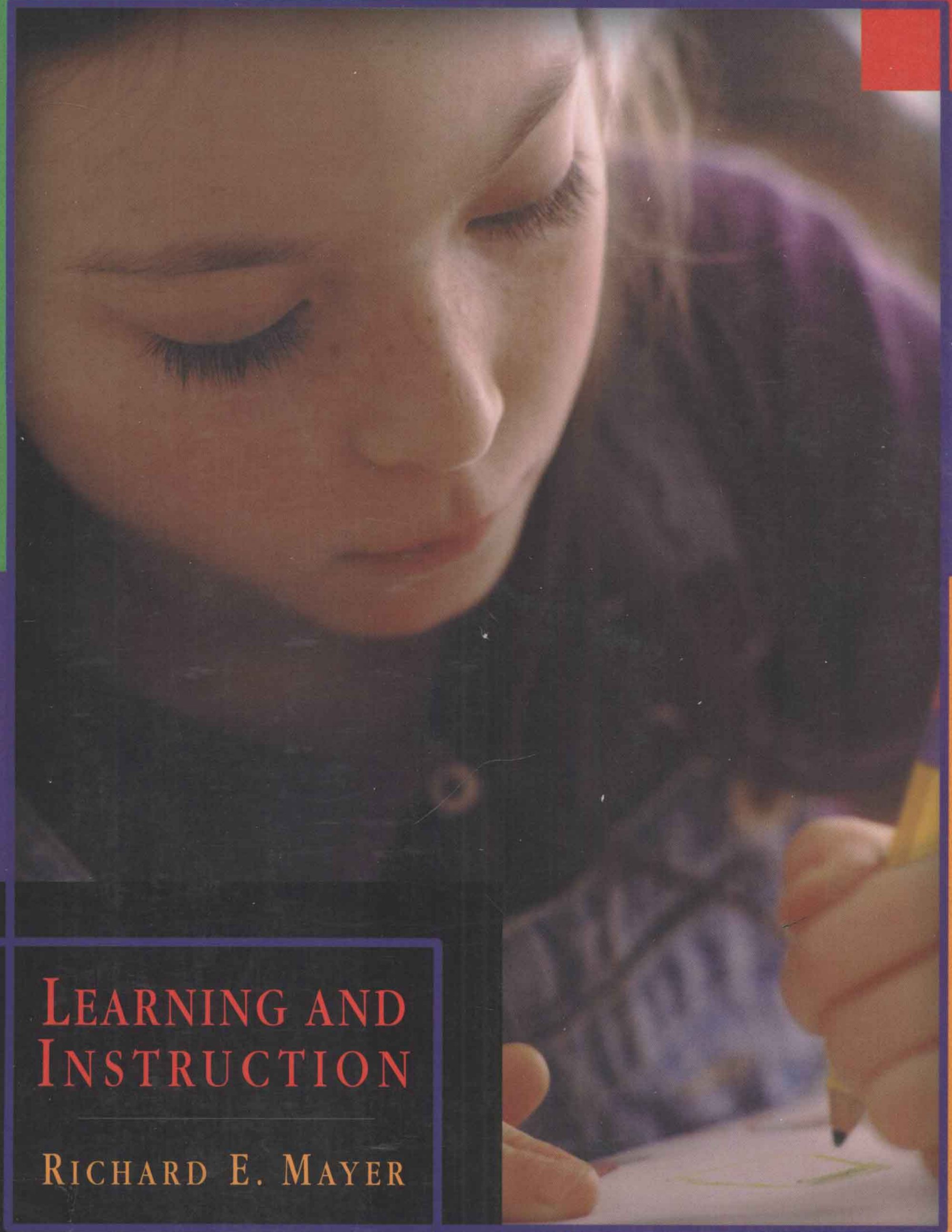

LEARNING AND INSTRUCTION

RICHARD E. MAYER

Learning and Instruction

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Dedicated to

Beverly

PREFACE

How do people learn? How can we promote their learning? If these questions interest you, then you should read this book. These seemingly simple questions have interested educators and researchers for more than 100 years, but significant advances in answering them have been occurring recently. Although I am not able to give you a complete answer to these questions in this book, I try to show you some of the exciting progress that has been made.

