knowledge about teaching and teaching practice. A college physics teacher can, for example, know about peer instruction as a strategy for teaching Newton’s Third Law without actually using it in the classroom, or seek to refine its use via an iterative cycle of experimentation and evaluation. We have emphasized pedagogical content knowledge as a central component of good college teaching practice, but it is not teaching practice itself. Much of what follows is devoted to understanding the conditions for cultivating pedagogical content knowledge and translating it into practice in college classrooms across the country.

Faculty, as subject-matter experts, are not typically taught in graduate school how undergraduate students learn these subjects, nor how to teach them to learn particular disciplinary topics. Most faculty learn how to teach on the job, with little formal preparation. The teaching theories herein described represent a good first step toward developing professional development programs to support faculty members’ growth as teachers. But organizing and supporting successful teaching improvement initiatives requires that their leaders, too, have a deep understanding of what good teaching looks like. We return to this topic in our recommendations. Next, however, we illustrate teaching improvement initiatives on U.S. campuses, and what we see as their strengths and weaknesses.

31. For an example of such translation, see Anna Neumann, “Staking a Claim on Learning: What We Should Know About Learning in Higher Education and Why,” *The Review of Higher Education* 37 (2) (2014): 249–267.

Teaching Improvement Initiatives in U.S. Higher Education

As we have noted, there is growing pressure on the U.S. postsecondary education system to improve the quality of education provided to students. But many improvement efforts, enacted at an abstract policy level, remain distant from the day-to-day teaching and learning within college classrooms. Such efforts rarely reach into teaching practice. Conversely, other efforts that originate on or are attuned to local campuses have sought to develop and assess instructional practices that college teachers use with their students. But many of these efforts emphasize the development of general pedagogical knowledge. Only a handful have seriously tackled the challenge of developing faculty members' pedagogical content knowledge. These rare initiatives have, to date, made only preliminary strides in this direction.

We describe six such examples of the improvement of teaching practice, four internal to a campus, and two external to it, and varying in their emphasis on pedagogical content knowledge and general pedagogical knowledge. These are not intended to be exemplars; rather they illustrate the challenges and potential of systematic undergraduate teaching improvement initiatives. Where appropriate, we comment on their strengths and weaknesses using the approaches to good teaching practice that we presented above as a guide.

Internal Teaching Improvement Initiatives

Teaching improvement on the modern-day American campus is associated usually with teaching centers, faculty mentoring programs, and instructors working alone, or sometimes with others, to improve their teaching reflectively.

Teaching Centers

Teaching centers offer resources and support to faculty seeking to improve their teaching; they are typically constituted as formal (budgeted) organizational units staffed with members of the faculty development profession. Though

data on the total number of teaching centers in existence today are spotty,³² many U.S. institutions of higher education currently lay claim to one and sometimes to several teaching centers. They go by various names—teaching and learning centers, faculty development centers, institutes for improving teaching and learning, teaching excellence centers, and so on—and can be found in all types of institutions, regardless of control or mission. What counts as a teaching center seems to vary greatly—from simple closets to vast and lavishly appointed mega-libraries linked electronically to resources around and beyond a campus. Although some institutions have developed specialized discipline-based teaching improvement centers,³³ we focus primarily on campus-wide centers attending to the needs of faculty who teach undergraduates. The largest of these centers are well used by faculty and richly staffed with specialists and other support staff; they also serve as exemplars to the emergent field of faculty development.³⁴ Yet even the most used and most richly stocked teaching centers are limited in their offerings, given the predefined bandwidth of what teaching improvement stands for on their campuses. We learned that the centers often adopt new sources quickly, building library-like checkout or access systems for faculty on campus, thereby broadening their offerings in response to local need and interest. Though budgeted largely through their institutions’ operating funds, teaching centers may include externally funded efforts. Most teaching centers, and their staffs of faculty developers, affiliate with the Professional Organization Development Network (POD), viewing it as a source of substantive support and professional legitimation, on and off campus.

Our review of pertinent writings and of the websites of several centers suggests that historically, they have emphasized “development” around what it means to be a faculty member and to carry out faculty work, broadly defined (e.g., interacting with students, academic leadership duties, attending to campus imperatives). As the faculty role has changed over time, so have center emphases and offerings.³⁵ In attending to classroom-based teaching improvement, the centers have focused largely on faculty members’ development of general pedagogical knowledge: the teaching expertise that generalizes across all/most disciplines and subject matters (e.g., class management, educational technologies, use of student groups). The centers appear to have shied away from the

32. Our examination of key higher education data bases (e.g., HERI, COACHE, IPEDS) sheds no light on the number of colleges and universities claiming at least one. While helpful, information on teaching center activity on several hundred campuses, compiled by the Professional Organizational Development (POD) network, does not include a full population listing (<http://podnetwork.org/publications/google-custom-search-of-center-web-sites/>).

33. For example, serving the faculty of a school of business, a medical school, a division of arts and sciences, etc.

34. Examples include centers at the University of Michigan, University of Texas, Vanderbilt, and Carnegie Mellon.

35. Mary Deane Sorcinelli et al., *Creating the Future of Faculty Development* (Bolton, MA: Anker Publishing Company, 2006); Andrea L Beach et al., *Faculty Development in the Age of Evidence* (Sterling, VA: Stylus Publishing, 2016).

development of faculty members' pedagogical content knowledge. In researching this, we gleaned that on some campuses, center staff may be exploring the possibility of redirecting center efforts toward service to "faculty collectivities" (e.g., the collective faculty of an academic program versus individuals).³⁶

Clearly, teaching centers are significant loci of professional development and teaching support in higher education. However, rigorous studies of their effects on faculty members' teaching appear nonexistent—or if these do exist, they are not publicly posted.³⁷ Given the sizable institutional resources currently devoted to teaching centers, better data on their offerings, operations, and effects could usefully contribute to teaching improvement.³⁸

Moreover, teaching centers to date have not served as sites for exploring key questions—such as what counts as good teaching in different disciplines and fields and for particular populations (in the spirit of pedagogical content knowledge and related models), or how faculty learn to teach. Yet the very existence of these centers and the massive support they have garnered, especially in larger institutions, suggest that they could orient their work toward these critical issues.

