THE ADVANCEMENT OF LEARNING

Building the Teaching Commons

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3

MAPPING THE COMMONS

One of the central ways we make sense of experience is by making differences. The world presents itself without inherent order, and our impulse is to place things in piles, count them, and name them. In the act of creation, day is divided from night. Aristotle classifies just about everything. Shakespeare gives us the seven ages of man, Dante maps the circles of hell, Burton anatomizes melancholy. In ways that Kant never intended by the phrase, we are driven by a "categorical imperative," the irresistible impulse to place things in categories.[1]

CONTRIBUTIONS TO THE COMMONS by scholars of teaching and learning pose exciting possibilities for exchange. As the commons takes shape, faculty exploring new approaches in the classroom can increasingly find like-minded colleagues and useful resources to support their efforts. Scholars of teaching and learning whose projects and investigations produce results that others might find useful are further motivated by the likelihood that their work will find an audience, be enriched by colleagues' comments and critique, and contribute to a larger community of thought and practice. What such a commons makes possible for teaching and learning is, we believe, deeply intriguing, hope giving, and worthy of investment of faculty time and institutional resources. But it is not simple.

The work of teaching occurs in an almost infinite set of contexts—contexts defined by discipline, student demographics, institutional type, pedagogical approach, and curricular goals, to name just a few of the elements whose permutations distinguish one classroom from another. Scholars of teaching and learning deliberately keep their focus close to the classroom, seeking to preserve the particulars of practice. One does not, after all, teach students in general or content in general, but, say, calculus to students who will go on to teach mathematics to our nation's children, or the structure of the cell to students who will take only one biology course. As Kenneth Eble observes in his 1988 classic study, *The Craft of Teaching*, "It is attention to particulars that brings any craft or art to a high degree of development" (p. 6). As the examples we provide in this chapter show, the scholarship of teaching and learning's special role is to concentrate attention on pedagogical particulars and allow others to learn from them.

This attention to context gives the scholarship of teaching and learning much of its richness, and distinguishes it from most (though not all) general or basic research on learning and teaching. As more of this work enters the commons, however, its focus on particular classrooms is beginning to pose a significant conceptual challenge. If the commons is to be something other than a wilderness of unrelated projects and efforts, the work within it must yield to Shulman's version of the categorical imperative. An important task, then, is to identify categories around which the work converges, which can in turn provide maps for traversing and using the commons.

As the scholarship of teaching and learning grows both in the United States and abroad, this mapping task has been much on our minds. In our work with the Carnegie Academy for the Scholarship of Teaching and Learning, for example, we have watched CASTL Scholars from over twenty different fields and all types of institutions frame questions about learning in their particular contexts and explore those questions in myriad ways. Getting to know these people and projects, one by one, has been a great pleasure and privilege. At the same time, we have seen our role as cartographers, regularly stepping back from our engagement with the CASTL participants' particular projects in an effort to discern larger contours of the terrain, looking for themes and questions around which their efforts and those of many others seem to converge.

Examples of the Work

We have already introduced the scholarship of teaching and learning through an example drawn from the work of Dennis Jacobs at Notre Dame. In this chapter, we present five additional examples of the scholarship of teaching and learning from others in the CASTL program. We use them, in part, to highlight that aspect of this pedagogical work that is new: "regular" faculty framing and systematically investigating questions about teaching and learning in their own classrooms. More specifically, we feature these five because their efforts too have sparked the interest of many people we have shared them with, and because, all together, they provide a window into the varied themes and methods that characterize the scholarship of teaching and learning, and thus an opportunity to map out important features of the commons as it evolves.

We look first at the five new examples, then return at the end of the chapter to the mapping task. Along the way we hope these examples will put more meat on the bones of the concept of the scholarship of teaching and learning presented in the previous chapter. We hope, too, that they will begin to answer the question we are often asked: What are the results of all this work? What can others learn from it? In Chapter One, we noted that Dennis Jacobs's project produced evidence on the effectiveness of a new way of teaching chemistry to at-risk students. The examples presented here have contributed to (among other things) a taxonomy of mathematical knowledge for pedagogical purposes, a typology of the ways students use history in political action projects, a theory of intellectual community in seminar courses, strategies to help students deal with difficulty in literary texts, and ways of engaging science-averse students with the concept of the cell in a biology course. These results are improving learning in the classrooms in which they were generated. Some have already made a difference in other classrooms as well.

