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Using the Decoding the Disciplines model, faculty who are deeply ingrained in their disciplinary research answer a series of questions to understand how students think and learn in their field. The cross-disciplinary nature of the process clarifies the thinking for each discipline.

Decoding the Disciplines: A Model for Helping Students Learn Disciplinary Ways of Thinking

Joan Middendorf, David Pace

In the last twenty years, the call for faculty members to focus on critical thinking has led to a laudable effort on the part of faculty members and teaching support professionals to move the focus of courses to the higher levels of Bloom's (1956) classification of learning behaviors. But efforts to help students learn at the levels of analysis, synthesis, and evaluation may be impeded by a mismatch between the kinds of thinking actually required in specific classes and generic formulas for encouraging higher-order thinking. In fact, the notion of a unified "critical thinking" runs counter to an important strand in current thinking about teaching that stresses the disciplinary nature of knowledge.

Critical Thinking and the Disciplines

In the last twenty years, a number of major researchers have stressed the importance of shaping instruction to match the specific conditions of each academic field. In his 1986 inaugural address as president of the American Educational Research Association, Lee Shulman argued that whereas teacher training had been dominated by a focus on mastering disciplinary content

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in the nineteenth century and on assimilating generic educational theory in the first three quarters of the twentieth century, attention should be henceforth expanded to the study of learning in the particular contexts created by specific disciplines (Shulman, 1987). In the same period, other scholars were developing the notion of "cognitive apprenticeship" in which the process of learning an academic discipline was compared with learning to function in a foreign culture (Brown, Collins, and Duguid, 1989). And in the 1990s, the importance of the differences among disciplines was made even clearer by Tobias, who observed the difficulties that even intelligent and highly trained instructors and graduate students faced when they were transplanted into undergraduate courses far removed from their own specialties (Tobias, 1992–1993).

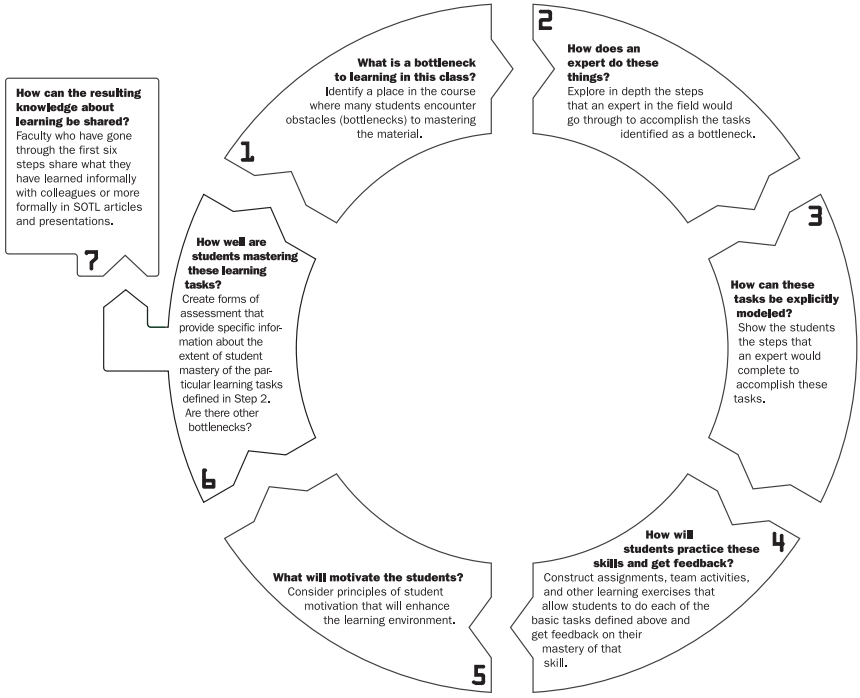
Two different but important approaches have made progress in understanding the way knowledge is structured and how experts think in specific disciplines. Donald (2002) represents higher-order thinking in several disciplines to show how faculty and students perceive the learning process, while the Committee on Developments in the Science of Learning (Bransford, Brown, and Cocking, 2000) links the scientific study of thinking and learning to classroom practices. Even though their approaches differ, both reach the conclusion that disciplines need to be more involved in the research on how people think and how students learn. Donald states, "There is a substantial convergence in the need for deeper understanding of the disciplines. The continuing challenge is how to draw on the expertise of scholars to improve post-secondary education" (2002, p. 299). Thus, we have only begun to understand what kind of thinking goes on in different disciplines, nor do we know the similarities and differences across the disciplines.