Mentoring Programs

A Google search of "faculty mentoring" yields lots of hits, with many at the top of the list featuring campus-based programs within which senior faculty mentor early-career professors, or peers mentor one another. But what it means for faculty to mentor one another, how it bears on undergraduate teaching, and whether mentoring pays off in helping novice faculty become effective teachers are difficult to discern. Our review suggests that most faculty mentoring programs do not pointedly address teaching improvement, attending instead to the broader array of faculty work in research, teaching, and service.³⁹

36. We base these claims on a limited review of the websites of selected "leading light" centers in different kinds of institutions (four major universities, two four-year colleges, one community college), informal conversations with center staff, websites of professional associations, and numerous research reports (herein cited).

37. We have learned that at least one major university, with an exemplary teaching center, reviews that center through its multi-year program review cycle. We did not have access to that university's review report and thus could not investigate what was learned. We do not know how widespread such practices are.

38. Though listing their services and resources, most of the centers we explored do not appear to document and analyze the teaching and professional interactions at their core. We identified no large-scale center assessments. Nor are we aware of theory-driven, in-depth research on their activities and outcomes. This is surprising given the proliferation of centers, their increased holdings and services, expanding staffs, and direct costs, some running well over a million dollars a year.

39. We conducted a Web of Science search for social sciences reports (scholarly books and peer-reviewed articles) on faculty mentoring, published between 2000–2016; our search yielded 110 sources. Close examination of these sources indicated virtually no attention to teaching improvement. Instead sources focused on mentoring as general support, especially for junior faculty seeking to learn the full range of responsibilities required of them; implications for faculty commitment and retention; women in the sciences as responsive to mentoring; and mixed responses to mentoring by faculty of color and needs to adjust the process.

To be sure, faculty mentoring, as practiced in many institutions, is viewed as experienced and/or expert faculty guiding novices, and this can extend to teaching practice. But who is eligible for such a mentoring relationship, what is the purpose, and how does mentoring proceed are typically not well-specified. In many institutions, faculty mentoring may be more admired than implemented. As institutions seek to demonstrate their legitimacy to external stakeholders, it is little wonder that faculty mentoring gets featured on institutional websites.

Beyond the ambiguities of “mentoring of what?” and “for whose benefit?” we find a relatively weak research base for faculty mentoring other faculty in higher education. A wide-ranging review of research on mentoring in business and higher education by Darlene Zellers, Valerie Howard, and Maureen Barcic prefigures our assessment. Pointing out the range of “vibrant faculty mentoring programs” identifiable on the websites of leading American university campuses (e.g., Iowa State University, University of Wisconsin, Indiana University, and Stanford University, among others), the study’s authors registered surprise that “little scholarship is being generated and/or disseminated about these model programs.”⁴⁰ This is as true of less prestigious institutions as it is of these research-intensive universities.⁴¹

Mentoring programs such as these do give some attention to teaching, but they largely elide key issues such as how an instructor might go about identifying key subject matter ideas to be taught in an introductory class; how students will likely make sense initially of core disciplinary ideas; how students will experience instructors’ approaches to addressing their prior knowledge (framed either as assets or misconceptions); and how to select and deploy subject-matter representations likely to advance students’ disciplinary understanding. As we note elsewhere in this paper, campus reward structures rarely orient novice faculty or their mentors to the nature or quality of undergraduate teaching, and campuses offer few explicit opportunities for faculty to discuss such questions relative to their own discipline. It is thus disappointing but not surprising that researchers and leaders have paid so little attention to faculty mentoring as a mechanism for undergraduate teaching improvement, especially given its potential to develop general pedagogical knowledge and to cultivate pedagogical content knowledge as foundations for teaching practice.

Guided Reflection Programs

Students are not the only learners in higher education; faculty learn too. Pay-offs of faculty learning include improved performance as teachers and scholars; and modeling learning as a type of professional expertise for students’ bene-

40. Darlene Zellers, Valerie Howard, and Maureen Barcic, “Faculty Mentoring Programs: Reenvisioning Rather Than Reinventing the Wheel,” *Review of Educational Research* 78 (3) (September 1, 2008): 580.

41. Credible research designs for assessing the impact of mentoring initiatives are hard to construct, given small participant samples, reliance on diffuse outcome measures, heavy reliance on self-reports, and tendencies toward self-selection into programs.

fit. Although more needs to be understood about college instructors' learning, research suggests that one process, in particular, is key: that is, reflection, defined as instructors probing their own thoughts about teaching—before, during, or after engaging in it.⁴²

But what kinds of things may college and university faculty learn while teaching? Research has shown that faculty learn about teaching, subject matter, and students' learning as they teach, and as they reflect on that teaching both before and after instruction.⁴³ Yet we have little research-based knowledge about what inspires and supports such reflection, how it is manifest, how it unfolds, and how it impacts students' learning.

