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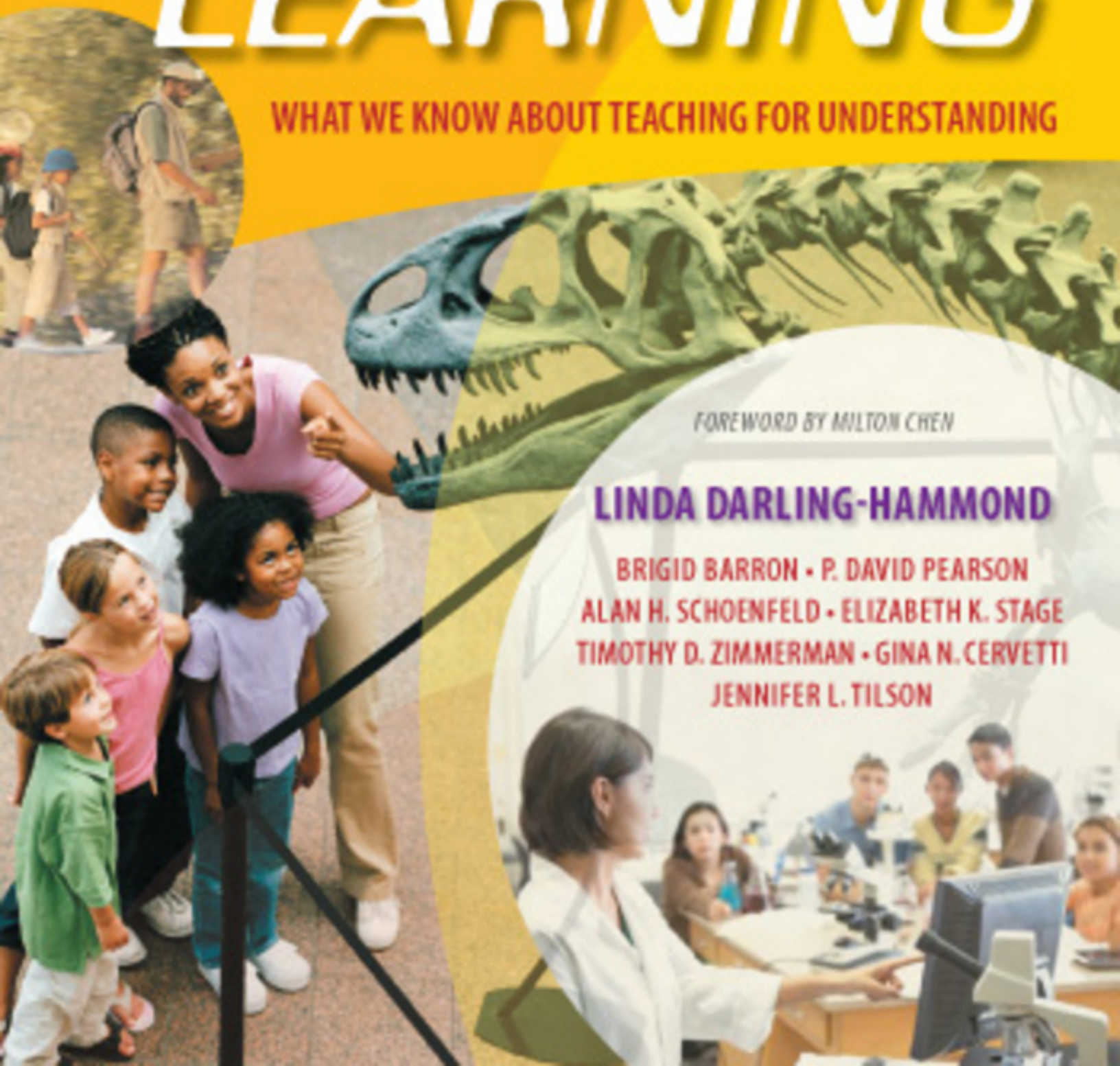
POWERFUL LEARNING

WHAT WE KNOW ABOUT TEACHING FOR UNDERSTANDING

FOREWORD BY MILTON CHEN

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FOREWORD

Our Foundation began in 1991 with an ambitious mission: to demonstrate how innovative learning environments in classrooms, supported by powerful new technologies, could revolutionize learning. As an organization founded by George Lucas, we believed that the same benefits of technology that were transforming business, health care, entertainment, and manufacturing could be applied in education. Industrial assembly-line models based on the productivity of individual workers were giving way to more collaborative ways of organizing work in teams. Information was being shared more readily and rote tasks were being automated. And this was in the days before the Internet.