Example 1: Learning to Think Like a Mathematician

Though they have become a kind of whipping boy for many of the ills facing higher education today, the disciplines are powerful tools for understanding the world. They are where most faculty "live," their primary intellectual home, and the source of some of their most deeply felt hopes for student learning. Not surprisingly, then, the disciplines (and interdisciplines) are also the source of many of the questions explored by scholars of teaching and learning. How do students come to understand key concepts in the field? How do they employ those concepts to make sense of new information and ideas? How do students learn to think like, say, a historian or a physicist? Consider, as a case of the scholarship of teaching and learning focused on disciplinary understanding, the work of Curtis Bennett, a mathematician who has taught at Bowling Green University in Ohio, Michigan State University, and Loyola Marymount University in Los Angeles.[2]

Bennett is a theoretical mathematician, but many of his students are preparing for something very practical: to teach secondary school. He is particularly concerned that these students grasp not only the mechanics and procedures of the discipline but its underlying principles, and what Joseph Schwab called the *syntax* of the field (1964). In particular, he wants students to understand—and therefore be able to teach *their* future students—"what makes a good mathematical question." He wants them to appreciate "the beauty and elegance of a good mathematical proof." As he describes in a course portfolio documenting his efforts to meet these goals in a senior capstone course, "Even though the students in the course were above average, few of them understood what mathematics was. . . . A result of this was that the students treated work in the course as a set of hoops they needed to jump through" (2002, p. 2). Math problems, these future teachers believed, were puzzles that could be solved in five minutes or not at all.

With this challenge in view, Bennett redesigned the course around semester-long, open-ended mathematical research projects intended to challenge students' assumptions about what it means to do math. In groups of two or three, he explains, "Students answered complicated mathematical questions that forced them to confront issues their coursework never led them to before. For example, they needed to create definitions, to refine mathematical problems, and to become owners and creators of mathematics" (2002, p. 2). To track the impact of this new approach, Bennett administered surveys of student attitudes toward mathematics before and after taking the class, kept a journal, copied and analyzed all graded homework assignments and exams, taped and analyzed office-hour conversations with student project groups, and conducted interviews with individual students after final grades were turned in. His scholarship of teaching and learning thus entailed a careful, multidimensional examination of the impact of a new approach on the learning of students.

What did Bennett discover? What insights does his work contribute to the teaching of mathematics? For starters (again, as documented in his course portfolio), he found that the new approach led students to "a more mathematical view" of the work of the field, and, in particular, of what makes a good mathematical problem. But equally important, Bennett asserts, is the way the work brought to light important *next* questions about student learning, especially because "mathematicians judge the value of a question by what it leads to" (Curtis Bennett, interview with the authors, October 22, 2004).

Building on what he learned about students' mathematical understandings, Bennett has moved to a next stage in his investigation, looking at a larger body of evidence with new questions in view, and, importantly, working with a departmental colleague at Loyola Marymount, Jackie Dewar (Bennett and Dewar, 2004b). Together, the two are studying how students grow in their view of mathematical reasoning and argumentation as they move from a freshman workshop course into more advanced work in the major—focusing especially on "what moves students from a reliance on examples to an understanding of and desire for proof" (Bennett and Dewar, 2004a, p. 1). This second project has taken the mathematicians beyond their own setting and discipline into the wider world of educational research. Building on work in cognitive psychology, they have adapted the think-aloud research tool to develop a "proof-aloud protocol" for probing students' thinking, in which they ask students to investigate a number theory statement, say how confident they are about their conclusions and what would make them more confident, write a proof for their conclusions, and discuss what mathematics learning they drew on for these tasks.

