Ron Ritchhart • Mark Church • Karin Morrison

FOREWORD BY DAVID PERKINS

MAKING THINKING VISIBLE

How to Promote **Engagement**, **Understanding**, and **Independence** for All Learners

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FOREWORD

Have you ever listened to one side of a conversation and wondered, "Where did that come from?" A number of years ago, I had a signal experience of this sort. I was walking slowly across the Cambridge Common toward my office at the Harvard Graduate School of Education. A man was sitting on a park bench talking loudly on his cell phone: "I have to! He lied to me and he lied to you! What did he tell you on the phone? Everything's A-okay, he said. Well everything's not A-okay!"

I felt a powerful temptation to ask, "Where did that come from?" but an even more powerful inhibition against intruding on a stranger's life. So I swallowed my curiosity and strolled along, memorizing what the stranger said and writing it down as soon as I got to my office. Several times in the ensuing years I've reread my note and wondered about the story behind the man on the park bench. This small experience has come to symbolize for me how much remains to be revealed when we hear just half a conversation . . . and hearing half a conversation happens a lot in our lives, especially when we interpret "conversation" broadly.

Thinking is a good example. We do not generally hear other people's thinking, just the results of their thinking—an idea, an opinion, a plan. The messiness of "what if," "on the other hand," "but I worry that," or even just "my gut says" all happens on the other end of the line. What the person says to us may sometimes sound like the whole story, but it is only half or much less than half of the internal conversation. That's why we sometimes have to ask ourselves, "Where did that come from?"

Often we could ask that same question about our own thinking. Research suggests that most people are not sharply aware of how they go about figuring out a problem or coming to a position on an issue. If this seems strange, let's compare with why coaches are so important in athletic learning. A coach, besides having expertise the athlete does not, can pay attention in ways the athlete cannot—from the outside and without having to perform physically at the same time.

All this signals why the ideas about *Making Thinking Visible* are so important to education. In broadest terms, these ideas call for externalizing processes of thought so that learners can get a better handle on them. To this end, the authors foreground a range of ideas about questioning, listening, documenting, naming, and more, including many specific strategies and a general approach to establishing a positive, engaged, and thoughtful culture of learning in classrooms. Ron Ritchhart, Mark Church, and Karin Morrison have been deeply involved for many years, along with me and a few other colleagues in various combinations, in developing these ideas and fostering their practice. Here they bring us the wisdom of their experience.

However, more is at stake here than learning to think better. The mission addressed by this book is not only learning to think but thinking to learn. To elaborate, there is an uncomfortable question I like to ask people from time to time: "What ideas did you learn during your pre-university education that are important in your life today?" Some people have a hard time identifying much beyond a list of facts, but others report knowledge they have found to be tremendously important to who they are, how they understand the world, and how they behave. For instance, I recall one person mentioning the French Revolution, not for its details but for how it had served as a lens to look at conflicts of all sorts. I remember another person discussing ecological understandings that influenced substantially not only what policies the person supported but the conduct of everyday life. In general, when people bring forward themes that have mattered to them, they mention themes to think *with*, not just themes to think *about*—think *with* the French Revolution to understand other conflicts or think *with* your ecological knowledge to revise some of your everyday behaviors.

Thinking with is two important steps beyond just knowing information, the focus of far too much education. One step beyond is thinking about a topic, often interesting and valuable but in itself leading toward rather specialized understandings. When learners get comfortable thinking with the ideas in play, those ideas become far more meaningful. Horizons of application open up . . . everything from managing everyday relationships or making a smart purchase to making sense of global warming on a personal level.

The place of thinking about and thinking with what is learned gives us a second reason why making thinking visible and related themes are so important to learners. Back to that park bench one more time: in the complex, conflicted, and sometimes precarious world of today and tomorrow, the better people think about and with what they know, the more likely they will be able to make sense of the half conversations we all encounter. And the more prepared they will be to enter meaningfully into the whole conversation.

David Perkins

PREFACE

In 2005, my colleagues at Harvard Project Zero and I had just finished a five-year project exploring how to cultivate thinking dispositions in school settings. The project, Innovating with Intelligence, unfolded at Lemshaga Akademi in Sweden with the financial backing of the Carpe Vitam Foundation. Drawing on a long line of research on dispositions and enculturation, we developed a set of thinking routines: simple strategies for scaffolding thinking that were designed to be woven into a teacher's ongoing classroom practice. These routines formed the foundation of our intervention and became the core practice of an approach we eventually called "Visible Thinking." We documented our efforts and presented a set of initial routines to the world via a website: www.pz.harvard.edu/vt.