In two decades, the world has moved ahead dramatically, but our schools remain caught in a web of educational thinking and systems that originated a century ago—or, some would say, even earlier. The instructional model of the teacher and the textbook as the primary sources of knowledge, conveyed through lecturing, discussion, and reading, has proven astonishingly persistent. Even the traditional form of classroom seating, with students arrayed in rows—a configuration that prevents group work and conversation—is still common. In my boyhood classroom of the sixties, changing the classroom layout might have been impossible, because the chairs and desks were bolted to the floor. Today, with furniture that is movable, there's no excuse. It's clear we first need to unbolt our thinking.

Fortunately, this “dominant paradigm” is showing signs of wear. In our own work of finding and telling the stories of innovative learning in and out of schools, we see many

more examples of individual teachers and principals, as well as some districts and even states, implementing new forms of project-based curricula and performance-based assessment. In these classrooms, students are organized in teams, where they must address such open-ended and complex questions as “What is the air and water quality in your community?” “How would you design a school of the future? or a hybrid car?” For these projects, students gather and sift information from many sources, analyze data, and produce products of their investigation for presentation to their peers, families, and communities, in person and on the Web.

These classrooms also benefit from new pipelines for teacher development, starting in schools of education, so that teachers can embrace their new role as learning coach and manager, rather than solely as direct instructor. As in the modern workplace, these classrooms function as a digital environment, where technology enables access to a much wider world of information and students are able to express their multiple intelligences and build on their strengths and interests as learners.

As a Foundation, we have understood the critical importance of developing a research basis for these innovations. We have spent more than a decade documenting examples of project-based learning and cooperative learning in classrooms, as well as in informal and after-school settings; and publishing documentary films, *Edutopia* magazine, and a multimedia Web site (www.edutopia.org). Yet, for these many individual examples to take root in more places, their effectiveness must be demonstrated in educational research. Importantly, policymakers investing funds in the curriculum, instruction, and assessment required to bring these innovations to scale have to base their policies on documented results. These beliefs led to our support for this volume.

With it, Linda Darling-Hammond and her colleagues at Stanford University; the University of California, Berkeley; and the Lawrence Hall of Science have taken an important step forward for the field. Their review of the literature on teaching practices such as project-based learning; cooperative learning; and specific instructional strategies in literacy, mathematics, and science summarizes what is known and what new research is needed. Their analyses take advantage of important new developments in cognitive research in the past decade, such as the landmark volume *How People Learn*, published by the National Academy of Sciences in 1999. Although they point to studies of the effectiveness of these strategies, they also temper the results with an important caveat: effectiveness relies heavily on the quality of the teachers implementing them.

I hope this book will lead to greater shared understanding of the research record on innovative classroom practices. At the same time, it should lead to efforts to invest in the new forms of research designs and measures needed to study these practices and their ways of organizing students and their learning. Perhaps ironically, the types of meaningful learning experiences described here return us to a much earlier time, when learning was more connected to daily life and where young people learned in the company of their elders as well as with each other.

On behalf of our Foundation, I express our appreciation to the authors for their contributions to this important book: Linda Darling-Hammond and Brigid Barron, at Stanford University; David Pearson, Alan Schoenfeld, Timothy Zimmerman, and Gina Cervetti, at the University of California, Berkeley; and Elizabeth Stage and Jennifer Tilson, at the Lawrence Hall of Science. They have brought their acknowledged wisdom as thoughtful and creative leaders in the field of education and educational research to this work. *Powerful Learning* should provoke new

thinking about the kinds of “powerful research” needed to support creation of many more twenty-first-century schools and school systems.

Milton Chen
Executive Director
George Lucas Educational Foundation

The George Lucas Educational Foundation (GLEF) is a nonprofit foundation that gathers and disseminates the most innovative models of K-12 teaching and learning in the digital age. The foundation serves its mission through a variety of media—a magazine, videos, books, e-newsletters, DVDs, and a Web site: www.edutopia.org.



Online discussion questions for *Powerful Learning* are available at: www.josseybass.com/go/powerfullearning

ABOUT THE AUTHORS

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INTRODUCTION: TEACHING AND LEARNING FOR UNDERSTANDING

Linda Darling-Hammond

Since *A Nation at Risk* (1983) was published a quarter century ago, mountains of reports have been written about the need for more powerful learning focused on the demands of life and work in the twenty-first century. Whereas 95 percent of jobs in 1900 were low-skilled and required just the ability to follow basic procedures designed by others, today such jobs make up only about 10 percent of the U.S. economy. Most of today's jobs require specialized knowledge and skills, including the capacity to design and manage one's own work; communicate effectively and collaborate with others; research ideas; collect, synthesize, and analyze information; develop new products; and apply many bodies of knowledge to novel problems that arise (Drucker, 1994).