Eric Mazur and his colleagues' development of the peer-instructional model, including a protocol for guiding teachers' analyses of students' thinking in response to brief segments of instruction, stands as an exception. Developed from within Mazur's and others' own teaching, the model requires an instructor to offer brief instruction around a meaningful unit of subject matter (e.g., an aspect of a physics concept), collect data on students' understanding of the unit, then analyze the data toward on-the-spot decisions about optimal next steps. The cycle then repeats with new content and instruction. A single class session may include several cycles. The peer-instruction model structures teachers' reflection on their students' subject-matter thinking and their own decision-making with regard to next instructional moves.⁴⁴ Research on the impact of the peer instruction model on students' understandings of physics concepts indicates significant positive effects.⁴⁵

42. Donald Schon, *Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions* (San Francisco: Jossey-Bass, 1987); Donald Schon, *The Reflective Practitioner* (New York: Basic Books, 1983). We refer to initiatives focusing on faculty reflection as guided reflection programs, although the notion of "guidance" underlying such initiatives is diffuse, as reflection can be solo or occur amidst others, and learning from reflection may reside primarily in one faculty member or be shared among colleagues.

43. Deborah Ball, "With an Eye on the Mathematical Horizon: Dilemmas of Teaching Elementary School Mathematics," *The Elementary School Journal* 93 (4) (1993): 373–397; Ruth Heaton and Magdalene Lampert, "Learning to Hear Voices: Inventing a New Pedagogy of Teacher Education," in *Teaching for Understanding: Challenges for Policy and Practice*, ed. David Cohen, Milbrey McLaughlin, and Joan Talbert (San Francisco: Jossey-Bass, 1993), 43–83; Schon, *Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions*; Schon, *The Reflective Practitioner*; Anna Neumann, *Professing to Learn* (Baltimore: The Johns Hopkins University Press, 2009).

44. Eric Mazur, *Peer Instruction: A User's Manual*, 1st ed. (Upper Saddle River, NJ: Prentice Hall, 1997); Julie Schell, ed., *What Is Peer Instruction...in 2 Mins*, <https://blog.peerinstruction.net/2014/05/01/what-is-peer-instruction-in-2-mins> (accessed 2017).

45. Catherine H. Crouch and Eric Mazur, "Peer Instruction: Ten Years of Experience and Results," *American Journal of Physics* 69 (9) (2001): 970–977; Mercedes Lorenzo, Catherine H. Crouch, and Eric Mazur, "Reducing the Gender Gap in the Physics Classroom," *American Journal of Physics* 74 (2) (2006): 118–122; Nathaniel Lasry, Eric Mazur, and Jessica Watkins, "Peer Instruction: From Harvard to the Two-Year College," *American Journal of Physics* 76 (11) (2008): 1066–1069.

Mazur's peer-interaction model focuses heavily on what Donald Schon calls "reflection in action."⁴⁶ Seeking to strengthen some oft-ignored phases of teaching, especially planning and post-hoc reflection, other researchers call for the production and curating of artifacts of students' semester-long learning in subject-matter classes. The resulting learning portfolios array data on students' thinking in response to instruction, enabling teachers to reflect on the assembled data and to channel insights into plans for their future teaching. Still other researchers focus on instructors' assembling of teaching portfolios featuring their instructional actions and related insights; these portfolios also are believed to stimulate instructors' reflection on teaching.⁴⁷ Vivid examples of how portfolios, and related tools, can contribute to postsecondary teaching improvement are evident in the work of scholars associated with the Carnegie Academy of the Scholarship of Teaching and Learning (CASTL), which we discuss in the next section.

Although "reflection in action" is often a solo activity, we believe that guided reflection may contribute to future undergraduate teaching improvement efforts. Subject-specific efforts such as those piloted by Eric Mazur, and by proponents of teaching portfolios, may extend beyond general pedagogical knowledge into the pedagogical content knowledge we deem so central.

The Science Education Initiative

Although the three preceding teaching improvement initiatives have focused on college teachers, with little attention to organizational context, the Science Education Initiative (SEI) addresses both. Physicist Carl Wieman has recently recounted the history of the SEI, an effort to improve the teaching of science at the University of Colorado (CU) and the University of British Columbia (UBC) over roughly the past decade.⁴⁸ He oversaw a competitive grants program to six science departments in each institution, awarding approximately \$1 million per department over a five- or six-year period (around \$5 million at CU and \$10 million at UBC).

Wieman recognized that the formal incentive system in each institution was the primary barrier to change. He believed that a competitive grants program with department-level awards of a sizeable amount could transform science teaching. The department was the key unit of change, as courses are lodged in departments. The change mechanism was what he referred to as Science Education Specialists (SEs): postdoctoral fellows with disciplinary knowledge

46. Schon, *Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions*; Schon, *The Reflective Practitioner*.

47. Nona Lyons, *With Portfolio in Hand: Validating the New Teacher Professionalism* (New York: Teachers College Press, 1999); Val Klenowski, Sue Askew, and Eileen Carnell, "Portfolios for Learning, Assessment and Professional Development in Higher Education," *Assessment & Evaluation in Higher Education* 31 (3) (2006): 267–286.

48. Carl Wieman, *Improving How Universities Teach Science: Lessons from The Science Education Initiative* (Cambridge, MA: Harvard University Press, 2017).

and teaching expertise who were hired by, and embedded in, the academic departments. Working with the SESs, faculty could examine what students *should* be learning in a particular course; what they were *actually* learning; and what research-based instructional practices could promote the desired learning. Although implementation of the SEI was uneven across departments, Wieman found evidence that hundreds of thousands of credit hours in science classes each year were taught differently—i.e., using practices drawn from the learning sciences—due to the initiative.