This concern with the disciplinary nature of learning has been one of the primary motivations for the development of a scholarship of teaching and learning in which faculty from across universities make contributions to pedagogical literature (Hutchings and Shulman, 1999; Huber and Morreale, 2002). Many of the essays in this volume are examples of this kind of extension of the responsibility for thinking and writing about teaching and learning.

The contributors in this volume are from fields as diverse as creative writing, marketing, and genetics. They have a deep understanding of the content of their disciplines, and now they want to understand how students learn this content. Their chapters show faculty in the disciplines doing this kind of work and provide what we have named "Decoding the Disciplines," a process for getting them deeply into the specifics of thinking and learning in their disciplines.

But these efforts did not begin as an endeavor to stimulate such scholarship. Instead, they emerged from an attempt to bridge the gap between the marvelous strategies for increasing learning that have emerged from educational research in the past several decades and the concrete experiences

Figure 1.1. Decoding the Disciplines: Seven Steps to Overcome Obstacles to Learning



of faculty trying to help students master specific material in particular disciplines.

The story of how the Decoding the Disciplines model is used in the Indiana University Faculty Learning Community (IUFLC) will be left until Chapter Ten. For now, suffice to say that each year ten to twelve faculty from across the disciplines participate in a two-week seminar in which they practice new teaching strategies and serve as students for each other. The IUFLC arose from a strong realization that the mental operations required of undergraduates differ enormously from discipline to discipline, that these ways of thinking are rarely presented to students explicitly, that students generally lack an opportunity to practice and receive feedback on particular skills in isolation from others, and that there is rarely a systematic assessment of the extent to which students have mastered each of the ways of thinking that are essential to particular disciplines. The result of ten iterations of this FLC was a seven-step framework (see Figure 1.1) within which teachers can develop strategies for introducing students to the culture of thinking in a specific discipline and, in the process, level the playing field for those students who do not come to college "preeducated."

There is nothing mechanical or deterministic about these steps. Rather, they serve as a series of questions that instructors can ask themselves as they work on responding to the specific challenges posed by learning in their disciplines. This process emerged from a shared effort involving more than fifty faculty members who have used this general model to produce their own strategies for helping their students overcome bottlenecks to learning in their classes. This approach does not stand in opposition to other, preexisting strategies for increasing learning. The structure within which the authors in this volume have worked has, in fact, made it easier to make effective use of such methods as active, collaborative, and inquiry-based instruction. The systematic identification of what students have difficulty learning and what they should know how to do makes the design of methods for practice and effective assessments relatively straightforward. But the application of this approach by the IUFLC fellows has produced some remarkable solutions to learning challenges in a wide range of disciplines, and we hope that process described here can be adopted and adapted by other institutions.

The remainder of this chapter serves as an introduction to the Decoding the Disciplines model that has helped the contributors of this volume and faculty in other programs at this and other universities become more effective teachers and advocates for student learning. We believe that this work will respond to two central questions in contemporary pedagogy: First, how is the nature of disciplines to be brought into the discussion of teaching and learning? Decoding the Disciplines places disciplines at the center of the discussions of teaching, and paradoxically, the cross-disciplinary nature of the work clarifies thinking in the disciplines themselves. As contributors Durisen and Pilachowski conclude in Chapter Four, "Interactions with faculty in different disciplines clarified the role of discipline-specific thinking in teaching and learning and helped us to recognize the learning strategies that our students bring to their study of astronomy."

Second, this work may also provide a means of answering a second crucial question: How can faculty in all disciplines be encouraged to become involved in the scholarship of teaching and learning? Many of the essays in this volume serve as evidence that the Decoding the Disciplines model can give faculty who have never thought of publishing about teaching the tools they need to conduct such inquiry. It focuses their attention on crucial difficulties students have in learning their disciplines, gives them a framework within which to respond to these challenges, and provides them with models with which to assess evidence of student learning.

Step 1. What Is a Bottleneck to Learning in This Class?