Furthermore, the nature of work will continue to change, and ever more rapidly. Whereas during much of the twentieth century, most workers held two or three jobs during their lifetime, the U.S. Department of Labor (2006) estimates that today's average worker holds more than ten jobs before the age of forty. The top ten in-demand jobs projected for 2010 did not exist in 2004 (Gunderson, Jones, & Scanland, 2004). Thus we are currently preparing students for jobs that do not yet exist, to use technologies that have not yet been invented, and to solve problems that we don't even know are problems yet.

Meanwhile, knowledge is expanding at a breathtaking pace. It is estimated that five exabytes of new information (5,000,000,000,000,000,000 bytes, or 500,000 times the

volume of the Library of Congress print collection) was generated in 2002, more than three times as much as in 1999. Indeed, in the four years from 1999 to 2002 the amount of new information produced approximately equaled the amount produced in the entire history of the world previously (Varian & Lyman, 2003). The amount of new technical information is doubling every two years, and it is predicted to double every seventy-two hours by 2010 (Jukes & McCain, 2002). As a consequence, effective education can no longer be focused on transmission of pieces of information that, once memorized, constitute a stable storehouse of knowledge. Education must help students learn how to learn in powerful ways, so that they can manage the demands of changing information, technologies, jobs, and social conditions.

These new demands cannot be met through passive, rote-oriented learning focused on basic skills and memorization of disconnected facts. Higherorder goals demand what some analysts have called “meaningful learning” (Good & Brophy, 1986)—that is, learning that enables critical thinking, flexible problem solving, and transfer of skills and use of knowledge in new situations. Nations around the world are reforming their school systems to meet these new demands, revising curriculum, instruction, and assessment to support the more complex knowledge and skills needed in the twenty-first century, skills needed for framing problems, seeking and organizing information and resources, and working strategically with others to manage and address dilemmas and create new products.

What do we know about the kind of teaching that produces more powerful learning? Based on research on learning and teaching conducted over the last fifty years, this book summarizes much of what is known about effective teaching and learning strategies in three major subject areas—reading and literacy, mathematics, and science—as

well as selected strategies that are used across domains and in interdisciplinary contexts, including project-based learning, performance-based assessment, and cooperative learning. We also look at the factors and conditions that can influence the effectiveness of these strategies. Finally, we examine the quality of the research base in these areas, and we identify gaps that exist in our knowledge base and how future research might address them.

INTENDED AUDIENCE

This book is intended for the policymakers whose decisions shape our educational systems, and the teachers, administrators, and other educators who determine what happens in schools and classrooms. Researchers concerned with effective education will also find this book useful for their studies. It gives evidence about the outcomes of successful educational strategies, examples of what they look like in practice, and insights about how they can become the norm, rather than the exception, in our schools.

PRINCIPLES OF LEARNING FOR EFFECTIVE TEACHING

Any discussion of teaching needs to start with what we know about learning, especially the kind of intellectually ambitious learning demanded in today's knowledge-based society. As the National Academy of Sciences summary of how students learn (Donovan & Bransford, 2005) notes, there are at least three fundamental and well-established principles of learning that are particularly important for teaching:

1. *Students come to the classroom with prior knowledge that must be addressed if teaching is to be effective. If*

what they know and believe is not engaged, learners may fail to grasp the new concepts and information that are taught, or they may learn them for purposes of a test but not be able to apply them elsewhere, reverting to their preconceptions outside the classroom. This means that teachers must understand what students are thinking and how to connect with their prior knowledge if they are to ensure real learning. When students from a variety of cultural contexts and language backgrounds come to school with their own experiences, they present distinct preconceptions and knowledge bases that teachers must learn about and take into account in designing instruction. Teachers who are successful with all learners must be able to address their many ways of learning, prior experiences and knowledge, and cultural and linguistic capital.

2. *Students need to organize and use knowledge conceptually if they are to apply it beyond the classroom.* To develop competence in an area of inquiry, students must not only acquire a deep foundation of factual knowledge but also understand facts and ideas in the context of a conceptual framework, and organize knowledge in ways that facilitate retrieval and application. This means teachers must be able to structure the material to be learned so as to help students fit it into a conceptual map and teach it in ways that allow application and transfer to new situations. The teaching strategies that allow students to do this integrate carefully designed direct instruction with hands-on inquiries that engage students actively in using the material, incorporate applications and problem solving of increasing complexity, and require ongoing assessment of students' understanding for the purpose of guiding instruction and student revisions of their work.