The scientific study of education began about 100 years ago, when the world's first educational psychologist, E. L. Thorndike, initiated his 40-year-long research program at Columbia University in 1901. Then, as now, researchers and educators sought to understand how students learn and how to design instruction that would promote their learning. During the last quarter century the pace and productivity of educational research has accelerated, yielding exciting advances in our understanding of school learning and instruction. In particular, the two most significant breakthroughs involve *psychologies of subject matter*—that is, how students learn school subjects such as reading, writing, mathematics, science, and history—and *cognitive process instruction*—that is, research on how to help students use appropriate cognitive processes on specific academic tasks, such as how to abstract the theme of a passage or how to identify needed and unneeded information in an arithmetic story problem. My goal in writing this book is to introduce you to some of the exciting research on school learning and instruction. If you are interested in what research has to say about school learning and instruction, then this book is for you.

I do not assume that you have any previous background in education or psychology. I do assume that you prefer to focus on research about learning and instruction rather than opinions and unsubstantiated claims. This book is appropriate for courses in education or psychology that focus on learning and instruction. I created it by merging and updating two recently published books: *The Promise of Educational Psychology, Volume I: Learning in the Content Areas* and *The Promise of Educational Psychology, Volume II: Teaching for Meaningful Learning. Learning and Instruction* also represents an up-to-date revision and extension of my earlier book, *Educational Psychology: A Cognitive Approach.*

This book is based on several fundamental values that I have developed over the years as an author and teacher. First, in each chapter I prefer to focus clearly on a few big ideas rather than to mention everything there is to say on a topic. If you somehow miss the big ideas, I summarize them at the end of each chapter. I would prefer for you to understand a few exemplary ideas deeply than to learn about a list of topics superficially. My approach is focused rather than encyclopedic. Second, I prefer to base my conclusions on scientific research rather than on the opinion of experts. When I present an exemplary research study, I try to give you enough detail so you can see what was done (method), what was found (results), and what it all means (conclusion). I prefer for you to be able to see how educational practice can be informed by research rather than ask you to "trust me." My approach values solid research over well-intentioned opinions. Third, I prefer to convey an understanding of what is known about how to help people learn rather than give you a list of specific prescriptions for immediate classroom practice. My approach values understanding the learning/teaching process rather than memorizing a set of classroom procedures. When I present instructional implications, I try to help you see how they follow

from research and theory. Fourth, I value clear organization so I provide a chapter outline that is keyed to the headings I use throughout the chapter. Fifth, I value active learning so I try to engage you in tasks that are directly relevant to the theme of a chapter or section, and I write in a conversational style in which I address you directly. Sixth, I value meaningful learning so I try to provide clear definitions and concrete examples of key concepts. Overall, rather than simply presenting information, my approach values conciseness, research-based conclusions, theory-based recommendations, clear structure, empathy, and concreteness.

Preparing this book has reminded me of the exciting progress researchers have made in understanding how students learn in subject areas and how instruction can promote meaningful learning. I hope that you enjoy reading this book as much as I have enjoyed writing it. If it conveys this sense of progress and if it makes sense to you, then I will consider this book a success. Please feel free to contact me with any comments or suggestions (at mayer@psych.ucsb.edu).