Decoding the Disciplines begins with a simple task: identifying bottlenecks—that is, points in a course where the learning of a significant number of students is interrupted (Anderson, 1996). Virtually anyone who has

set foot in a classroom can identify some area in which learning has not occurred in ways that the instructor wished it to. Like many of these steps in this process, this question seems so obvious that it is surprising in retrospect how often it is omitted. But in practice, many efforts to reshape classes begin with questions such as, how can I make use of this new technique? Or, how can I increase my students' critical thinking? Such questions are often too broad to provide a clear focal point for designing more effective strategies. They sometimes draw attention to parts of the course that are not in great need of reform, and they generally focus the process on the means (teaching) rather than the end (student learning).

In the FLC seminars, there is a tactical advantage to beginning with the bottlenecks defined by the fellows because this makes their instructional concerns central to the process. This approach also focuses the process at the points where change is most needed, and it tends to narrow the work to a "chunk size" that can be dealt with more readily. Because faculty can often identify numerous places where there seem to be obstacles to learning, it is important to prioritize those that most seriously interfere with the central learning in a course. The nature of these obstacles may vary considerably, with some involving both cognitive and affective elements and others more narrowly intellectual.

Step 2. How Does an Expert Do These Things?

The second step in this process is for faculty to reconstruct the steps that they themselves do when solving similar problems. This is generally the most intellectually demanding of all the steps in the Decoding the Disciplines approach. The research of Donald (2002), Tobias (1992–1993), Wineberg (2001), and Bransford, Brown, and Cocking (2000) has demonstrated how varied the thinking is in different disciplines, and the uniqueness of particular ways of posing and solving problems is often invisible to professionals in the field. This step is difficult because it requires metacognition: faculty have to dissect their own innate thinking. Faculty generally chose to go into fields where they were successful at that kind of thinking and have been working within that particular disciplinary framework for years. Therefore, they may have leaped almost automatically over obstacles that can prove daunting for novices.

Instructors in every discipline can begin this process of exploring its specific ways of operating by working to distance themselves from all that is natural and automatic to members of their field. We facilitate this process in the IUFLC by having the fellows from different disciplines work together so that they will be less likely to skip over steps that are "intuitively obvious." Taking inspiration from the experiments of Tobias, we also sent the fellows into classes that were as far removed from their own specialty as possible. For example, the historians attended a genetics class, the geneticists attended a philosophy of art class, and the humanities professors

attended finite math courses, all with instructions to take notes as if they were to be examined on the material.

But the most intense intervention involved a ninety-minute interview in which each fellow had to explain in precise detail just what an expert would do if faced with one of the tasks that students had difficulty completing successfully. Typically, the instructor would provide an initial response that contained unexplained terms and undefined processes that seemed too obvious to be consciously recalled. The task of the interviewers was to repeatedly probe beneath the surface, asking questions such as, "Just how are the students supposed to do that?" or, "What does that instruction assume that students are able to do?" In the process they go from a vaguely worded idea such as "critical thinking" to a more detailed analysis of the kinds of thinking their students need to master. For example, a creative writing professor realized he had to model the process of choosing descriptive images and words. And a molecular biology professor realized he had to teach students to visualize complex molecular structures as dynamic three-dimensional cartoons, just as he did. During the interview, fellows often experience an "aha" moment. The interviews give them a preview of how deeply they will examine their students' thinking.

These interviews can be duplicated in almost any educational institution by having instructors in different fields explain to each other how an expert would overcome an obstacle that seems daunting to many of their students. Anyone who attempts this will have to remember to remain focused on what an expert does and not on the content of the lesson or the steps that might be taken to teach students this skill. And it will generally be necessary to probe many levels beneath the surface because the initial response will almost certainly pass over steps that are so obvious to the expert that they are not even noticed.

Step 3. How Can These Tasks Be Explicitly Modeled?

The next step is to devise ways to demonstrate to students the steps that come naturally to the expert. There will generally be a need to set priorities and to determine which operations are most essential and thus most important to model. In some cases, this may entail some systematic assessment of the levels of mastery of these operations that typically exist among the students at the beginning of the course. But we strongly encourage anyone using this method to devote some time to deciding which of these basic skills do or do not have be modeled; this will probably determine which members of the class will be included in the learning process, and that decision has important ethical and political dimensions.