3. *Students learn more effectively if they understand how they learn and how to manage their own learning.* A “metacognitive” approach to instruction can help students learn to take control of their own learning by having a set of learning strategies, defining their own learning goals, and monitoring their progress in achieving them. Teachers need to know how to help students self-assess their understanding and how they best approach learning. Through modeling and coaching, teachers can teach students how to use a range of learning strategies, including the ability to predict outcomes, create explanations in order to improve understanding, note confusion or failures to comprehend, activate background knowledge, plan ahead, and apportion time and memory. Successful teachers provide carefully designed “scaffolds” to help students take each step in the learning journey with appropriate assistance, steps that vary for different students depending on their learning needs, approaches, and prior knowledge.

These key principles of learning are evident in the research that has emerged on effective teaching. Looking across domains, studies consistently find that highly effective teachers support the process of meaningful learning by:

- Creating *ambitious and meaningful tasks* that reflect how knowledge is used in the field
- Engaging students in *active learning*, so that they apply and test what they know
- Drawing *connections to students’ prior knowledge* and experiences
- Diagnosing student understanding in order to *scaffold the learning process* step by step

- *Assessing student learning continuously* and adapting teaching to student needs
- Providing clear *standards*, constant *feedback*, and opportunities for work
- Encouraging *strategic and metacognitive thinking*, so that students can learn to evaluate and guide their own learning

ADAPTING STRATEGIES TO KINDS OF LEARNING

Having identified some general principles about learning and teaching, it is important to acknowledge that effective teaching strategies differ with the kind of learning. As Bransford, Darling-Hammond, and LePage (2005) point out, the appropriateness of using particular types of teaching strategies depends on

(1) the nature of the materials to be learned; (2) the nature of the skills, knowledge, and experiences that learners bring to the situation; and (3) the goals of the learning situation and the assessments used to measure learning relative to these goals. These variables are represented in the model seen in [Figure 1](#), developed by James Jenkins. One important point of the model is that a teaching strategy that works within one constellation of these variables may work very poorly if one or more factors are changed.

For our discussion, the kind of learning sought is especially critical to examine: Does it aim for rote understanding and recall, or does it aim for the kind of meaningful learning that would allow learners to use what they've learned to solve problems? For example, what if we wanted to teach students about veins and arteries?¹ The text presents the

facts that arteries are thicker than veins and more elastic, and they carry blood rich in oxygen from the heart. Veins are smaller, less elastic, and carry blood back to the heart. What's the best way to help students learn this information? The Jenkins model reminds us that the answer to this question depends on who the students are, what we mean by “learning” in this context, and how we measure the learning that occurs.