Almost immediately the website became a hit with the teachers with whom we had been working as well as a valuable resource for our colleagues and ourselves in our ongoing work. Teachers who had been involved with Teaching for Understanding saw the thinking routines as short understanding performances that enhanced their efforts with students. Colleagues Shari Tishman and Patricia Palmer found them useful in supporting an initiative, Artful Thinking, focusing on arts integration. Faculty at the Harvard Graduate School of Education found them to be useful tools for actively engaging students with complex ideas. Some colleagues even used the routines as structures for reflecting on and writing about the ideas they were developing. Facilitators at our annual summer institutes gravitated toward the routines for supporting adult

learning in much the same way they might use a protocol to structure a professional discussion.

At the same time, David Perkins, Mark Church, Karin Morrison, and I were beginning the Cultures of Thinking project at Bialik College, a pre-K through grade 12 independent school in Melbourne, Australia, with the financial support of Abe and Vera Dorevitch. We felt that thinking routines would be a good starting place for teachers to begin their own thinking about the forces shaping classroom culture. Although our broader goal was to focus teachers' attention on the issue of developing a culture of thinking, we had noticed in our earlier research that as teachers worked with thinking routines in earnest and over time, they soon found themselves thinking about the other cultural forces at play; most notably time, language, opportunities, and interactions (for more on these, see Chapter Seven).

Not long after the VT website's debut, educators we didn't even know began to write us about how they were using the thinking routines and to express an eagerness for more: more routines, more stories from classrooms, more video illustrations, and more examples of teachers' efforts at different grade levels and subject areas. In short, more support for learning designed to enhance the effectiveness of routines in their educational settings. Although educators shared how valuable the website was as a resource, they kept expressing a desire for a book that would take their learning deeper: a collection that they could set on their desks as a ready resource and thumb through at their leisure, something that they could bring to planning meetings, share with colleagues, and mark up with their own notes and tips. Some teachers admitted to having gone so far as to print off the entire website and bind it together in order to fulfill this need.

This outpouring of interest and enthusiasm led Mark, Karin, and me to begin thinking about creating a book that would both extend and complement the Visible Thinking website. In our early conversations we identified several goals that we thought such a book would need to fulfill. First, we thought it was important to capture the development that had occurred in our own thinking as researchers, developers, and facilitators since we originally debuted the idea of visible thinking back in 2005. Our ongoing research and conversations with colleagues had expanded our thinking about visibility beyond just the use of routines, and we wanted to share these additional strategies. We present these ideas in Chapter Two.

Second, we felt an obligation to share the many stories of teachers who were making use of thinking routines in novel ways. Over the years, we have worked with thousands of educators, and we never cease to be amazed at their inventiveness. However, we wanted to find a way to tell these stories that would help readers see the power of the routines to

support thinking and learning and not just as clever activities. As the popularity and use of thinking routines has spread, we have seen a few too many examples of their ineffective use and wanted to help people better understand the conditions under which the power of thinking routines is realized. Consequently, in designing our template for writing up the routines, we decided to emphasize the importance of selecting appropriate content along with some ideas for the formative assessment of students' thinking, something we had not dealt with explicitly in our earlier work. You'll find more about this new template in Chapter Three. Drawing on the wealth of examples gleaned from teachers, both through the Cultures of Thinking project at Bialik College and elsewhere, we crafted rich "pictures of practice" that highlighted each teacher's thinking as he or she planned, implemented, and reflected on his or her use of that thinking routine. These stories are found throughout Chapters Four, Five and Six.

As an accompaniment to the original Visible Thinking website, we had also produced a DVD that became available in 2005. This video collection highlighted teachers from the International School of Amsterdam and has become a popular resource for educators who want to share what Visible Thinking is all about with their colleagues. We had seen the power of these videos to present an embedded teaching practice that highlights the interactive quality of routines and the importance of using them with powerful content. Consequently, Mark, Karin, and I wanted to include as part of this book a DVD containing video stories from a more diverse range of classrooms that would highlight teaching done by teachers in the United States, Australia, and Europe. We reference the seven videos captured on the included DVD throughout this book and hope that this resource will enhance your reading and understanding of the ideas presented.

Another goal we identified for our writing was to situate the use of thinking routines and other tools within the larger enterprise of teaching, addressing such goals as fostering engagement, uncovering understanding, and promoting independence within a classroom culture of thinking. In Chapter One, we unpack thinking and discuss the critical role it plays in learning, making the case that promoting thinking isn't a nice extra but is central to learning. We then situate the thinking routines and visibility strategies presented throughout the book within three case studies: one from a classroom, one from a museum, and one from a professional group, which we present in Chapter Seven. These cases demonstrate how strategies for making thinking visible exist within the larger mosaic of a culture of thinking. Finally, we conclude this volume by pulling together our "Notes from the Field" in Chapter Eight. Here we present some of our research on how teachers learn to use routines and work with them over time, as well as

a collection of tips, triumphs, and hints for moving forward with your own use of visible thinking practices.

