How Learning Works

Seven Research-Based Principles for Smart Teaching

Susan A. Ambrose, Michael W. Bridges, Michele DiPietro, Marsha C. Lovett, Marie K. Norman

Foreword by Richard E. Mayer

Jossey-Bass
A Wiley Imprint
www.josseybass.com
student learning that enables them to make sound teaching decisions. In other words, instructors need a bridge between research and practice, between teaching and learning.

We wrote this book to provide such a bridge. The book grew out of over twenty-nine years of experience consulting with faculty colleagues about teaching and learning. In these consultations, we encountered a number of recurring problems that spanned disciplines, course types, and student skill levels. Many of these problems raised fundamental questions about student learning. For example: Why can’t students apply what they have learned? Why do they cling so tightly to misconceptions? Why are they not more engaged by material I find so interesting? Why do they claim to know so much more than they actually know? Why do they continue to employ the same ineffective study strategies?

As we worked with faculty to explore the sources of these problems, we turned to the research on learning, and from this research we distilled seven principles, each of which crystallizes a key aspect of student learning. These principles have become the foundation for our work. Not only have we found them indispensable in our own teaching and in our consultations with faculty, but as we have talked and worked with thousands of faculty from around the world, we have also found that the principles resonate across disciplines, institution types, and cultures, from Latin America to Asia. In our experience, these principles provide instructors with an understanding of student learning that can help them (a) see why certain teaching approaches are or are not supporting students’ learning, (b) generate or refine teaching approaches and strategies that more effectively foster student learning in specific contexts, and (c) transfer and apply these principles to new courses.

In this book, we offer these principles of learning, along with a discussion of the research that supports them, their implications for teaching, and a set of instructional strategies targeting each principle. Before briefly summarizing the full set of principles and discussing the characteristics they share and some ways that this book can be used, we begin by discussing what we mean by learning.

WHAT IS LEARNING?

Any set of learning principles is predicated on a definition of learning. In this book, we define learning as a process that leads to change, which occurs as a result of experience and increases the potential for improved performance and future learning (adapted from Mayer, 2002). There are three critical components to this definition:

1. Learning is a process, not a product. However, because this process takes place in the mind, we can only infer that it has occurred from students’ products or performances.
2. Learning involves change in knowledge, beliefs, behaviors, or attitudes. This change unfolds over time; it is not fleeting but rather has a lasting impact on how students think and act.
3. Learning is not something done to students, but rather something students themselves do. It is the direct result of how students interpret and respond to their experiences—conscious and unconscious, past and present.

OUR PRINCIPLES OF LEARNING

Our seven principles of learning come from a perspective that is developmental and holistic. In other words, we begin with the recognition that (a) learning is a developmental process that intersects with other developmental processes in a student’s life, and
(b) students enter our classrooms not only with skills, knowledge, and abilities, but also with social and emotional experiences that influence what they value, how they perceive themselves and others, and how they will engage in the learning process. Consistent with this holistic perspective, readers should understand that, although we address each principle individually to highlight particular issues pertaining to student learning, they are all at work in real learning situations and are functionally inseparable.

In the paragraphs below, we briefly summarize each of the principles in the order in which they are discussed in the book.

**Students’ prior knowledge can help or hinder learning.**

Students come into our courses with knowledge, beliefs, and attitudes gained in other courses and through daily life. As students bring this knowledge to bear in our classrooms, it influences how they filter and interpret what they are learning. If students’ prior knowledge is robust and accurate and activated at the appropriate time, it provides a strong foundation for building new knowledge. However, when knowledge is inert, insufficient for the task, activated inappropriately, or inaccurate, it can interfere with or impede new learning.

**How students organize knowledge influences how they learn and apply what they know.**

Students naturally make connections between pieces of knowledge. When these connections form knowledge structures that are accurately and meaningfully organized, students are better able to retrieve and apply their knowledge effectively and efficiently. In contrast, when knowledge is connected in inaccurate or random ways, students can fail to retrieve or apply it appropriately.

**Students’ motivation determines, directs, and sustains what they do to learn.**

As students enter college and gain greater autonomy over what, when, and how they study and learn, motivation plays a critical role in guiding the direction, intensity, persistence, and quality of the learning behaviors in which they engage. When students find positive value in a learning goal or activity, expect to successfully achieve a desired learning outcome, and perceive support from their environment, they are likely to be strongly motivated to learn.

**To develop mastery, students must acquire component skills, practice integrating them, and know when to apply what they have learned.**

Students must develop not only the component skills and knowledge necessary to perform complex tasks, they must also practice combining and integrating them to develop greater fluency and automaticity. Finally, students must learn when and how to apply the skills and knowledge they learn. As instructors, it is important that we develop conscious awareness of these elements of mastery so as to help our students learn more effectively.

**Goal-directed practice coupled with targeted feedback enhances the quality of students’ learning.**
Learning and performance are best fostered when students engage in practice that focuses on a specific goal or criterion, targets an appropriate level of challenge, and is of sufficient quantity and frequency to meet the performance criteria. Practice must be coupled with feedback that explicitly communicates about some aspect(s) of students' performance relative to specific target criteria, provides information to help students progress in meeting those criteria, and is given at a time and frequency that allows it to be useful.