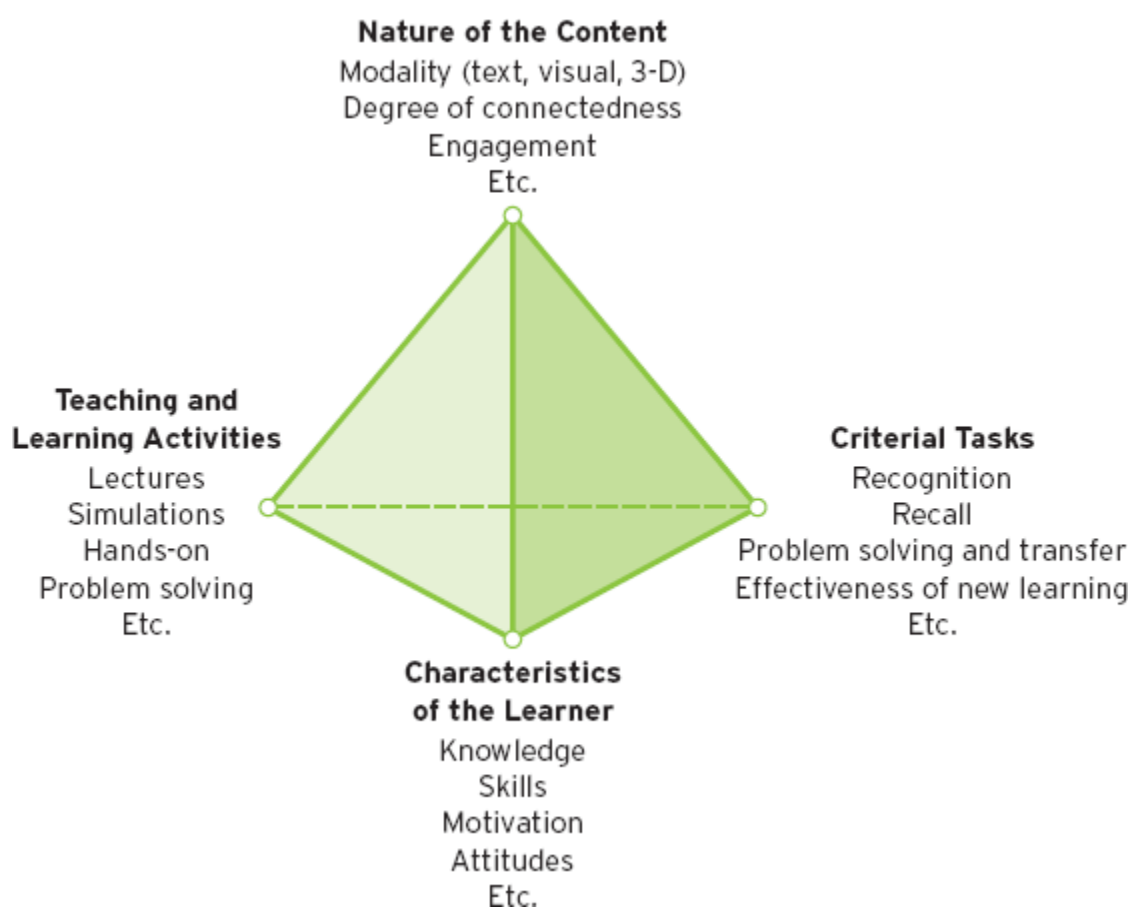


FIGURE 1 The Tetrahedral Model of Learning

If we want to ensure only that students remember certain key facts about arteries—for example, that they are thicker than veins and more elastic—then one strategy would be to use a mnemonic technique such as teaching students to remember the sentence “Art(ery) was *thick* around the middle so he wore pants with an *elastic* waist band.” If

students understand the vocabulary being used, this technique would “work” for remembering these specific facts.

Suppose, however, that we want students not only to remember certain facts but to *understand* why they are important with respect to bodily functioning. This involves a change in learning goals and assessments, as well as teaching and learning strategies. To learn with understanding, students need to learn *why* veins and arteries have certain characteristics. For example, arteries carry blood from the heart, blood that is pumped in spurts. This helps explain why they would need to be elastic (to handle the spurts). In contrast, veins carry blood back to the heart and hence need less elasticity due to a lessening of the spurts.

Learning to understand relationships such as why arteries are elastic and arteries are less so should facilitate subsequent transfer. For example, imagine that students are asked to design an artificial artery or vein. Would it have to be elastic? Students who have only memorized information have no grounded way to approach this problem. Students who have learned with understanding know the functions of elasticity and hence are freer to consider possibilities such as relatively nonelastic materials that can still handle differences in pressure (adapted from Bransford & Stein, 1993).

This example illustrates how memorizing versus understanding represent distinctive kinds of learning, and how changes in these goals require different types of teaching strategies. To understand how arteries function, students would have to examine how they work *in the context* of the cardiovascular system and other bodily functions. They would need to *link* this knowledge to other knowledge they have acquired about physical properties of

matter (aspects of force and gravity that are implicated in the need to pump fluid from the legs to the heart), and they would likely need opportunities to *construct or analyze* models of how this operates. The details of teaching strategies also vary with the knowledge, skills, attitudes, and other characteristics that students bring to the learning task. For example, younger students may not know enough about pumping, spurts, and elasticity to learn with understanding if they are simply told about the functions of arteries. They may need to see dynamic simulations that display these properties and consider examples that draw on aspects of the world that are already familiar (such as how elastic works in a rubber band). Seeing and experiencing things concretely is often an important prerequisite to learning to use information in more abstract or general ways.

Research examining whether “something works” should take into consideration each perspective of the Jenkins framework. In the box are a few critical questions to help position the teacher.

TEACHING WITH LEARNING IN MIND

What kind of content is worth having students spend their time learning?

What are the goals for learning?

Are the assessments of learning consistent with the goals?

Who is being taught?

How might teaching techniques need to change for students with differing sets of prior skills and knowledge?

A sophisticated understanding of the content, the learner, and the goals of instruction is important for effective teaching. As we proceed, we highlight these concerns as we discuss general strategies for teaching and learning for understanding and describe how they play out in a number of subject matter domains.

¹ *This example is drawn from Bransford, Darling-Hammond, and LePage (2005), pp. 18-20, and was modified with help from John Bransford, for clearer explication of the biological principles involved.*

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HOW CAN WE TEACH FOR MEANINGFUL LEARNING?