As Bennett and Dewar grappled with characterizing students' development in mathematical understanding, they also turned to the literature on assessment. "We needed a more nuanced way to describe the progression of our students' understanding," Dewar explains (Jackie Dewar, interview with the authors, October 22, 2004). In the end, they adapted a framework for assessing student learning by Stanford University professor of education Richard Shavelson (see Shavelson and Huang, 2003),[3] overlaid it with a model of student progression from novice toward expert (Alexander, 2003), and reframed the whole to meet their own purposes and needs. (See Exhibit 3.1.)

The result is a *mathematical knowledge expertise grid* that they and other mathematicians can use for targeting instruction and that gives language for describing critical aspects of student learning in mathematics (Bennett and Dewar, 2004a). It is also, not incidentally, a nice example of how efforts from different communities inside the bigger tent of the scholarship of teaching and learning can converge to create something new.

Exhibit 3.1. Bennett and Dewar Taxonomy of Mathematical Knowledge Expertise

	Acclimation	Competence	Proficiency
Affective Interest	Students are motivated to learn by external (often grade-oriented) reasons that lack any direct link to the field of study in general. Students have greater interest in concrete problems and special cases than abstract or general results.	Students are motivated by both internal (that is, they are intrigued by the problem) and external reasons. Students still prefer concrete concepts to abstractions, even if the abstraction is more useful.	Students have both internal and external motivation. Internal motivation comes from an interest in the problems from the field, not just applications. Students appreciate both concrete and abstract results.
Confidence	Students are unlikely to spend more than five minutes on a problem if they cannot solve it. Students don't try a new approach if first approach fails. When given a derivation or proof, they want minor steps explained. They rarely complete problems requiring a combination of steps.	Students spend more time on problems. They often spend more than five minutes on a problem before quitting and seeking external help. They may consider a second approach. They are more comfortable accepting proofs with some steps "left to the reader" if they have some experience with the missing details. They can start multistep problems but may have trouble completing them.	Students will spend a great deal of time on a problem and try more than one approach before going to text or instructor. Students will disbelieve answers in the back of the book if the answer disagrees with something they feel they have done correctly. Students are accustomed to filling in the details of a proof. They can solve multistep problems.
	Acclimation	**Competence**	**Proficiency**
Cognitive Factual	Students start to become aware of basic facts about the topic.	Students have working knowledge of the facts of the topic, but may struggle to access the knowledge.	Students have quick access to and broad knowledge about the topic.
Procedural	Students start to become aware of basic procedures. They begin to mimic procedures from the text.	Students have working knowledge of the main procedures. They can access them without referencing the text, but may make errors or have difficulty with more complex procedures.	Students can use procedures without reference to external sources or difficulty. Students are able to fill in missing steps in procedures.

Schematic	Students begin to combine facts and procedures into packets. They use surface level features to form schema.	Students have working packets of knowledge that tie together ideas with common theme, method, and/or proof.	Students have put knowledge together in packets that correspond to common theme, method, or proof, together with an understanding of the method.
Strategic	Students use surface level features of problems to choose between schema, or they apply the most recent method.	Students choose schema to apply based on just a few heuristic strategies. Students are slow to abandon a nonproductive approach.	Students choose schema to apply based on many different heuristic strategies. Students self-monitor and abandon a nonproductive approach for an alternate.
Epistemic	Students begin to understand what constitutes evidence in the field. They begin to recognize that a valid proof cannot have a counterexample. They are likely to believe based on five examples; however, they may be skeptical.	Students are more strongly aware that a valid proof cannot have counterexamples. They use examples to decide on the truth of a statement but require a proof for certainty.	Students recognize that proofs don't have counterexamples, are distrustful of five examples, see that general proofs apply to special cases, and are more likely to use "hedging" words to describe statements they suspect to be true but have not yet verified.
Social	Students will struggle to write a proof and include more algebra or computations than words. Only partial sentences will be written, even if they say full sentences. Variables will seldom be defined, and proofs lack logical connectors.	Students are likely to use an informal shorthand that can be read like sentences for writing a proof. They may employ connectors, but writing lacks clarity often due to reliance on pronouns or inappropriate use or lack of mathematical terminology.	Students write proofs using complete sentences that are clear and concise. They employ correct terminology and are careful to define variables.