Once one has decided which basic operations should be modeled, it is then time to devise demonstrations that will help students to begin to understand what this kind of thinking entails. Like the second stage of the Decoding the Disciplines model, this often requires serious intellectual

labor, and it can be one of the most exhilarating parts of the process. In most cases, a good deal of redundancy will need to be built into the process and operations presented in several ways. Chapters Two and Five in this volume provide strong examples of faculty modeling their thinking. In addition to faculty demonstrating the kind of thinking they want students to do, in some cases (Chapters Three, Five, and Seven), faculty have to walk the students through an exercise to build bit by bit the mental model that faculty use. This is still part of the modeling step; it is not to be confused with the practice exercises of step 4.

It is important to remember both that complex ways of thinking are rarely assimilated in a single presentation and that different groups of students internalize such learning in different modalities (for example, visually, orally, and kinesthetically). Thus, it is often desirable to repeat the modeling on several occasions (MacKinnon, 2003) and in several different media (for example, in a classroom presentation and a class Web site). Finally, it is wise strategically to build modeling exercises around content that is particularly essential to the course so that the time devoted to modeling serves other purposes for the course as well.

Step 4. How Will Students Practice These Skills and Get Feedback?

Whereas in step 3 the instructor demonstrates the intellectual skill that the students need to learn, the focus in step 4 is to have the students practice the task and gauge the proficiency of their attempts. Decoding the Disciplines breaks down the basic operations required in a particular class and presents them systematically to students. But students can rarely move directly from hearing a complex set of operations described to internalizing the steps and then to applying them as part of a larger task some weeks later. Learning to think and work within the culture of a particular discipline is more complex than generally appears to be the case to professionals in the field, and students must be given a chance to perfect these skills and to receive feedback that clarifies where they are and are not succeeding. We need only imagine ourselves in a learning situation that is unfamiliar to us—a first lesson in knitting, a new computer program, or the grammar of a foreign language—to realize that simply hearing a lecture on a complex process is rarely sufficient to permit us to actually perform the task and to integrate it with dozens of other new procedures.

At this point, the marvelous new learning tools created over the past several decades can be integrated into the process. All the strategies associated with active, collaborative, and inquiry-based learning can be used to help students master the operations once they have been modeled, as seen in Chickering (1991), Yuretich (2004), Silberman (1996), Smith and MacGregor (1992), Michaelsen (1997), Wright (1994), and DiPasquale, Mason, and Kolkhorst (2003).

The process of defining and subdividing these operations, in fact, makes the application of such strategies particularly effective. Creating an exercise to allow students to actively perform some complex and ill-defined act of critical thinking is difficult, and it is not likely to provide students with clear feedback on their performance. If students do not succeed at a task that requires the integration of a half dozen discrete but undefined operations, they are not likely to be able to distinguish between skills they have mastered and those that must still be learned. By contrast, instructors who have gone through the first three steps of the Decoding the Disciplines process have already defined the focal point for such exercises, and they need only generate a framework within which these operations can be practiced one after another. Once a particular set of skills has been mastered by most of the class, the instructor can begin to generate more complex exercises that provide the occasion for synthesis and application. And throughout this process, the instructor can make strategic decisions about the subject matter used in these exercises to be sure that the time spent on these skills reinforces the most essential topics in the course.

Step 5. What Will Motivate the Students?

In the earlier stages of the development of this model, motivation was treated almost as an afterthought. But as we worked with successive generations of FLC fellows, it became increasingly clear that motivation was of sufficient importance to warrant its own position in the sequence of steps. If the students are not drawn actively into the modeling and the practice-and-feedback phases of the process, real learning is highly unlikely to occur.

Fortunately, the structure of this system lends itself to the application of the kinds of strategies supported by the literature on motivation (Svinicki, 1999; Perry, Menec, and Struthers, 1995). If, as the ancient Roman rhetorician Quintilian argued, "The job of the teacher is to arrange victories for the students," the Decoding the Disciplines process helps set the stage for a series of small but cumulative successes. Because large, complex tasks are divided into their constituent parts and each part is modeled and practiced, students are more apt to conceptualize their situation as one in which it is possible to learn and in which success or failure is seen in terms of their own effort, rather than luck.

It is not sufficient to assume that the structures of learning created by this process will automatically motivate students. Conscious effort needs to be dedicated to making the students partners in the learning process. The nature of this process allows an instructor to present himself or herself as an ally who has devoted considerable energy to creating a course in which success is possible and who really wants students to do well. Students often respond positively to instructors who are clearly dedicated to creating a level playing field on which students who have not been preeducated at elite

institutions will have the same opportunity to succeed as those who have been more privileged.