Brigid Barron and Linda Darling-Hammond

THE NEED FOR INQUIRY-BASED LEARNING TO SUPPORT TWENTY-FIRST-CENTURY SKILLS

Enthusiasm for approaches to instruction that connect knowledge to the contexts in which it will be applied has been on the upswing since the 1980s. Recommendations from an array of organizations have emphasized the need to support twenty-first-century skills through learning that supports inquiry, application, production, and problem solving. More than a decade ago, the SCANS Report (Secretary's Commission on Achieving Necessary Skills, 1991) suggested that for today's students to be prepared for tomorrow's workplace they need learning environments that allow them to explore real-life situations and consequential problems. These arguments have been echoed in scholarly research (for example, Levy & Murnane, 2004), national commission reports (such as NCTM, 1989; MLSC et al., 1996), and policy proposals (see NCREL EnGauge, 2003; Partnership for 21st Century Skills, 2002), urging instructional reforms to help students gain vital media literacies, critical thinking skills, systems thinking, and interpersonal and self-directional skills that allow them to manage projects and competently find resources and use tools.

For these capacities to be nurtured, the reports argue, students must be given opportunities to develop them in the context of complex, meaningful projects that require sustained engagement, collaboration, research, management of resources, and development of an ambitious performance or product. The rationale for these recommendations has come in part from research demonstrating that students do not routinely develop the ability to analyze, think critically, write and speak effectively, or solve complex problems from working on constrained tasks that emphasize memorization and elicit responses that merely demonstrate recall or application of simple algorithms (Bransford, Brown, & Cocking, 1999; Bransford & Donovan, 2005). In addition, there is a growing body of research indicating that students learn more deeply and perform better on complex tasks if they have the opportunity to engage in more “authentic” learning.

A set of studies have found positive effects on student learning of instruction, curriculum, and assessment practices that require students to construct and organize knowledge, consider alternatives, apply disciplinary processes to content central to the discipline (such as use of scientific inquiry, historical research, literary analysis, or the writing process), and communicate effectively to audiences beyond the classroom and school (Newmann, 1996). For example, a study of more than twenty-one hundred students in twenty-three restructured schools found significantly higher achievement on intellectually challenging performance tasks for students who experienced this kind of “authentic pedagogy” (Newmann, Marks, & Gamoran, 1995). The use of these practices predicted student performance more strongly than any other variable, including student background factors and prior achievement.

This is promising, but the checkered history of efforts to implement “learning by doing” makes clear the need for greater knowledge about how to successfully manage problem and project-based approaches in the classroom (Barron et al., 1998). The kind of teaching suggested by these descriptions is not straightforward and requires knowledge of the characteristics of successful strategies and highly skilled teachers to implement them. In this chapter, we focus on the design and implementation of inquiry-based curriculum that engages children in extended constructive work, often in collaborative groups, and subsequently demands a good deal of self-regulated inquiry.

INQUIRY-BASED LEARNING

The family of approaches that can be described as *inquiry-based* includes project-based learning, design-based learning, and problem-based learning.

The research we review spans the K-12 years, college, and graduate education and can be found across core disciplines and in interdisciplinary programs of study¹. Two major conclusions emerge:

Small group inquiry approaches can be extremely powerful for learning. To be effective, they need to be guided by thoughtful curriculum with clearly defined learning goals, well-designed scaffolds, ongoing assessment, and rich informational resources. Opportunities for professional development that include a focus on assessing student work increase the likelihood that teachers will develop expertise in implementing these approaches.

Assessment design is critical. Designing good assessment is an important issue for *revealing* the benefits of inquiry approaches as well as for *promoting* the success of learning. Specifically, if one looks only at traditional learning outcomes, such as memorization of information or responses to multiple-choice questions, inquiry-based and traditional methods of instruction appear to yield similar results. Benefits for inquiry learning emerge when the assessments require application of knowledge and measure quality of reasoning. Consequently, we also take up a discussion of *performance assessment* and its role in both supporting and evaluating meaningful learning.

Our discussion within this chapter is organized into four sections.

First, we provide a historical perspective on inquiry-based learning in the context of the ongoing calls to develop inquiry and collaborative capacities in learners.

Next, we summarize research on collaborative small group learning. Our review focuses primarily on studies that offer data on the outcomes of cooperative or collaborative learning approaches. However, we also look at the kinds of interaction between children that lead to deeper learning and better group problem solving, and what we have

learned about how teachers can support productive interactions.

In the third section, we summarize what we know about the forms of inquiry-based approaches (project, design, and problem-based) with respect to learning outcomes, supportive activity structures, and classroom norms.

