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*

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How Students Learn

HISTORY, MATHEMATICS, AND SCIENCE IN THE CLASSROOM

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. Letâ€™s look at the situation when you donâ€™t use any specific coursebook for lessons (you have a tailored course) or prepare students for exams. You plan to study the topics â€œFood, Holidays, and Sportâ€, let students decide which topic they want to study first. Today's students have the life compared to how learning was conducted in the past. Rather than just sitting in a dull schoolhouse each and every day listening to teachers, the modern classroom is filled with technology that advances education. Some people might think that technology is a bad thing and that it hinders our brain's ability to learn new information. That's true to some extent when we look at technologies that "numb our brain" like social media, Netflix, and others. 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.Â 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. When you sit down to study, how do you transfer that massive amount of information from the books and notes in front of you to a reliable spot in your mind? You need to develop good study habits.Â This article received 113 testimonials and 80% of readers who voted found it helpful, earning it our reader-approved status. This article has been viewed 4,671,420 times. When you sit down to study, how do you transfer that massive amount of information from the books and notes in front of you to a reliable spot in your mind? Students learn by connecting new knowledge with knowledge and concepts that they already know, most effectively in active social classrooms where they negotiate understanding through interaction and varied approaches. Instructors can help students learn to build conceptual frameworks that are deeply interconnected, transferable, and rooted in a solid memory and skills foundations. Transfer of Knowledge to New Contexts.

Learn how to build a brand with purpose and personality. Design School. Courses.Â 01. Create a learner identity with a personal page. Do your students see themselves as more than studentsâ€”as learners with an identity of their own, with a sense of direction and ownership over their education? Encouraging students to form a â€œlearner identityâ€ will help them fuse the notion of lifelong learning with their current studies, and to see themselves as active participants in a process that extends beyond a single unit, class, or school year. Remember that how and why questions help to improve a personâ€™s understanding. Students can start by making a list of ideas they need to learn. Then, they go down the list and ask themselves questions about how these ideas work and why. Next, students have to go through their class material again and find the answers to their own questions. 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.Â 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 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. Letâ€™s look at the situation when you donâ€™t use any specific coursebook for lessons (you have a tailored course) or prepare students for exams. You plan to study the topics â€œFood, Holidays, and Sportâ€, let students decide which topic they want to study first.