It is, however, also important to avoid any sense that there is something remedial about this process. High expectations are an essential element in any meaningful strategy for increasing student motivation. The Decoding the Disciplines model substitutes a series of small, manageable steps for the giant leaps required in many traditional courses, but students should be expected to cover the same intellectual distance as they would in other courses. And there is a good chance that this approach will actually require students to work more.

Step 6. How Well Are Students Mastering These Learning Tasks?

In the past, faculty have often found themselves in a dilemma. On the one hand, the focus was on content learning that seemed to be relatively easy to assess but that did not reach the level of thinking that most faculty members desire to generate in their students. On the other was critical thinking, which dealt with an appropriate cognitive level but was generally perceived as impossible to assess (Cohen, 1987). In popular discussions, critical thinking often involves a number of different mental processes that are neither clearly defined nor adequately distinguished from one another. It is difficult to be certain when enough of these complex and often vague attributes are sufficiently in evidence to declare that the threshold of critical thinking has been reached.

The more precisely defined operations that are at the core of Decoding the Disciplines make assessment a different matter altogether. Because instructors have already broken bottlenecks down into the constituent parts that they want their students to learn, it is much easier to determine whether students have mastered them. Angelo and Cross's (1993) Classroom Assessment Techniques provide a good starting place for faculty to learn assessment methods, with simple and direct ways to determine whether students were able to perform specific disciplinary operations. Faculty have adapted these techniques or devised other ways to gauge student understanding. Often exercises that provide students with an opportunity to practice and receive feedback automatically provide the instructor with a good deal of information about what is and is not being learned. But as the essays that make up this volume amply demonstrate, the mastery of defined disciplinary operations can be assessed in a great variety of ways.

The assessments that emerge from this process are also more useful. It is easy to find out which of the basic operations are being mastered by most of the students and which need to be modeled or practiced more effectively or repeated several times during the course. Moreover, the skills being

assessed are precisely those that the instructor has defined as most important for this particular class, an important consideration when more accountability is being demanded of higher education.

Step 7. How Can the Resulting Knowledge About Learning Be Shared?

This step of sharing initially arose out of the institutional concerns surrounding the IUFLC. The investment of resources that Indiana University was making in a relatively small number of instructors could be justified only if the ideas that the fellows developed in the program were shared with other faculty. Over time, however, we have come to recognize that this step is an integral part of the process. Those of us who employ collaborative strategies in our teaching often tell our students that they do not fully understand something until they have succeeded in explaining it to someone else. Our experiences in the IUFLC have convinced us that this is just as true for instructors. The process of sharing teaching goals and strategies forces us to make explicit elements that might otherwise have escaped our notice, to see possibilities that had previously escaped us, and to recognize inconsistencies or flawed logic. All of this can be cycled back into the process of course development to steadily increase learning in our classes.

The sharing of knowledge may occur in many forms. At one extreme is a simple conversation with colleagues; at the other, publication of one's findings in refereed journals and even large grants for building on one's work. And in between are such means of sharing as presentations of model lessons to other faculty, the exchange of course modules by instructors teaching similar courses as well as course portfolios.

But whatever the medium of sharing, the steps of the Decoding the Disciplines process make the interchange easier. The specificity of the focus, the clarity of the modeling, the ingenuity of the practice exercises, and the weight of the assessments all make it easier for instructors to learn from each others' experiments in the classroom. And, ironically, an approach that begins with an emphasis on the differences among disciplines can in the end provide a means to communicate across the chasms that separate academic fields.

In conclusion, it is important to stress that the Decoding the Disciplines approach should not be viewed as a narrow, prescriptive formula for all course development. The steps evolved as part of a group process of shared pedagogical exploration (see Chapter Ten). In other contexts, new steps may be necessary; some of ours may not be relevant; and the concrete strategies for defining, modeling, and providing practice may be completely different from those presented in this volume. This is only a tool, and it must therefore be adapted to the task at hand.

We have found that this approach has served to help many of the IUFLC fellows not only find new ways to enhance learning in their classes

but also bring a new excitement to their teaching. The model serves to link teaching more closely with the kind of intellectual inquiry that drew the fellows toward being teachers in the first place, and it allows them to bring to teaching more of the skills that they have developed in their research. It also takes advantage of the differences in thinking among academic fields to decode each individual discipline. The energy that this process has engendered has carried the contributors to this volume beyond their individual disciplines into the scholarship of teaching and learning. We hope that the essays contained in this volume will convey this excitement to our readers.