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I am indebted to my publisher, my teachers, my colleagues, my students, and my family. I thank Kevin Davis and his associates at Merrill/Prentice Hall for their patience and support during the course of this project. This text is a combination and updating of two currently published books: *The Promise of Educational Psychology: Learning in the Content Areas* and *The Promise of Educational Psychology, Volume II: Teaching for Meaningful Learning*. I wish to thank the reviewers of these two works for their helpful critques: Thomas Anderson, University of Illinois; Carol Anne Kardash, University of Missouri–Columbia; Kenneth Kiewra, University of Nebraska; Kathryn W. Linden, Purdue University; John R. McClure, Northern Arizona University; Michael S. Meloth, University of Colorado; Otherine Neisler, Yale University; Gary Phye, Iowa State University; and Paul R. Pintrich, The University of Michigan. I also appreciate the production services of Clarinda Publication Services. I am grateful to my mentors at the University of Michigan (where I received my Ph.D. in 1973), including James Greeno and Bill McKeachie. I also learned much from my colleagues at Indiana University (where I served from 1973 to 1975) and at the University of California, Santa Barbara (where I have served since 1975), as well as colleagues around the nation and the world. I have been fortunate to be able to work with an outstanding group of graduate students and postdoctoral scholars over the years, and I appreciate the many helpful suggestions of undergraduate students in my educational psychology course. I am grateful to my parents, who were my first teachers, and whose memory is now never far from my thoughts. I thank my children, Ken, Dave, and Sarah, for reminding me to keep the book interesting, and for keeping my life so interesting. I particularly wish to thank my wife, Beverly, for her unwavering support and encouragement, and just for bringing so much happiness into my life. I dedicate this book to her with love.

Richard E. Mayer
Santa Barbara, California

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CHAPTER 1

Introduction to Learning and Instruction

CHAPTER OUTLINE

Wild Boy

What Is Educational Psychology?

A Brief History of the Relationship Between Education and Psychology

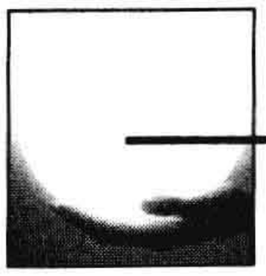
A Closer Look at the Learner-Centered Approach

How to Foster Meaningful Learning

What Is the Promise of Educational Psychology?

Chapter Summary

After exploring a classic educational study, this chapter defines educational psychology, summarizes the history of the educational psychology, explores the role of educational psychology, explains how to foster meaningful learning, and examines how educational psychology can help to answer questions about educational practice. It also provides an organization for the rest of the book.



WILD BOY

Suppose a child was freed completely of all social interaction with other humans. Suppose this child was allowed to develop without any social contact with other people. This experiment could be viewed as providing a child with the ultimate in educational freedom. What would happen to such a child? What would the child be like? Is society needed in order to help children develop to their fullest potential as human beings? Take a moment to provide some predictions in Figure 1–1.

These questions were at the heart of an historic educational experiment that began in 1800 in Paris. The experiment involved only one student, an adolescent boy named Victor, and his teacher, a physician named Dr. Jean-Marc Itard. Victor had been discovered living in the forests of Aveyron in France. Apparently, the boy had grown up in the forest, without any human contact. When captured, the boy was completely naked, dirty, and inarticulate. He seemed insensitive to temperature and pain, and was incapable of maintaining attention. He ate his food raw, using only his hands. Although physically healthy, he was totally unsocialized. The public showed great interest in the boy, and he become popularly known as the "enfant sauvage de l'Aveyron"—that is, the "wild boy of Aveyron." Dr. Itard was convinced that the boy, whom he named Victor, could be taught to become a civilized member of French society. For the next five years, Dr. Itard worked with his student, often having to develop new materials and instructional techniques.

Dr. Itard's educational program was based on several principles. First, he believed that the needs and characteristics of the student should dictate the educational program, an approach that can be called *learner-centered.* Instead of letting the curriculum determine what students would learn, in lock-step fashion, the teacher must be free to shape instruction to suit the needs of the student. Second, he believed that education depends on the student having had certain experiences (i.e., most educational programs assume that the child has acquired "readiness skills" through natural interactions with the physical and social environment). For example, a student needs experiences with objects before learning the language names for them. If a student lacks appropriate sensory experiences, then these experiences must be provided as prerequisites to more academic components of an educational program. Third, he believed that the student had to be motivated to learn. According to Dr. Itard, Victor successfully learned to cope in the wild because his survival depended on it. Now, Dr. Itard introduced new needs for Victor so that Victor would be motivated to learn social skills. Finally, Dr. Itard believed that instruction often requires the development of new instructional devices and techniques. Many of the materials and techniques of behavior modification that Dr. Itard developed became the basis for subsequent programs to teach special education students.