Wieman’s book is full of insights, some specific to the SEI and others applying more broadly to teaching improvement efforts. Although the initial focus was on transforming *courses*, he came to understand that transforming *faculty* was more appropriate; some faculty would vigorously resist curricular and instructional change, seeing it as a threat to their professional identities, and it made more sense to work with those faculty who were more receptive to innovation. Wieman also concluded that he had underestimated the importance of direct incentives to faculty for engaging in course transformation, such as course releases, extra teaching assistants, or partial support for a research assistant. The incentives, he mused, needed to be substantial enough that the threat of losing them would spur compliance with the initiative’s goals.

Finally, Wieman saw the overall quality of management and organization within the institution and its departments as the primary determinant of whether the SEI was well-implemented in a department. Change was unlikely to occur unless actors at every institutional level—system heads and policy leaders, college presidents and senior administrators, and department chairs and individual faculty—came to understand good undergraduate teaching as subject-matter driven, student-knowledge driven, and research-and-assessment driven. Some departmental cultures, especially those that downplayed collective activity, reduced the likelihood of success. Conversely, some department chairs took strategic action to support the SEI, such as reassuring junior faculty that poor course evaluations in an early iteration of a transformed course would not be held against them.

Wieman remains optimistic, as do we, about the potential of research-based teaching improvement initiatives such as the SEI to improve undergraduate teaching, in the sciences and other fields. There are some warning signs, however, even beyond the significant learning curve that exists for faculty to establish learning goals, document student thinking, develop instructional materials, and assess their impact. The sustainability of course transformation at the department level in the absence of substantial external incentives is an unknown, and in several of the funded departments at CU and UBC, fewer than 50 percent of the faculty participated in the initiative. Moreover, even a well-funded initiative such as SEI was poorly aligned with campus-level policies and practices regarding faculty promotion and tenure and the level of central support for academic departments.

We see the lessons of the SEI about the importance of braiding teaching improvement at the individual instructor level with teaching improvement at

the department level, both driven by learning sciences research, as especially useful for future undergraduate teaching improvement initiatives, whether in the sciences or other fields of study.

External Teaching Improvement Initiatives

Though campus-supported teaching centers and mentoring programs are conveniently positioned to guide instructional improvement on faculty members' home campuses, external organizations and communities supporting individual faculty members in undergraduate teaching improvement have also arisen. Below, we review two of the most promising examples: the Carnegie Academy for the Scholarship of Teaching and Learning (CASTL) and the Discipline-Based Education Research (DBER) community.

The Carnegie Academy for the Scholarship of Teaching and Learning (CASTL)

In 1998, Lee Shulman, president of the Carnegie Foundation for the Advancement of Teaching, established CASTL as a route to higher education teaching improvement. One may interpret Shulman's leadership as an effort to render useable the scholarship of teaching and learning (SOTL) that his predecessor, Ernest Boyer, had broadly conceptualized.⁴⁹

Boyer's SOTL and Shulman's pedagogical content knowledge complemented one other. SOTL theorized college teaching as a form of scholarship rooted in faculty members' disciplinary knowledge, whereas Shulman's pedagogical content knowledge offered teachers ways to use their disciplinary expertise in classrooms to support student learning. Thus, SOTL spoke to faculty scholarly values and career aspirations; pedagogical content knowledge offered tools for teaching improvement. Combined, the two concepts yielded a vision of teaching as public, and thereby open to colleagues' review and use; subject to the oversight of scholar-teachers with deep understanding of subject matter; and shared within a community of subject-matter teaching experts and novices (i.e., scholarship as "community property").⁵⁰ CASTL could bring this vision of a link between college teaching practice and its improvement to life.

CASTL involved three sets of actors: disciplinary teacher-scholars (CASTL Scholars), disciplinary and professional associations, and college and university campuses. According to Carnegie researchers Pat Hutchings, Mary Taylor Huber, and Anthony Ciccone, CASTL sought to "build a critical mass of scholars of teaching and learning whose work would show what was possible [in and through college teaching], illustrate the diverse shapes and forms that

49. Ernest L. Boyer, *Scholarship Reconsidered: Priorities of the Professoriate* (San Francisco: Jossey-Bass, 1990). According to Boyer, four scholarships frame faculty work and careers: discovery, integration, teaching, and application.

50. Ibid.; Lee Shulman, *The Wisdom of Practice: Essays on Learning, Teaching, and Learning to Teach* (San Francisco, CA: Jossey-Bass, 2004).

SOTL could take, and serve as models for work by others.”⁵¹ Given its roots in pedagogical content knowledge, alongside broader insights on teaching as a form of faculty work in contemporary higher education, CASTL left few instructional stones unturned.

The CASTL Scholars program was designed as a ten-day summer residency during which CASTL Scholars clarified their plans for a teaching-learning project. This was followed by a second ten-day residency a year later during which the Scholars presented project results, implications, and plans for advancing their efforts and sharing them with others. CASTL Scholars also participated in an interim winter meeting to address opportunities and challenges in their work.

A distinctive feature of CASTL is that it was well-studied. A series of monographs documented its aims and concrete products—the latter, through case portrayals of classroom practice.⁵² A final survey of the CASTL Scholars painted a detailed picture of participants’ learning from immersion in the program.⁵³ In providing exemplars of CASTL Scholars learning to engage in continuous teaching improvement, documenting implementation processes, and revealing changes in participants’ teaching orientations and practices, this body of research served as a proof of concept while laying the groundwork for a pedagogical content knowledge of higher education.⁵⁴ CASTL’s results were promising and unfolded over a decade of intensive activity among 158 CASTL Scholars organized in six cohorts.⁵⁵ What remains unclear is the extent to which CASTL Scholars shared their learning with campus colleagues, and what campus-based mechanisms facilitated such exchanges.⁵⁶

Three features of CASTL bear particular attention in light of our exposition of the contributions of the learning sciences to good teaching: One, CASTL’s

51. Pat Hutchings, Mary Taylor Huber, and Anthony Ciccone, *The Scholarship of Teaching and Learning Reconsidered* (San Francisco, CA: Jossey-Bass, 2011), 153–154.

