

How Students Learn

HISTORY, MATHEMATICS, AND SCIENCE IN THE CLASSROOM

Committee on *How People Learn*, A Targeted Report for Teachers

M. Suzanne Donovan and John D. Bransford, *Editors*

Division of Behavioral and Social Sciences and Education

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**COMMITTEE ON *HOW PEOPLE LEARN*:
A TARGETED REPORT FOR TEACHERS**

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Preface

This book has its roots in the report of the Committee on Developments in the Science of Learning, *How People Learn: Brain, Mind, Experience and School* (National Research Council, 1999, National Academy Press). That report presented an illuminating review of research in a variety of fields that has advanced understanding of human learning. The report also made an important attempt to draw from that body of knowledge implications for teaching. A follow-on study by a second committee explored what research and development would need to be done, and how it would need to be communicated, to be especially useful to teachers, principals, superintendents, and policy makers: *How People Learn: Bridging Research and Practice* (National Research Council, 1999). These two individual reports were combined to produce an expanded edition of *How People Learn* (National Research Council, 2000). We refer to this volume as *HPL*.

In the present book, the goal is to take the *HPL* work to the next step: to provide examples of how the principles and findings on learning can be used to guide the teaching of a set of topics that commonly appear in the K-12 curriculum. As was the case in the original work (1999), the book focuses on three subject areas: history, mathematics, and science. Each area is treated at three levels: elementary, middle, and high school. Distinguished researchers who have extensive experience in teaching or in partnering with teachers were invited to contribute the chapters. The committee shaped the goals for the volume, and commented—sometimes extensively—on the draft chapters as they were written and revised. The principles of *HPL* are embedded in each chapter, though there are differences from one chapter to the next in how explicitly they are discussed.

Taking this next step to elaborate the *HPL* principles in context poses a potential problem that we wish to address at the outset. The meaning and relevance of the principles for classroom teaching can be made clearer with specific examples. At the same time, however, many of the specifics of a particular example could be replaced with others that are also consistent with the *HPL* principles. In looking at a single example, it can be difficult to distinguish what is necessary to effective teaching from what is effective but easily replaced. With this in mind, it is critical that the teaching and learning examples in each chapter be seen as illustrative, not as blueprints for the “right” way to teach.

We can imagine, by analogy, that engineering students will better grasp the relationship between the laws of physics and the construction of effective supports for a bridge if they see some examples of well-designed bridges, accompanied by explanations for the choices of the critical design features. The challenging engineering task of crossing the entrance of the San Francisco Bay, for example, may bring the relationship between physical laws, physical constraints, and engineering solutions into clear and meaningful focus. But there are some design elements of the Golden Gate Bridge that could be replaced with others that serve the same end, and people may well differ on which among a set of good designs creates the most appealing bridge.

To say that the Golden Gate Bridge is a good example of a suspension bridge does not mean it is the only, or the best possible, design for a suspension bridge. If one has many successful suspension bridges to compare, the design features that are required for success, and those that are replaceable, become more apparent. And the requirements that are uniform across contexts, and the requirements that change with context, are more easily revealed.

The chapters in this volume highlight different approaches to addressing the same fundamental principles of learning. It would be ideal to be able to provide two or more “*HPL* compatible” approaches to teaching the same topic (for example, the study of light in elementary school). However, we cannot provide that level of specific variability in this already lengthy volume. Nevertheless, we hope that common features across chapters, and the variation in approach among the chapters, are sufficient to provide instructive insights into the principles laid out in *How People Learn*.

This volume could not have come to life without the help and dedication of many people, and we are grateful to them. First and foremost, the committee acknowledges the contributions of Robbie Case, who was to have contributed to the mathematics chapters in this volume. Robbie was at the height of a very productive career when his life came to an unexpected end in May 2000. Robbie combined the very best in disciplinary research and attention to the incorporation of research findings into classroom tools

to support teaching and learning. In this respect, he was a model for researchers interested in supporting improved educational practice. The mathematics chapters in this volume are marked by Robbie Case's influence.

The financial support of our sponsors, the U.S. Department of Education and the President's Circle of the National Academy of Sciences, was essential. We appreciate both their support and their patience during the unexpectedly long period required to shape and produce so extensive a volume with so many different contributors. Our thanks to C. Kent McGuire, former assistant secretary of the Office of Education Research and Improvement for providing the initial grant for this project, and to his successor and now director of the National Institute for Education Sciences, Grover J. Whitehurst; thanks are due as well to Patricia O'Connell Ross, Jill Edwards Staton, Michael Kestner, and Linda Jones at the Department of Education for working with us throughout, and providing the time required to produce a quality product.

