# Preface

## To Become a Nation of Skillful Thinkers

We, as teachers, find ourselves facing a continual reinvention of our educational systems. But revised curricula, new testing mandates, increased levels of accountability, and rapidly evolving educational technology don't seem to be pulling us out of the malaise that bedevils us at the speed that the world demands. Perhaps we have been looking in the wrong places.

In this book we offer a unique perspective on the teaching of thinking because

1. The ability to think metacognitively is essential if we expect our students to be prepared to live productively in a rapidly changing world. This book focuses on the teaching of metacognition to children so they will become more skillful thinkers and independent, lifelong learners.
2. This book provides an easy access to the theories underlying classroom practices. Teachers who read this book will understand why they do what they do.
3. This book demonstrates practical ways in which school and home can cooperate to create vibrant learning communities.

### Our Rationale for Writing This Book

The United States of America has forged a powerful presence in the world based primarily on the strength of our economy. Our economic growth over the last century was due predominantly to developing

new technologies. "Economic studies conducted even before the information-technology revolution have shown that as much as 85% of measured growth in U.S. income per capita was due to technological change" (National Research Council, 2006, p. 1). Our continued success in an increasingly global economy must be built on the foundation of a skilled and innovative *next generation.* There is growing evidence that we may not be producing that generation with our current educational practices.

An awareness that something is seriously amiss in education in the United States prompted legislators to ask the National Academy of Science to review the current condition of U.S. science education and to recommend the top 10 actions that Congress might take to insure that we remain leaders in innovation. The preamble to the ensuing report *Rising Above the Gathering Storm* (National Research Council, 2006) states, "Having reviewed trends in the United States and abroad, the committee is deeply concerned that the scientific and technological building blocks critical to our economic leadership are eroding at a time when many other nations are gathering strength" (p. 3). Norman Augustine, chairman of the committee producing this report, stated further that America today faces a serious and intensifying challenge with regard to its future competitiveness and standard of living and that we appear to be on a losing path.

Thomson Reuters Research Analytics tracks trends and performance in basic research. It has compiled comparative data from 1981 to 2009 measuring the production of research papers in science, engineering, and materials science from countries throughout the world. This information was released in two reports appearing in 2005 and 2010 (Adams & Pendlebury, 2010; "U. S. slide in world share continues," 2005). The first of these reports, from the online magazine *Science Watch,* shows

1. a steady decline in the U.S. contribution to world science,
2. a steady increase in the contribution from Asia Pacific countries, and
3. a relatively constant contribution from EU countries.

The 2010 report shows that

> the 20th century was largely dominated by the U.S. as a major powerhouse of scientific research and innovation, with 40% of the papers indexed in the *Web of Science* fielded by U.S.

> scientists in the 1990s. By 2009, that figure was down to 29%. The U.S. now struggles to keep pace with increased output from Europe and Asia. Yet research impact and the overall reputation of higher education institutions in the U.S. remain strong. (Thomson Reuters, n.d.)

This trend is mirrored in the growing production of PhDs in science, mathematics, and technology in China compared to the declining numbers in the United States. Our nation faces a future in which it is no longer dominant in the fields of science, mathematics, and engineering.

Further, evidence of the unsatisfactory academic performance of U.S. students comes from a major international study of student progress, the Program for International Student Assessment (PISA). This test, developed by the Organisation for Economic Co-operation and Development, examines students from the major developed countries—countries responsible for roughly 90% of the world economy. PISA tests 15-year-olds in mathematics, science, and reading every three years. The United States consistently performs at or below the average in each of these three subject areas, despite the fact that we spend more per capita on education than almost every other developed nation.

The United States performs a bit better on another test, the Trends in International Mathematics and Science Study (TIMSS), which tests students in grades 4 and 8 every four years. However, the cultural diversity in TIMMS is very wide, including countries like Botswana, Mongolia, Denmark, Australia, Palestine, England, and Canada. In addition, the focus of the two tests are significantly different; PISA measures the *ability of students to apply their knowledge and skills to meet real-life challenges,* whereas TIMMS measures the extent to which students have *mastered the taught curriculum* (Gonzales et al., 2004; Programme for International Student Assessment, 2003).

Our survival as a major economic and political power in the world is at risk if we cannot maintain our global competitiveness with a well-educated next generation. It simply isn't good enough that, when our 15-year-olds are asked to apply their learning, they perform at or below average compared with the rest of the developed world.