Finally, we close with common design principles and recommendations about approaches to assessment.

AN HISTORICAL PERSPECTIVE ON INQUIRY-BASED LEARNING

Projects as a means for making schooling more useful and readily applied to the world first became popular in the early part of the twentieth century in the United States. The term *project* represented a broad class of learning experiences. In early works one sees the label applied to activities as diverse as making a dress, watching a spider spin a web, and writing a letter. The key idea behind such projects was that learning was strengthened when “whole heartedness of purpose was present” (Kilpatrick, 1918).

Enthusiasm and belief in the efficacy of such approaches for schooled children has waxed and waned, with project-based learning having been rejected as too unstructured during several eras of “back to the basics” backlash, or policymakers having argued that applied projects are only needed for vocational training. Critics of the progressive movement held that discovery learning approaches led to “doing for the sake of doing” rather than doing for the sake of learning. There is a growing consensus that authentic problems and projects afford unique opportunities for learning, but that authenticity in and of itself does not guarantee learning (Barron et al., 1998; Thomas, 2000).

The key is how these complex approaches are implemented. For example, in the curricular reforms of the post-Sputnik years, initiatives using inquiry-based approaches (typically called “discovery learning” or project learning) were found to produce comparable achievement on basic skills tests while contributing more to students’ problem-solving abilities, curiosity, creativity, independence, and positive feelings about school (Dunkin & Biddle, 1974; Glass et al., 1977; Good & Brophy, 1986; Horwitz, 1979; McKeachie & Kulik, 1975; Peterson, 1979; Resnick, 1987; Soar, 1977). This kind of meaning-oriented teaching, once thought to be appropriate only for selected high-achieving students, proved to be more effective than rote teaching for students across a spectrum of initial achievement levels, family income, and cultural and linguistic backgrounds (Braddock & McPartland, 1993; Garcia, 1993; Knapp et al., 1995).

However, new curriculum initiatives focused on inquiry using complex instructional strategies were found more often to promote a significant increase in learning gains among students taught by the early adopters—teachers who were extensively involved in designing and piloting the curriculum and who were given strong professional development. These effects were not always sustained as curriculum reforms were “scaled up” and used by teachers who did not have the same degree of understanding or skill in implementation.

At the present time, there is still controversy over whether inquiry-oriented approaches are effective and efficient for developing the student’s basic knowledge of a domain. Implementation issues continue to be a concern for both practitioners and researchers and complicate research. Examples include studies that have suggested that “direct instruction”—usually understood as traditional lecture-based approaches—is preferable to “discovery learning.”

The sources of confusion are shown in a study by Klahr and Nigam (2004), which taught middle school students to set up controlled experiments and then measured the students' knowledge of experimental design and their ability to set up experiments that could appropriately control for potentially confounding variables. They labeled their conditions "direct instruction" and "discovery learning." However, both conditions included features of discovery learning, including the chance for students to explore the materials and try together to set up experiments. In their discovery learning condition, the researchers simply instructed the participating sixth graders to design experiments to evaluate variables related to the speed of a ball traveling down a ramp. In the direct instruction approach, the children were taught about the importance of not confounding variables in the context of demonstration experiments. This lesson was given after they had tried to set up experiments on their own.

Although the researchers' conclusions suggested that the direct-instruction approach yielded better learning, they failed to acknowledge that this approach included both a great deal of experimentation and some direct instruction. In addition, critics of the study's conclusion point out that in a real classroom situation children would be given much more guidance and scaffolding than took place in their discovery-learning condition. Thus the study does not prove that classroom-based inquiry approaches are do not work but only that they are more successful when combined with necessary instruction. This combination of appropriately timed direct instruction with the results of inquiry has also been found in other studies to be superior to either approach alone (see, for example, Bransford, Brown, & Cocking, 1999, box on p. 46). We return to this important principle later in the chapter.

Classroom research does indicate that well-designed, carefully thought-out materials and connected classroom practices are needed to capitalize on inquiry-based approaches. Without careful planning, students may miss opportunities to connect their project work with key concepts underlying a discipline. For example, Roth (2006) found that in an engineering-based curriculum for elementary school students engineering principles were unlikely to be discovered simply by successfully engineering solutions to problems such as building bridges or towers. Similarly, Petrosino (1998) described his observation of students building rockets in a science curriculum highlighting interesting products and a high level of engagement but no growth in learning the principles of flight. However, a slight variation in the task that required students to determine the variables related to how far a rocket will travel led to a dramatic increase in students' conceptual knowledge relative to the original project.