This report is a somewhat unusual undertaking for the National Research Council in that the committee members did not author the report chapters, but served as advisers to the chapter authors. The contributions of committee members were extraordinary. In a first meeting the committee and chapter authors worked together to plan the volume. The committee then read each draft chapter, and provided extensive, and remarkably productive, feedback to chapter authors. As drafts were revised, committee members reviewed them again, pointing out concerns and proposing potential solutions. Their generosity and their commitment to the goal of this project are noteworthy.

Alexandra Wigdor, director of the Division on Education, Labor, and Human Performance when this project was begun, provided ongoing guidance and experienced assistance with revisions. Rona Brière brought her special skills in editing the entire volume. Our thanks go to Allison E. Shoup, who was senior project assistant, supporting the project through much of its life; to Susan R. McCutchen, who prepared the manuscript for review; to Claudia Sauls and Candice Crawford, who prepared the final manuscript; and to Deborah Johnson, Sandra Smotherman, and Elizabeth B. Townsend, who willingly provided additional support when needed. Kirsten Sampson Snyder handled the report review process, and Yvonne Wise handled report production—both challenging tasks for a report of this size and complexity. We are grateful for their help.

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards

for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We thank the following individuals for their review of this report: Jo Boaler, Mathematics Education, School of Education, Stanford University; Miriam L. Clifford, Mathematics Department, Carroll College, Waukesha, Wisconsin; O.L. Davis, Curriculum and Instruction, The University of Texas at Austin; Patricia B. Dodge, Science Teacher, Essex Middle School, Essex Junction, Vermont; Carol T. Hines, History Teacher, Darrel C. Swope Middle School, Reno, Nevada; Janis Lariviere, UTeach—Science and Mathematics Teacher Preparation, The University of Texas at Austin; Gaea Leinhardt, Learning Research and Development Center and School of Education, University of Pittsburgh; Alan M. Lesgold, Office of the Provost, University of Pittsburgh; Marcia C. Linn, Education in Mathematics, Science, and Technology, University of California, Berkeley; Kathleen Metz, Cognition and Development, Graduate School of Education, University of California, Berkeley; Thomas Romberg, National Center for Research in Mathematics and Science Education, University of Wisconsin–Madison; and Peter Seixas, Centre for the Study of Historical Consciousness, University of British Columbia.

Although the reviewers listed above have provided many constructive comments and suggestions, they did not see the final draft of the report before its release. The review of this report was overseen by Alan M. Lesgold, University of Pittsburgh. Appointed by the National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authors, the committee, and the institution.

John D. Bransford, *Chair*
M. Suzanne Donovan, *Study Director*

Contents

1	Introduction	1
	<i>M. Suzanne Donovan and John D. Bransford</i>	
	A Fish Story, 2	
	Learning Environments and the Design of Instruction, 12	
	Putting the Principles to Work in the Classroom, 20	
	Intent and Organization of This Volume, 21	
	Notes, 25	
	References, 26	
Part I: History		
2	Putting Principles into Practice: Understanding History	31
	<i>Peter J. Lee</i>	
	History and Everyday Ideas, 33	
	Substantive Concepts, 61	
	History That Works, 65	
	Notes, 73	
	References, 74	
3	Putting Principles into Practice: Teaching and Planning	79
	<i>Rosalyn Ashby, Peter J. Lee, and Denis Shemilt</i>	
	The Reality Test, 80	
	Working with Evidence: Pilgrim Fathers and Native Americans, 84	
	Working with Evidence: The St. Brendan's Voyage Task, 119	

- Appendix 3A: Implications for Planning, 164
 Notes, 177
 References, 177
- 4 “They Thought the World Was Flat?": Applying the Principles of
How People Learn in Teaching High School History 179
Robert B. Bain
 Where to Begin? Transforming Topics and Objectives into
 Historical Problems, 181
 Designing a “History-Considerate” Learning Environment:
 Tools for Historical Thinking, 199
 Conclusion, 209
 Acknowledgments, 210
 Notes, 211
 References, 212

Part II: Mathematics

- 5 Mathematical Understanding: An Introduction 217
Karen C. Fuson, Mindy Kalchman, and John D. Bransford
 Principle #1: Teachers Must Engage Students’ Preconceptions, 219
 Principle #2: Understanding Requires Factual Knowledge and
 Conceptual Frameworks, 231
 Principle #3: A Metacognitive Approach Enables Student
 Self-Monitoring, 236
 Next Steps, 243
 Notes, 246
 References, 246
 Suggested Reading List for Teachers, 256
- 6 Fostering the Development of Whole-Number Sense:
 Teaching Mathematics in the Primary Grades 257
Sharon Griffin
 Deciding What Knowledge to Teach, 259
 Building on Children’s Current Understandings, 267
 Acknowledging Teachers’ Conceptions and Partial
 Understandings, 279
 Revisiting Question 2: Defining the Knowledge That
 Should Be Taught, 281
 How Can This Knowledge Be Taught?:
 The Case of Number Worlds, 282
 What Sorts of Learning Does This Approach Make Possible?, 302