52. Mary Taylor Huber, *Balancing Acts: The Scholarship of Teaching and Learning in Academic Careers* (Washington, D.C.: American Association for Higher Education, 2004); Mary Taylor Huber and Pat Hutchings, *The Advancement of Learning: Building the Teaching Commons* (San Francisco, CA: Jossey-Bass, 2005); Hutchings, Huber, and Ciccone, *The Scholarship of Teaching and Learning Reconsidered*. Through the life of CASTL, the Carnegie Foundation website featured an extensive gallery of portfolios, developed by CASTL Scholars and featuring subject-matter presentations, tools, and course materials. With thanks to Gary Otake for access on December 15, 2016, to an inactive site: <https://mail.google.com/mail/u/0/#search/Carnegie/15904a40057538c4>.

53. Rebecca Cox, Mary Taylor Huber, and Pat Hutchings, “Survey of CASTL Scholars,” in *The Advancement of Learning: Building the Teaching Commons*, ed. Mary Taylor Huber and Pat Hutchings (San Francisco, CA: Jossey-Bass, 2005), 135–149.

54. We note, though, that CASTL’s exemplary attention to subject matter may have overshadowed the role of students’ prior cultural knowledge in conceptualizing a pedagogical content knowledge of higher education.

55. Hutchings, Huber, and Ciccone, *The Scholarship of Teaching and Learning Reconsidered*.

56. For a similar analysis, see Steven Brint, “Focus on the Classroom: Movements to Reform College Teaching and Learning, 1980–2008,” in *The American Academic Profession: Transformation in Contemporary Higher Education*, ed. Joseph Hermanowicz (Baltimore, MD: The Johns Hopkins University Press, 2011).

explicit focus on disciplinary knowledge, including how this emphasis bridges to a view of teaching as scholarship; two, the accountable consistency with which the SOTL/pedagogical content knowledge vision was threaded through CASTL Scholars' work; and three, continuing formative assessment as a key to individuals' and collective learning. It is noteworthy that CASTL's perspective on teaching and teaching improvement is closely aligned with that guiding Carl Wieman's SEI, which also is an example of Discipline-Based Education Research (DBER), which we discuss next.

Discipline-Based Education Research (DBER) Community

According to a 2012 report by the National Research Council's (NRC) Committee on the Status, Contributions, and Future Directions of Discipline-Based Education Research, DBER seeks to "combine the expertise of scientists and engineers with methods and theories that explain learning."⁵⁷ With support from the National Science Foundation, DBER scholars seek to understand and improve undergraduate students' learning and instructors' teaching of science and engineering in ways that reflect each "discipline's priorities, worldview, knowledge, and practices."⁵⁸ DBER's goals are to:

- understand how people learn the concepts, practices, and ways of thinking of science and engineering;
- understand the nature and development of expertise in a discipline;
- help identify and measure appropriate learning objectives and instructional approaches that advance students toward those objectives;
- contribute to the knowledge base in a way that can guide the translation of DBER findings to classroom practice; and
- identify approaches to make science and engineering education broad and inclusive.⁵⁹

As an emerging professional movement, DBER reflects some of the strengths we have previously identified in CASTL and the SEI. First, the goals of DBER align well with the view of good teaching promoted by the learning sciences, and especially practice-based research on the teaching and learning of disciplinary subjects. Second, perhaps by virtue of their scientific training, DBER scholars value assessment and research; DBER-derived findings have significant credibility. Third, DBER's bottom-up quality, originating within the instructional experiences of teacher-researchers, suggests that these individuals' research questions will go to the heart of their teaching practices. Fourth,

57. Susan Singer, Natalie Nielsen, and Heidi Schweingruber, *Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering* (Washington, D.C.: National Academies Press, 2012), 1.

58. Ibid.

59. Ibid, 9.

DBER's anchoring in practice also may account for its rapid spread across the country—onto campuses, into some professional associations, and, possibly, into the faculty staffing patterns of some undergraduate science programs.⁶⁰ Fifth, faculty members' voluntary and seemingly uncompensated contributions to DBER signal its sustainability.

As expected, questions and challenges remain. First, we identified no extant efforts to examine the quality of DBER products (e.g., research reports, documented pedagogical improvements, etc.), especially their grounding in current research-based conceptions of teaching and learning. Although the publications and websites of prominent agencies (e.g., NRC, National Academies) proclaim such an alignment, it will be important to assess the extent to which aspirations match up with reality. Second, we cannot discern the amount or quality of interaction between the learning sciences community and the DBER community. DBER's impact on undergraduate teaching will be greatest if the two communities collaborate and learn from one another.

60. The first thirty hits of a Google search on DBER yielded notices of DBER interest group meetings on several university campuses (University of Nebraska, University of Colorado, MSU, RIT, George Mason University) and two professional associations (National Association of Geosciences Teachers) along with a job description for a tenure-track assistant professor in “Earth, Ocean or Environment Discipline-Based Education Research (DBER).”