That is the bad news; now here is the good news. At a time when we face this growing global challenge from the developing world, our emerging understanding of the human brain provides a means to rise to this challenge. Research from a variety of disciplines has produced a new picture of how the brain operates and how it learns

most effectively, a picture that emphasizes the brain's *plasticity*—it is an organ capable of continuous improvement and change. This new knowledge not only helps to explain how the brain operates, it also provides a means of self-understanding that can lead to new ways of learning—the skill of metacognition. Educational practices need to move beyond endless reforms of curriculum and assessment and accountability measures and incorporate these new understandings into the ways in which we do things in our schools and colleges.

## The Focus of the Book Is on Thinking About Thinking

So this is a book about *metacognition,* a long word which means thinking about how we think. It is an important concept because it is only by thinking about how we think that we can consciously and continuously improve our thinking. It is the only way to become skillful thinkers and independent learners.

The book is directed to teachers and school administrators who want to see their students transformed into skillful thinkers and their schools transformed into thoughtful and thought-filled places of learning. Skillful thinkers can adapt their thinking to new situations and transform what they learn in one context into another. When faced with new problems, they can formulate a plan of action and proceed to a solution. In a society where readiness for work is an increasingly significant factor in educational planning, we need to remain alert to the fact that if we train a young person with the skills required for a particular job and that job disappears, then he is trained for something that no longer exists. But if we educate young people who are flexible, metacognitive thinkers, they will be able to adapt their learning and find their way successfully in new territory.

Chapter 1 discusses the two major forces acting to change traditional education: first, the knowledge that the brain is plastic, which implies that we need to teach students how to use this flexibility, and how to think about their thinking so they can control their learning; and second, the global revolution in information and communication technology, which is changing the way people work, which in turn mandates a change in how students are prepared in order to deal with this changing workplace. In fact, many of the jobs that students entering school for the first time this year will be expected to fill a decade and a half later are not even defined yet.

Chapter 2 summarizes the relevant brain research on how people learn and introduces the principles of metacognition that underlie this work. We provide sufficient depth to justify the techniques for enhanced learning that follow and point readers to additional resources, should they wish to delve deeper.

Chapters 3, 4, 5, and 6 deal directly with metacognition, defining it carefully, deconstructing it into its constituents, and finally discussing the importance of language to metacognition. Chapters 7 and 8 focus on the implementation of metacognition, first in problem solving and then in the organization of knowledge. The final three chapters, 9, 10, and 11, provide strategies and tools for teaching thinking. Chapter 9 looks particularly at the role of questioning in eliciting metacognition and deeper levels of thinking. Chapter 10 provides some very practical strategies both for metacognitive note taking and for assessment that recognize the significance of metacognition, and in Chapter 11 we examine what schools can do to create a culture of metacognitive thinking throughout the school and in partnerships in learning with parents.

The final section provides a set of practical resources for teachers to help encourage metacognition with their students. It also provides materials schools can use to encourage and inform parents of ways they can participate in their children's learning.

## A Personal Perspective on How We Came to Write This Book

In a time when lives are lived at a fast pace and dinner-table conversation has become a rarity in many households, we have stuck to the old traditions and share our thoughts about events of the day around the dinner table in the evening. It was these conversations that provided the genesis of this book. We often began discussions that grew out of our own frustrations as educators.

Pat was an elementary school principal in the United States. She would describe the difficulties of trying to create a productive learning environment in a low-achieving and disadvantaged school. The problems seemed to come from every level: difficulties with parents, with students, with teachers, and with administrators.

At the same time Martin, a university professor of physics, was struggling to help his students achieve a conceptual understanding of science. While these students learned facts and simple procedures easily, when faced with questions or problems that required a deeper

understanding of the concepts involved, they faltered. As these discussions progressed, it became clear to us that the problems of these two different pedagogical situations had similar roots. Both had to do with thinking.

In a system relentlessly focused on standardized test results, school accreditation, and data analysis, Pat was fearful that there was so much focus on the development of test-taking skills, the memorization of content, and the learning of routines and formulaic responses to test questions that the teaching of skillful thinking and understanding was taking a back seat. Awakening in students an understanding of their own thinking processes and teaching them how to think skillfully is a complex, time-consuming process. There never seemed to be time for this as pressures increased to cover curriculum content before the next round of testing.