How far did Victor progress during the five years of instruction? He learned basic social skills, such as dressing himself, sleeping in bed without wetting, and eating with utensils. He learned to make use of his senses including sight, sound, and taste. He learned to show affection and to try to please others. Although he never learned to speak effectively, he did learn to communicate using written language. However, Victor did not reach full self-sufficiency, and spent the rest of his life under the supervision of a caretaker. The lack of complete success has been attributed to many causes including the lack

FIGURE 1–1

What would it be like for a child to grow up without any human contact?

Suppose that a child grew up from birth to age 12 in a forest, without any human contact. What do you think the child would be like at age 12? For each pair of attributes listed below, place a check next to the one you think would apply.

_____ physically weak and unhealthy	_____ physically strong and healthy
_____ attentive to stimuli	_____ unattentive to stimuli
_____ responsive to pain	_____ unresponsive to pain
_____ responsive to temperature	_____ unresponsive to temperature
_____ interested in other people	_____ uninterested in other people
_____ enjoyed a broad variety of food tastes	_____ restricted to a very few food tastes
_____ had developed a form of oral language	_____ hadn't developed a form of oral language
_____ had developed a form of gesturing language	_____ hadn't developed a form of gesturing language
_____ had developed a form of written language	_____ hadn't developed a form of written language
_____ had developed basic arithmetic skills	_____ hadn't developed basic arithmetic skills
_____ had invented many useful tools	_____ hadn't invented useful tools
_____ was well mannered with people	_____ wasn't well mannered with people
_____ longed for human affection	_____ was not interested in human affection
_____ would be able to learn basic social skills swiftly	_____ wouldn't be able to learn basic social skills swiftly
_____ would be able to learn basic language skills swiftly	_____ wouldn't be able to learn basic language skills swiftly

of appropriate stimulation during critical periods of development, the limitations of Itard's methods (including his insistence than Victor use spoken rather than sign language), and the possibility that Victor was born with brain damage. Thus, you would have been correct in your predictions in Figure 1–1 if you had checked each of the attributes on the right-hand side and none on the left side of Figure 1–1.

As we leave the "wild boy," let's consider what this case demonstrated about the nature of education. Some of the broader educational issues addressed by Itard were (Lane, 1976, p. 129):

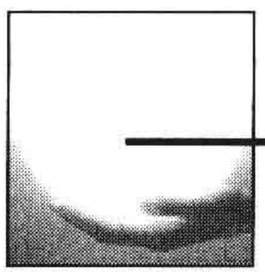
1. Society (including formal instruction) is crucial for human development. "The moral superiority said to be natural to man is only the result of civilization . . . [and without society, man] pitifully hangs on without intelligence and without feelings, a precarious life reduced to bare animal functions."

2. People learn in order to satisfy their needs. "In the most isolated savage as in the most highly civilized man, there exists a constant relation between ideas and needs."
3. Instructional programs should be based on science. "The progress of education can and ought to be illuminated by the light of modern medicine, which of all the natural sciences can help most powerfully toward the perfection of the human species."
4. Instructional programs should take into account the individual characteristics of each student. "[Progress will be made] by detecting the organic and intellectual peculiarities of each individual and determining from there what education ought to do for him."