Summary and Recommendations

We began our exploration of undergraduate teaching improvement in the United States with a description of some of the forces shaping teaching policies and practices on contemporary campuses. Undergraduate teaching quality has never been central to how institutions of higher education see themselves, and the external forces pressing on these institutions—e.g., expanding access, generating graduates, remaining solvent, and doing more with less—do little to alter this fundamental fact.⁶¹ Institutions are not immune to the laws of supply and demand, and organize their behavior to maintain a flow of students and resources. Key stakeholders—students and their parents; policy-makers; and the (tax-paying) public—rarely identify the quality of undergraduate teaching as a key concern, even as public accountability systems and the assessment of student outcomes have taken hold. And, to the extent that research universities represent the aspirational ideal for many institutions of higher education, their attention to the primacy of research reverberates throughout the higher education system, suppressing attention to individual students’ learning and to the teaching that advances it.

Altering this dynamic, we believe, begins with educating these stakeholders about the nature and importance of good undergraduate teaching. Good teaching practice requires several forms of professional knowledge: subject-matter knowledge (which we take as a given among college and university instructors); broad teaching skills that transfer across disciplines and fields of study, which we refer to as general pedagogical knowledge; and pedagogical content knowledge, the discipline-specific instructional skills that combine a deep knowledge of subject matter (and the distinctive concepts, methods, and ways of thinking inherent to particular disciplines), and how it is learned, with attention to students’ prior academic, cultural, and personal knowledge. Without this guiding view, it is hard to imagine how teaching improvement of any kind can proceed in meaningful and coordinated ways.

Our view of good undergraduate teaching must be supported by continuing assessment and research as drivers of ongoing improvement and change. Knowledge about teaching, and about its improvement, is scant, scattered, and varied in focus and quality. Our review suggests that improvement efforts

61. This is not to say that institutions of higher education have never been concerned with students’ exposure to particular bodies of knowledge, such as the liberal arts. Clearly, they have. But attention to curriculum, and even to small seminars as a delivery method, is not the same as attention to teaching quality.

pervade the history of higher education, but with a few recent exceptions, these have not been documented, and one generation's learning often is lost to the next. Higher education teachers, researchers, leaders, and policy-makers would benefit from documentation and analysis of future teaching improvement efforts, and of the vision of good teaching to which those efforts aspire.

Our review of teaching improvement initiatives, whether internal or external to a particular campus, reveals that teaching improvement is most likely when there is coordinated activity at multiple levels of the academic enterprise. Coordination is a significant issue that has received minimal attention. We also note (and discuss more fully in our recommendations) the potential for meaningful and sizeable incentives to strengthen the teaching efforts of individual faculty and academic departments. Such resources must be budgeted and put under the direction of institutional leaders with deep knowledge of both pedagogical content knowledge and organizational change mechanisms. Ideally, they will see undergraduate teaching improvement as both a faculty-based professional endeavor and an institutional process that they are responsible for guiding. When individuals have a deep understanding of a phenomenon such as undergraduate teaching, they are likely to bring it into play even when making decisions about topics that, on the surface, appear to be separate from teaching. For example, decisions about resource allocation, institutional values and positioning, fundraising, and the like will benefit from decision-makers' prioritization of students' academic learning and instructors' teaching.

Undergraduate teaching improvement may be expensive, and it is undoubtedly time-consuming. Institutional leaders must be prepared to promote it in public and in private, through all of the organizational tools available to them. Doing so, we believe, can elevate the importance of undergraduate teaching, generate promising teaching improvement efforts, and sustain the accomplishments of well-designed initiatives. Below, we offer a set of recommendations to guide these efforts.

Recommendations

We differentiate our policy recommendations by the policy actors involved: campus and system leaders, academic department leaders, disciplinary associations, and government and philanthropic foundations.

Recommendations for Campus and System Leaders

- Assess the role of undergraduate teaching in the institutional culture.

A first step toward the improvement of undergraduate teaching is understanding the current landscape. What is the evidence that undergraduate teaching matters in your institution? Do institutional administrators and governing boards value undergraduate teaching? Are decisions about resource allocation and budgeting at all responsive to institutional teaching improvement initiatives and the realities of teaching practice? How

do administrators understand the links between undergraduate teaching and other forms of faculty work, such as research and service?

- Analyze and realign the formal faculty incentive system.

In most institutions, the rewards for good undergraduate teaching are primarily intrinsic; many faculty want to share their love of their subjects with their students, and strive for a sense of competence as instructors. But formal faculty incentive systems rarely reward good undergraduate teaching. Teaching receives little attention, and even the teaching artifacts that are produced for tenure, promotion, and merit reviews are poor proxies for good practice. We recommend increasing the salience of teaching quality in reviews of faculty performance, such as reappointment, promotion and tenure, or annual merit reviews. There are several strategies for doing so. These include relying more heavily on teaching portfolios and expert observations of teaching practice; supporting instructors in the development of more detailed and specific teaching narratives that pointedly address pedagogical content knowledge and its grounding in subject matter and students' cultures, and encouraging their self-reflection on their teaching practice; and reducing reliance on student course evaluations as a mechanism for evaluating teaching quality. The formal faculty incentive system also can be expanded by developing criteria for teaching awards, with substantial cash incentives and expectations for winners to participate in campus-level undergraduate teaching improvement activities. College leaders can solicit funds to support the award of Endowed Teaching Chairs, with the goal of elevating the importance of teaching symbolically, rewarding expert teachers, and promoting the dissemination of effective undergraduate teaching practices.

A different kind of incentive applies to individuals or departments to engage in course-level teaching development to improve content and pedagogy. Course-level improvement could be supported by institution-level competitive grants programs with clear criteria for deliverables and timelines, and valuable incentives such as supplemental teaching and/or research assistants, releases from other faculty responsibilities, or salary supplements may leverage change.

- Fund and fill tenure-track faculty positions that emphasize undergraduate teaching.

Hiring faculty oriented toward teaching into tenure-track positions could increase the visibility and prestige of teaching in the faculty role. And since tenure-track and tenured faculty often fill leadership and governance roles, hiring faculty with an explicit orientation toward and commitment to undergraduate teaching can help ensure

that good undergraduate teaching receives consideration in academic decision-making.