When the school district brought Dr. Arthur Costa to provide professional development to principals, it was an "Aha!" moment. Costa introduced a list of habits or dispositions that characterize the behavior of successful people facing complex problems. He called this list the *Habits of Mind.* It became crystal clear that the path to lifelong, independent learning had to include the teaching of thinking. It was not an optional extra, but was fundamental to the success of every other kind of learning. Without the teaching of thinking, all of the test taking and passing in the world would not develop lifelong learning skills. It also became clear that this was not just something that applied only to schoolchildren.

All the adults involved in the endeavor—the parents, the teachers and the administrators—needed to be skilled thinkers as well. Skilled thinking needed to be part of the world outside the classroom—in government, in civic responsibility and participation, and in the workplace. The Habits of Mind provide a structure within which educators, parents, and the wider community can organize all the things we know to be so important about learning but have been in danger of forgetting. It also finally gives us a straightforward, jargon-free language that will enable us to talk about our thinking.

Over the last 20 years, Martin's primary concern in teaching physics at the university level had been to have students come to understand underlying concepts. It was not too difficult to teach students to solve simple physics problems expressed verbally, to plug in the numbers and turn the mathematical crank. But when students were asked questions that involved a deeper understanding of underlying concepts, they often became confused about what was being asked. They seemed to have no clear thinking procedures they

could apply to sort out their confusion. For example, in learning about motion, students learn about how objects move under the influence of gravity near the surface of the earth—about the flight of soccer balls and such. At another point they also learn about the forces required to keep an object moving in a circle. They are able to understand each of these two concepts individually. However, when faced with a question like "Why does an object dropped near the surface of the earth fall while the same object dropped in a space capsule floats?" many students respond by stating that gravity at the space capsule is much weaker than on earth. In fact, the gravitational force is only about 5% less in a low-earth orbit. Students found it difficult to combine their understanding of gravity and circular motion to answer the question; moreover, they often didn't know what steps to take to resolve the question.

Martin tried to engage the students in classroom discussions about how they were thinking, but it became clear that the content language, the language of physics and mathematics, was not sufficient to address all aspects of the students' thinking. Something else was needed. When Pat told him about Art Costa's visit to her school district and the Habits of Mind, he too saw the light. Together they began a systematic exploration of what else in addition to content is needed to engage students in a discussion about their own thinking and learning and, in the process, deepen conceptual learning. The result of that exploration is this book.

We were most influenced by three specific pieces of work: the National Research Council reports on *How People Learn,* the circle of ideas surrounding the Habits of Mind of Costa and Kallick, and the metastudies by the Mid-Continent Regional Education Laboratory and Robert Marzano describing effective teaching and learning strategies.

The *How People Learn* series explores the research of a broad range of experts in most aspects of learning (National Research Council, 1999, 2000, 2005). Its findings clarify the three most fundamental aspects of flexible learning:

- understanding and dealing with prior knowledge of a subject;
- understanding how knowledge is organized in one's brain; and
- the importance of thinking about one's own thinking, or metacognition.

The work of Costa and Kallick builds on this framework by providing and elaborating on a set of dispositions or habits that characterize successful people (Costa & Kallick, 2000, 2008). These are the

habits used by skillful thinkers who know how to behave when faced with complex problems and who are flexible learners.

Robert Marzano has identified a set of strategies that are used by successful teachers (Marzano, Pickering, & Pollock, 2001). We demonstrate in this book how many of these strategies can be used by teachers from pre-primary to tertiary levels as they develop learners with the ability to think effectively and become independent, lifelong learners.

The more completely we understand the thinking processes involved in learning and problem solving, the more likely we are to be able to monitor and adjust our practices in ways that further successful behaviors. We are not advocating endless navel-gazing and introspection. When confronted with problems, we need to find solutions and act on them in a timely fashion. But shooting from the hip has gotten us into a great deal of trouble, personally, socially, and politically. As we face the increasingly complex problems in our schools, our homes, and in the workplaces of our nation, we need to understand what we are doing, we need to think before we act, and we need to be sure that our thinking is explicit and appropriate. It is imperative that we think about our thinking!

We are grateful to many people: to Arthur Costa, who has been our constant source of encouragement and whose work with Bena Kallick was our inspiration at the start of our journey; to James Anderson and Elaine Brownlow, who supported our efforts in Australia; to Raj Chaudhury and Randy Caton in the United States for many useful discussions; to Richard Bartley, who was for Pat an important mentor; and to Deborah Stollenwerk and Alan Cook, who have guided us gently through the intricacies of editing.

We dedicate this book to the many classroom teachers in both the United States and Australia who have embraced these ideas and enriched our understanding as they shared their experiences and their thoughts.