References

Anderson, J. A. "Merging Teaching Effectiveness, Learning Outcomes, and Curricular Change with the Diverse Student Needs of the 21st Century." Paper presented at the 21st annual conference of the Professional and Organizational Development Network, Salt Lake City, Oct. 1996.

Angelo, T. A., and Cross, K. P. *Classroom Assessment Techniques: A Handbook for College Teachers.* 2nd ed. San Francisco: Jossey-Bass, 1993.

Bloom, B. S. (ed.). *Taxonomy of Educational Objectives: The Classification of Educational Goals.* New York: McKay, 1956.

Bransford, J. D., Brown, A. L., and Cocking, R. R. (eds.). *How People Learn: Brain, Mind, Experience, and School.* Washington, D.C.: National Academy Press, 2000.

Brown, J. S., Collins, A., and Duguid, P. "Situated Cognition and the Culture of Learning." *Educational Researcher,* 1989, *18,* 32–42.

Chickering, A. W. "Seven Principles for Good Practice in Undergraduate Education." In A. W. Chickering and Z. F. Gamson (eds.), *Applying the Seven Principles for Good Practice in Undergraduate Education.* New Directions for Teaching and Learning, no. 47. San Francisco: Jossey-Bass, 1991.

Cohen, S. A. "Instructional Alignment." *Educational Researcher,* 1987, *16*(8), 16–20.

DiPasquale, D. M., Mason, C. L., and Kolkhorst, F. W. "Exercise in Inquiry: Critical Thinking in an Inquiry-Based Exercise Physiology Laboratory Course." *Journal of College Science Teaching,* 2003, *32*(6), 388–393.

Donald, J. G. *Learning to Think.* San Francisco: Jossey-Bass, 2002.

Huber, M. T., and Morreale, S. P. (eds.). *Disciplinary Styles in the Scholarship of Teaching and Learning: Exploring Common Ground.* Washington, D.C.: American Association for Higher Education, 2002.

Hutchings, P., and Shulman, L. S. "The Scholarship of Teaching: New Elaborations, New Developments." *Change,* 1999, *31*(5), 10–15.

MacKinnon, G. R. "Why Models Sometimes Fail: Eight Suggestions to Improve Science Instruction." *Journal of College Science Teaching,* 2003, *32*(7), 430–433.

Michaelsen, L. "Three Keys to Using Learning Groups Effectively." *Essays on Teaching Excellence,* 1997, *9*(5), 1–2.

Perry, R., Menec, V., and Struthers, C. "Student Motivation from the Teacher's Perspective." In R. J. Menges and M. E. Weimer (eds.), *Teaching on Solid Ground: Using Scholarship to Improve Practice.* San Francisco: Jossey-Bass, 1995, pp. 75–100.

Shulman, L. "Knowledge and Teaching: Foundation of the New Reform." *Harvard Education Review,* 1987, *57,* 1–22.

Silberman, M. *Active Learning: 101 Strategies to Teach Any Subject.* Needham Heights, Mass.: Allyn & Bacon, 1996.

Smith, B., and MacGregor, J. "What Is Collaborative Learning?" In *Collaborative Learning: A Sourcebook for Higher Education.* University Park, Pa.: National Center on Postsecondary Teaching, Learning, and Assessment, 1992.

Svinicki, M. D. "New Directions in Learning and Motivation." In M. D. Svinicki (ed.), *Teaching and Learning on the Edge of the Millennium: Building on What We Have Learned.* New Directions for Teaching and Learning, no. 80. San Francisco: Jossey-Bass, 1999.

Tobias, S. "Disciplinary Cultures and General Education: What Can We Learn from Our Learners?" *Teaching Excellence,* 1992–1993, *4*(6), 1–3.

Wineburg, S. *Historical Thinking and Other Unnatural Acts: Charting the Future of Teaching the Past.* Philadelphia: Temple University Press, 2001.

Wright, D. "Using Learning Groups in Your Classroom: A Few How-to's." *Teaching at UNL Newsletter,* 1994, *15*(4), 1–2, 4–5.

Yuretich, R. F. "Encouraging Critical Thinking." *Journal of College Science Teaching,* 2004, *33*(3), 40–45.

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