- Create teaching improvement efforts oriented to the entire campus, to academic departments, and to individual faculty.

Although campus-level teaching improvement initiatives contribute to building a culture that supports teaching at an institution, these initiatives and the culture do not themselves improve teaching. Faculty, within departments, are the real change agents, but many faculty may only change their orientations and practice with campus-level supports. Orienting improvement efforts that address each of the campus, department, and individual faculty levels will be more likely to produce sustained change than efforts that treat these levels in isolation from one another.

- Put someone in charge of undergraduate teaching improvement at the campus level, and give that person authority and resources.

Organizational change requires legitimate authority and a stock of resources, as institutional cultures often support maintaining the status quo. A campus official must serve as an ambassador, who clearly and regularly speaks to the importance of undergraduate teaching. A major focus of this person's job is to illuminate good undergraduate teaching practices. It is also essential that she or he have the budgetary resources to reward innovation and excellence. This may distinguish the leadership position on undergraduate teaching improvement that we call for from the director of a campus teaching center, a more constrained role with less authority. There are, nevertheless, some potential overlaps. The campus official, complemented by or working with a teaching center director, can publicize the existence of a knowledge base for good college teaching; oversee creation of institution-level archives of good practice and models of good teaching so that they can be shared; promote peer observation of classes within and across departments; promote peer observation of classes across institutions; and collaborate with other campus academic leaders to realign the formal incentive system to support good undergraduate teaching.

We acknowledge, though, that it is all too easy to place someone into such a role and assume that the work is done. A campus-level official is necessary but not sufficient to ensure campus-wide teaching improvement. It is the policies and practices that the official creates and oversees, and the community of teacher-scholars that she or he supports, that are the real drivers of teaching change.

Recommendations for Academic Departments

- Prepare graduate students to teach.

Scholars enter graduate school and pursue academic careers to interact with subjects that are meaningful to them. The study of these subjects should routinely include attention to how to teach them. Even graduate students who do not aspire to academic careers can benefit from thinking about how to teach subjects they know deeply to novices. It is doubly important for graduate students to learn both general pedagogical skills and the skills to teach their subjects, as they represent a substantial share of the undergraduate teaching force in most institutions.

- Provide management and organizational support for teaching improvement to academic departments.

Department chairs and heads are rarely recruited and selected on the basis of their expertise in undergraduate teaching. As is true for many aspects of the role, new chairs and heads learn about teaching and how to support its improvement by trial and error. We recommend that department chairs receive a sustained introduction to the research base on college teaching and learning that can orient them to a program of department-level activity.

- Balance the academic department and individual faculty members as the key unit of change.

Do not assume that all faculty will change their teaching practice. Start with those expressing an interest in change, and build around them. It is likely that the faculty on a campus interested in improving their teaching will be drawn from multiple departments and fields of study, and the campus official in charge of undergraduate teaching improvement will need to orchestrate how they engage with one another without diminishing the centrality of disciplinary knowledge and ideas.

At the same time, curriculum and courses are situated within academic departments, and although individual faculty may claim “ownership” of a course, it is the department that has responsibility for what is taught. We strongly suggest focusing undergraduate teaching improvement on lower-division introductory courses that reach large numbers of students. These courses introduce core disciplinary ideas, and they offer students foundational knowledge for studying other disciplines and fields. Lower-division introductory courses also are gateways to more advanced study in a discipline or a related professional area.

- Build teaching expertise and promise into the faculty recruitment cycle.

A department that takes teaching seriously will seek to recruit faculty who can demonstrate their expertise or promise as classroom teachers.

Teaching expertise and/or promise can be an explicit qualification for faculty positions, and the process of reviewing candidates can involve a variety of artifacts of teaching performance, such as teaching demonstrations or detailed statements about teaching practice that go beyond rote statements of a teaching philosophy.

- Invigorate department-level curriculum and teaching committees.

Department curriculum committees can become stale, focusing on minutiae while losing sight of the bigger picture. We encourage department-level curriculum committees to treat teaching (and courses and curriculum) as community property, rather than the exclusive property of individual faculty. Students learn more in settings where there is collective responsibility for student learning, including shared ownership of courses and curriculum.⁶²

- Cover important material more deeply, and reduce the amount of material presented in each course.

Create and assess measurable student learning outcome goals at the course level that relate to the big ideas in a course. We also recommend reducing the expanse of material to be covered in particular courses. This is not to be read as a “dumbing down” of the curriculum, but rather a plea to focus on the big ideas in a course and the discipline or field in which it is situated, and to cover them more deeply, clarifying how the ideas in a particular course may be linked to ideas in other courses.

Recommendations for Disciplinary Associations

- Develop discipline-specific undergraduate teaching resources to support the teaching of core disciplinary ideas.

Disciplinary associations are well-situated to create sharable archives of teaching resources, including syllabi, video demonstrations of the teaching of core ideas, classroom exercises, and sample assessments. But disciplinary associations have generally shied away from articulating core concepts and competencies to be taught through the use of such resources. Foundations have been more active in promoting disciplinary frameworks for teaching, learning, and assessment. A key opportunity for future philanthropic support is the development of models of discipline-specific pedagogical content knowledge—the knowledge of how to teach particular disciplinary topics to specific groups of learners.

62. Valerie E. Lee and Julia Smith, “Collective Responsibility for Learning and Its Effects on Gains in Achievement for Early Secondary Students,” *American Journal of Education* 104 (3) (1996): 103–147.

- Develop discipline-specific banks of formative and summative assessments of student learning to support research on effective pedagogical practices.