Students' current level of development interacts with the social, emotional, and intellectual climate of the course to impact learning.

Students are not only intellectual but also social and emotional beings, and they are still developing the full range of intellectual, social, and emotional skills. While we cannot control the developmental process, we can shape the intellectual, social, emotional, and physical aspects of the classroom climate in developmentally appropriate ways. In fact, many studies have shown that the climate we create has implications for our students. A negative climate may impede learning and performance, but a positive climate can energize students' learning.

To become self-directed learners, students must learn to monitor and adjust their approaches to learning.

Learners may engage in a variety of metacognitive processes to monitor and control their learning—assessing the task at hand, evaluating their own strengths and weaknesses, planning their approach, applying and monitoring various strategies, and reflecting on the degree to which their current approach is working. Unfortunately, students tend not to engage in these processes naturally. When students develop the skills to engage these processes, they gain intellectual habits that not only improve their performance but also their effectiveness as learners.

WHAT MAKES THESE PRINCIPLES POWERFUL?

The principal strength of these seven principles is that they are based directly on research, drawing on literature from cognitive, developmental, and social psychology, anthropology, education, and diversity studies, and research targeting not only higher education but also K-12 education. Although, of course, this is not an exhaustive review and any summary of research necessarily simplifies a host of complexities for the sake of accessibility, we believe that our discussions of the research underlying each principle are faithful to the scholarship and describe features of learning about which there is widespread agreement. Indeed, several of our principles converge with those that others have delineated (Pittsburgh Science of Learning Center, 2009; American Psychological Society, 2008), a convergence that we believe attests to their salience.

Not only are these principles research-based, but as we have shared them with colleagues over the years, we have found that they are

- Domain-independent: They apply equally well across all subject areas, from biology to design to history to robotics; the fundamental factors that impact the way students learn transcend disciplinary differences.
## CONTENTS

- List of Figures, Tables, and Exhibits  ix
- Foreword  xiii
  Richard E. Mayer
- Acknowledgments  xvii
- About the Authors  xix

### Introduction Bridging Learning Research and Teaching Practice
1  

1. How Does Students' Prior Knowledge Affect Their Learning?  10
2. How Does the Way Students Organize Knowledge Affect Their Learning?  40
3. What Factors Motivate Students to Learn?  66
4. How Do Students Develop Mastery?  91
5. What Kinds of Practice and Feedback Enhance Learning?  121
7. How Do Students Become Self-Directed Learners?  188

### Conclusion Applying the Seven Principles to Ourselves  217
LIST OF FIGURES, TABLES, AND EXHIBITS

Figures
Figure 1.1. Qualities of Prior Knowledge That Help or Hinder Learning 14
Figure 2.1. Differences in How Experts and Novices Organize Knowledge 45
Figure 2.2. Examples of Knowledge Organizations 50
Figure 3.1. Impact of Value and Expectancy on Learning and Performance 70
Figure 3.2. Interactive Effects of Environment, Efficacy, and Value on Motivation 80
Figure 4.1. Elements of Mastery 96
Figure 4.2. Stages in the Development of Mastery 97
Figure 5.1. Cycle of Practice and Feedback 126
Figure 5.2. Unequal Effects of Practice on Performance 135
Figure 6.1. Interactive Effect of Student Development and Course Climate on Learning 157
Figure 7.1. Cycle of Self-Directed Learning 193
Figure B.1. Sample Concept Map 229

Tables
Table D.1. Sample Verbs for Bloom's Taxonomy 246
<table>
<thead>
<tr>
<th>Exhibits</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exhibit A.1. Sample Self-Assessments</td>
<td>226</td>
</tr>
<tr>
<td>Exhibit C.1. Rubric for Class Participation</td>
<td>233</td>
</tr>
<tr>
<td>Exhibit C.2. Rubric for Oral Exams</td>
<td>234</td>
</tr>
<tr>
<td>Exhibit C.3. Rubric for Papers</td>
<td>236</td>
</tr>
<tr>
<td>Exhibit C.4. Senior Design Project Rubric</td>
<td>239</td>
</tr>
<tr>
<td>Exhibit D.1. Sample Learning Objectives</td>
<td>247</td>
</tr>
<tr>
<td>Exhibit E.1. Sample Ground Rules</td>
<td>249</td>
</tr>
<tr>
<td>Exhibit E.2. A Method for Helping Students Create Their Own Ground Rules</td>
<td>250</td>
</tr>
<tr>
<td>Exhibit F.1. Sample Exam Wrapper</td>
<td>253</td>
</tr>
<tr>
<td>Exhibit G.1. Sample Paper Checklist</td>
<td>256</td>
</tr>
<tr>
<td>Exhibit H.1. Sample Reader Response/Peer Review Instrument</td>
<td>258</td>
</tr>
</tbody>
</table>

To the faculty and graduate instructors of Carnegie Mellon, whose dedication to student learning continues to inspire us.