The conclusions of Itard, written 200 years ago, can serve as a starting point for this book on the promise of educational psychology's future. Like Itard's research, this book is based on a *learner-centered approach* in which the learner is at the heart of all learning (Lambert & McCombs, 1998). In taking a learner-centered approach, the first overarching goal is to understand the cognitive processes and knowledge used by learners in carrying out academic tasks. What are the cognitive processes that a skilled reader engages in while reading a textbook lesson? What are the cognitive processes that a skilled writer engages in while composing an essay? What are the cognitive processes that a skilled mathematician engages in while solving a mathematics problem? What are the cognitive processes that a skilled scientist uses in investigating a new phenomenon? These kinds of cognitive questions are addressed in the first section of this book on learning. In short, I seek to understand what skilled readers, writers, mathematicians, and scientists know.

The second overarching goal is to understand how to help students to develop the processes used by skilled practitioners to perform academic tasks. How can we help a beginning reader to know what a skilled reader knows? How can we help an aspiring writer to know what a skilled writer knows? How can we help novice mathematics and science students to have the knowledge needed to think like skilled mathematicians and scientists? These kinds of instructional questions are addressed in the second section of this book on instruction. In short, I seek to understand the kinds of learning experiences that foster cognitive growth in learners.

In summary, this book takes a learner-centered approach to learning and instruction. In particular, I examine the learning issue of what students need to learn to accomplish academic tasks and the instructional issue of how to help students achieve meaningful learning. The remainder of this chapter explores some of the basic issues in educational psychology.



WHAT IS EDUCATIONAL PSYCHOLOGY?

DEFINITIONS

What is educational psychology? Based on the learner-centered perspective described in the previous section, educational psychology can be defined as a branch of psychology concerned with understanding how the instructional environment and the characteris-

tics of the learner interact to produce cognitive growth in the learner. In particular, educational psychology focuses on the scientific study of techniques for manipulating human cognitive processes and knowledge states. There are three major components in this definition:

1. Educational psychology is a science, namely a branch of psychology.
2. Educational psychology investigates the instructor's manipulation of the environment (i.e., instruction).
3. Educational psychology investigates resulting changes in the learner's cognitive processes and knowledge structures (i.e., learning).

In short, educational psychology studies how instruction affects learning.

What is instruction? Educational psychology stands between instruction and learning (i.e., between the instructional manipulations provided by the teacher and the changes in knowledge and behavior created in the learner). Instruction refers to the teacher's construction of environments for the student, where such environments are intended to foster changes in the learner's knowledge and behavior. For example, Gagne (1974, p. vii) defines instruction as "the arrangement of external events to activate and support the internal processes of learning." Thus, the definition of instruction has two main components:

1. Instruction is something the teacher does.
2. The goal of instruction is to promote learning in the student.

This definition of instruction is broad enough to include lectures, discussions, educational games, textbooks, research projects, and Web-based presentations.

What is learning? If the goal of education is to promote learning, it is worthwhile to understand what learning is. Learning refers to lasting changes in the learner's knowledge, where such changes are due to experience. Thus, learning is defined as a relatively permanent change in someone's knowledge based on the person's experience. This definition has three parts:

1. Learning is long-term rather than short-term, such as learning how to use a word-processing program. A change that disappears after a few hours does not reflect learning.
2. Learning involves a cognitive change that is reflected in a behavioral change, such as changing from not knowing to knowing the procedure for erasing a word in a word-processing program. If there is no change, then no learning occurred.
3. Learning depends on the experience of the learner, such as reading a word-processing manual. A change that occurs solely because of a physiological state—such as being tired, hitting one's head, or taking a mind-altering drug—is not an example of learning. Furthermore, it depends not on what is done to the learner, but rather on how the learner interprets what happens, that is, on the learner's personal experience.

Although two of the components of the definition of learning (learning is permanent and experience-based) have remained consistent for a century, the issue of what is changed (or what is learned) has been more controversial (Mayer, 1992a, 2001a). Does learning involve a behavioral change or a cognitive change? This question reflects the classic tension between behaviorist and cognitive approaches to learning. In this book, I take a cognitive approach by defining "what is learned" as a cognitive change that is reflected in a behavioral change.