In recent years, the research base on inquiry approaches has grown to include both comparative studies and more descriptive classroom investigations of teaching and learning processes. There is a growing consensus on the importance of a number of design principles that characterize successful inquiry-based learning environments and that can be used by teachers as they embark on developing or enacting new curriculum. We summarize the relevant research base beginning with collaborative approaches to learning and then moving to three specific approaches to designing inquiry experiences: project-based learning, design-based learning, and problem-based learning. (See [Table 1](#) of the Appendix for a summary of design principles that have emerged from classroom research.)

COLLABORATIVE SMALL GROUP LEARNING: EVIDENCE AND BEST PRACTICES

The technique of having small groups of students work together on learning activities has its roots in part in an experiment that was aimed at supporting friendships across ethnic groups following desegregation (Aronson & Bridgeman, 1979). This effort was based on theories of interpersonal relationship formation developed in the field of social psychology (Deutsch, 1949), and it proved successful not only at developing relationships but also at improving achievement.

Cooperative small group learning is one of the most studied pedagogical interventions in the history of educational research. E. G. Cohen (1994b) defines cooperative learning as “students working together in a group small enough that everyone can participate on a collective task that has been clearly assigned” (p. 3). This definition includes what has been called cooperative learning, collaborative learning, and other forms of small group work. This context for learning has been the subject of hundreds of studies and several meta-analyses (P. A. Cohen, Kulik, & Kulik, 1982; Cook, Scruggs, Mastropieri, & Castro, 1985; Hartley, 1977; Johnson, Maruyama, Johnson, Nelson, & Skon, 1981; Rohrbeck, Ginsburg-Block, Fantuzzo, & Miller, 2003). Overall these analyses come to the same conclusion: there are significant learning benefits for students when they are asked to work together on learning activities as compared to approaches where students work on their own (Johnson & Johnson, 1981, 1989).

For example, in a comparison of four types of problems presented to individuals or cooperative teams, researchers found that teams outperformed individuals on all types and

across all ages (Quin, Johnson, & Johnson, 1995). Problems varied in terms of how well defined they were (a single right answer versus open-ended projects such as writing a story) and whether they were more or less reliant on language. Individual experimental studies have shown that groups outperform individuals on learning tasks, and further that individuals who work in groups do better on later individual assessments as well (Barron, 2000b, 2003; O'Donnell & Dansereau, 1992).

There are desirable outcomes for students in other areas of their lives as well, including improvement in student self-concept, social interaction, time on task, and positive feelings toward peers (P. A. Cohen et al., 1982; Cook et al., 1985; Ginsburg-Block, Rohrbeck, & Fantuzzo, 2006; Hartley, 1977; Johnson & Johnson, 1989). Ginsburg-Block and colleagues (2006) focused on the relationship between academic and nonacademic measures. They found that both social and self-concept measures were related to academic outcomes. Larger effects were found for interventions that used same-gender grouping, interdependent group rewards, structured student roles, and individualized evaluation procedures. They also found that low-income students benefited more than high-income students, and urban students benefited more than suburban. Racial and ethnic minority students benefited even more from cooperative group work than nonminority students, a finding that has been repeated over several decades (see Slavin & Oickle, 1981). Ginsburg-Block and colleagues (2006) conclude that those dimensions of group work that support academic outcomes also yield social and self-concept benefits.

Most recently, the focus has gone beyond the practical benefits of collaboration for individual learning to recognize the importance of helping children develop the capacity to collaborate as necessary preparation for all

kinds of work. For example, the Science for All Americans, Project 2061 (American Association for the Advancement of Science, 1989) suggests that a core practice of scientific inquiry is collaborative work; schools should be preparing students for this kind of work through classroom activities that require joint efforts.

The collaborative nature of scientific and technological work should be strongly reinforced by frequent group activity in the classroom. Scientists and engineers work mostly in groups and less often as isolated investigators. Similarly, students should gain experiences sharing responsibility for learning with each other. In the process of coming to understandings, students in a group must frequently inform each other about procedures and meanings, argue over findings, and assess how the task is progressing. In the context of team responsibility, feedback and communication become more realistic and of a character very different from the usual individualistic textbook-homework-recitation approach [AAAS, 1989, p. 202].

Challenges of Small Group Work in Classrooms

Although there is much consensus about the desirability of developing collaboration skills, and research is clear about the general benefits of small group interaction for learning, this does not mean that helping small groups engage in high-quality discussion and sharing is easy. Research has identified at least three major challenges for cooperative learning in classrooms: (1) developing norms and structures within groups that allow individuals to work together; (2) developing tasks that support useful cooperative work; and (3) developing discipline-appropriate strategies for discussion that support rich learning of content.