	Summary and Conclusion, 305	
	Acknowledgments, 306	
	Notes, 306	
	References, 306	
7	Pipes, Tubes, and Beakers: New Approaches to Teaching the Rational-Number System	309
	<i>Joan Moss</i>	
	Rational-Number Learning and the Principles of <i>How People Learn</i> , 312	
	Instruction in Rational Number, 319	
	Conclusion: How Students Learn Rational Number, 341	
	Notes, 343	
	References, 345	
8	Teaching and Learning Functions	351
	<i>Mindy Kalchman and Kenneth R. Koedinger</i>	
	Addressing the Three Principles, 359	
	Teaching Functions for Understanding, 373	
	Summary, 389	
	Acknowledgments, 391	
	Notes, 392	
	References, 392	
	Other Relevant Readings, 393	
Part III:		
Science		
9	Scientific Inquiry and <i>How People Learn</i>	397
	<i>John D. Bransford and M. Suzanne Donovan</i>	
	Principle #1: Addressing Preconceptions, 399	
	Principle #2: Knowledge of What It Means to “Do Science,” 403	
	Principle #3: Metacognition, 407	
	The <i>How People Learn</i> Framework, 411	
	Conclusion, 415	
	Notes, 416	
	References, 416	
10	Teaching to Promote the Development of Scientific Knowledge and Reasoning About Light at the Elementary School Level	421
	<i>Shirley J. Magnusson and Annemarie Sullivan Palinscar</i>	
	The Study of Light, 422	
	The Study of Light Through Inquiry, 426	

	Supporting Learning Through Cycles of Investigation, 460	
	The Role of Subject-Specific Knowledge in Effective Science Instruction, 467	
	Conclusion, 469	
	Notes, 470	
	References, 472	
11	Guided Inquiry in the Science Classroom	475
	<i>James Minstrell and Pamela Kraus</i>	
	The Unit: The Nature of Gravity and Its Effects, 477	
	Summary, 511	
	Notes, 512	
12	Developing Understanding Through Model-Based Inquiry	515
	<i>James Stewart, Jennifer L. Cartier, and Cynthia M. Passmore</i>	
	Genetics, 516	
	Developing Darwin's Model of Natural Selection in High School Evolution, 540	
	Classroom Environments That Support Learning with Understanding, 555	
	Summary, 561	
	Notes, 562	
	References, 563	
 A Final Synthesis: Revisiting the Three Learning Principles 		
13	Pulling Threads	569
	<i>M. Suzanne Donovan and John D. Bransford</i>	
	Engaging Resilient Preconceptions, 569	
	Organizing Knowledge Around Core Concepts, 575	
	Supporting Metacognition, 577	
	Principles of Learning and Classroom Environments, 586	
	Notes, 588	
	References, 589	
	Other Resources, 590	
	Biographical Sketches of Committee Members and Contributors	591
	Index	597

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**HISTORY, MATHEMATICS, AND SCIENCE
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How Students Learn: History, Mathematics, and Science in the Classroom is the title of a 2001 educational psychology book edited by M. Suzanne Donovan and John D. Bransford and published by the United States National Academy of Sciences's National Academies Press. The book focuses on "three fundamental and well-established principles of learning that are highlighted in How People Learn and are particularly important for teachers to understand and be able to incorporate in their teaching How can we teach our young and adult students to learn and what we can start with? Involve students in planning the curriculum. Give them the possibility to choose what topic will be following. Let's look at the situation when you don't use any specific coursebook for lessons (you have a tailored course) or prepare students for exams. You plan to study the topics "Food, Holidays, and Sport", let students decide which topic they want to study first. I personally think, how students learn? is geared towards cognitive process (s). For example, searching knowledge/information, processing and creating. All these happen in the brain. We need to elaborate it more. Tell how they are going to learn it. - How will it be done? Tell them how they will prove competency of learning. Can it be done? Now tell them a story that relates the education or skills you are teaching to real life and gives the learning meaning for them. "How Students Learn: History in the Classroom, edited by M. Suzanne Donovan and John D. Bransford. Washington, DC: The National Academies Press, 2005. 615 pages. \$34.95, paper, with a CD-ROM". The History Teacher. Society for History Education. 39 (3): 410-411. doi:10.2307/30036810. ISSN 0018-2745. Gilbert, John K. (2005-09-26). These good habits for students are based on how the learning strategies top students use to reach their goals. Here's how you can take the lead! 10 Good Habits for Students: How Top Students Learn. Posted on March 20, 2015 by Andrea Leyden. We all know someone who is outstandingly brilliant at learning. They are the Stephen Hawking or Marissa Mayer of your class and you're probably scratching your head wondering why you can't do it too, am I right?