It is difficult to assess the fruits of an innovative teaching practice without valid and reliable measures of student learning that are independent of a particular instructor. Disciplinary associations can lead in developing assessment resources, especially those that reveal students' thinking about the subject matter they are studying.

- Develop protocols for college classroom observations in particular fields of study.

Disciplinary associations, with their deep understanding of disciplinary concepts and competencies, may be successful in developing classroom observation protocols that are sensitive to subject matter. Although some disciplines sponsor teaching journals that publish articles about college teaching practice, and others have compendia of syllabi, there is little attention to what happens in the classroom in real time. In recent years, the evaluation of K-12 teaching performance has been augmented by standardized classroom observation protocols, such as Charlotte Danielson's *A Framework for Teaching*. It is unclear to what extent such protocols are appropriate for addressing the teaching of particular subjects in college classrooms, although there may be some use for understanding general pedagogical practice.

Recommendations for Government and Philanthropic Foundations

- Develop a DBER approach for the humanities and for the social sciences.

One of the most promising approaches to undergraduate teaching improvement has been discipline-based education research (DBER), an approach to study how students learn in particular scientific disciplines and how to improve instruction in those fields. The National Science Foundation has been a major funder of DBER, and the Board on Science Education of the National Research Council has also provided leadership in convening researchers and practitioners. Whereas DBER has, to date, been limited to science and engineering, there is good reason to think that many of the principles that undergird its approach to the improvement of teaching and learning can pay off for the humanities and the social sciences as well. We have no doubt that the learning sciences can contribute to understanding how students encounter ideas in the humanities and social sciences, as well as lead to effective instructional practices, as they already support scientific understanding in DBER. But funders will need to prioritize this research agenda.

- Develop resources for eliciting students' prior academic and cultural knowledge.

Research from the learning sciences makes clear that students' prior knowledge is a central part of the learning process, and that effective teaching makes use of that prior knowledge, whether academic, cultural, or both. But there are few protocols for eliciting such prior knowledge at the college level, and individual faculty are left to their own devices. Further, many college faculty think of teaching as the dissemination of subject-matter knowledge, rather than as the purposeful linking of disciplinary ideas to what students already know and believe. Basic research on measuring and eliciting students' prior academic and cultural knowledge would be a significant advance.

- Create cross-institutional, annotated “galleries” of the good teaching of core disciplinary concepts.

Everyone can benefit from seeing more examples of good college teaching, and virtual “galleries” with multiple representations and annotations are an excellent dissemination mechanism. Although disciplinary associations might organize such representations focused on specific disciplinary ideas, they typically would not look beyond their own discipline. And a particular college or university is likely to feature good teaching as it exists solely on its own campus. Organizations with a broader purview, such as philanthropic foundations, can draw on multiple institutions and a myriad of disciplines to create galleries that can stimulate thinking about good undergraduate teaching.

- Conduct basic research on college students' learning of subject matter, and effective approaches for teaching to support that learning.

All of these recommendations assume shared knowledge of how college students learn core disciplinary ideas and modes of thought, as well as how teachers can promote such learning. But much of what we know about disciplinary learning comes from the K-12 classroom, and there has been less research on college classrooms. Though some research findings about teaching and learning in K-12 classrooms may transfer to higher education settings, others may require revamping. Government and philanthropic foundations can augment the knowledge base about undergraduate teaching and learning through grantmaking.

- Educate the public on what good college teaching looks like.

This is easier said than done, as virtually everyone, whether a college attendee or not, has a reservoir of personal experience in the classroom that shapes his or her understandings of learning and of teaching. Nevertheless, persuasive examples of good college teaching—and of institutions and/or departments that value and model good college teaching—may create momentum for financial and political support of undergraduate teaching improvement.

Throughout these recommendations, we have sought to convey two key themes: the importance of organizing undergraduate teaching improvement efforts around the teaching and learning of specific disciplines and subjects (especially pedagogical content knowledge), and the value of considering multiple levels of the higher education system, and the key policy actors within those levels (including faculty themselves) simultaneously. Doing so, we believe, will maximize the likelihood that undergraduate teaching practice, and efforts to improve it, will thrive.

Contributors

Corbin M. Campbell is Assistant Professor of Higher Education at Teachers College, Columbia University. Her research focuses on understanding the organizational contexts that support learning and agency for students and faculty in higher education. She was a 2015 National Academy of Education/Spencer Postdoctoral Fellow, and has recently served on a National Academies committee on assessing interpersonal and intrapersonal competencies in college. Her current work considers new ways to conceptualize and measure the educational quality of colleges and universities that more closely reflect the teaching and learning process.

Anna Neumann is Professor of Higher Education at Teachers College, Columbia University. She studies postsecondary teaching and learning, professors' intellectual careers, and academic organization. Her current work examines the cognitive and cultural elements of good teaching in introductory-level humanities, social sciences, and sciences classrooms in highly diverse urban colleges, and professional development strategies for advancing good teaching. A former president of the Association for the Study of Higher Education, Neumann is a Fellow of the American Educational Research Association (AERA), an elected member of the National Academy of Education, and a recipient of the AERA Division J Exemplary Research Award.

Aaron M. Pallas is the Arthur I. Gates Professor of Sociology and Education and Chair of the Department of Education Policy and Social Analysis at Teachers College, Columbia University. He studies how schools sort students and the linkages among schooling, learning, and the human life course. A former editor of *Sociology of Education*, a journal of the American Sociological Association, he is a Fellow of the American Educational Research Association and an elected member of the Sociological Research Association. His most recent projects examine the interplay between education policies and the distribution of resources across schools in New York City.

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