Throughout this book, we have sought to weave together narrative threads from a diverse set of classrooms. This array of perspectives adds to the richness of the larger story we have been able to tell here. But the story isn't over. There are always more voices to add, more tales to tell. We continue to learn with and from teachers throughout the world; educators like yourself who are continually looking for ways to engage learners, develop understanding, support thinking, and promote independence. Since you are reading this book, we assume you are one of these inspired educators. And so, we hope that you will add your own voice to the chorus of teachers working to make thinking visible. Take these ideas and make them your own, embedding them within the culture of your classroom. Use this book as a resource, but stretch beyond it. Take risks in your teaching. Most of all, have confidence in every learner's ability to think and your capacity to nurture that thinking. The results will amaze and energize you.

Ron Ritchhart

ACKNOWLEDGMENTS

At the core of this book rests the idea that it is important to nurture thinking in the daily lives of learners and to make it visible so that a culture of thinking can be built and a strong learning community established in organizations, in schools, and in classrooms. Although this is an idea easy to embrace, it takes something more to bring it to fruition. It takes hard work, dedication, continual reflection, and most of all a willingness to take risks and reach outside the comfort zone of established practices. This is both an individual endeavor and a collective process, recognizing that one learns as much from others' practice as from one's own. We thank all of those who joined us in this journey of nurturing thinking and who were willing to dig in to the work of making thinking visible.

We are greatly indebted to Abe and Vera Dorevitch and the Bialik College School Council for the financial support provided. They have been the political visionaries who recognized the potential of these ideas to transform schools and classrooms. They were willing to support seven years of ongoing professional learning for the teachers at Bialik College to take ideas first developed as part of the Visible Thinking Project, funded through Carpe Vitam Foundation, and the research on Intellectual Character, supported by the Spencer Foundation, and advance them through on-the-ground, in-the-classroom exploration as part of the Cultures of Thinking Project. Their dedication to advancing the education happening not only at Bialik College but also around the world has

produced far-reaching benefits and ripple effects around the globe. In addition, Dow Chemical has financially supported the teachers of mid-Michigan in their application of these ideas; ATLAS Learning Communities provided support for teachers in New York City; Lemshaga Akademi in Sweden and the International School of Amsterdam have facilitated the coming together of teachers from around the world to share their experiences. And so, from the vision of just a few individuals willing to think big, we have seen a dramatic impact that continues to grow, nourishing our collective and ongoing development as educators.

The journey with these ideas plays out in real schools. All busy places with too much happening and too many agendas to serve. And yet, we have been blessed to find school leaders who valued this work and who have been willing to do the hard work to make sure the mission of making thinking visible could take hold at their schools. In particular, at Bialik College, Genia Janover carved out a central place for the Cultures of Thinking Project and ensured that teachers had time to meet regularly to share, discuss, and explore these ideas in depth. Her commitment and dedication to teacher learning have been instrumental in moving these ideas forward. Also at Bialik College, Daphne Gaddie and Tosca Mooseek brought these ideas into the ongoing discussion of teachers. In mid-Michigan, Rod Rock and Geralyn Myczkowiak provided the inspiration and leadership to bring together a diverse collection of teachers to pursue these ideas in a wide scale initiative across many public school districts. In Traverse City, Michigan, Jayne Mohr, Pam Alfieri, and Julie Faulkner made it possible for many teachers from Traverse City Area Public Schools to be a part of this work. In New York City at Vanguard High School, Principal Louis Delgado embraced these ideas and supported his teachers' work with them. In Clover Park School District in Washington state, Patty Maxfield facilitated the ongoing exploration of these ideas within the district. In Marblehead Public Schools in Massachusetts, Beth Delforge and Paul Dulac advanced a whole-district focus on thinking. Linda Gerstle embraced these ideas early on and integrated them into ATLAS Learning Communities' work around the United States. Julie Landvogt first saw the power of these ideas in 2000 and established a network of schools in Melbourne, Australia, to explore them. At Melbourne Grammar School, Chris Bradtke, Alan Bliss, and Roy Kelley took up the charge. And the list goes on and continues to grow.

As we have tried to move these ideas forward in our research and development work, we have been inspired by their broad applicability. The idea of making thinking visible and the assorted thinking routines that support that mission have found a place across a range of subject areas, in assorted organizations, in diverse settings, and with varied types

of learners. The heart of this book is contained in these Pictures of Practice. We only have been able to tell a relatively few number of stories here; however, we acknowledge all the other dedicated professionals who have been a part of this journey. Their stories serve as daily examples and inspiration for students and colleagues. In particular we thank the teachers of Bialik College, Saginaw Intermediate School District in Michigan, Traverse City Area Public Schools, Vanguard High School, Marblehead Public Schools, International School of Amsterdam, Lemshaga Akademi in Sweden, Brighton Primary in Tasmania, and Melbourne Grammar School, Methodists Ladies College, and Wesley College, all in Melbourne. These represent just a small number of the many schools and teachers at them who have journeyed with us.

In the writing of this book we have to thank the conceptual visionaries who pushed our thinking and contributed greatly to the formation of the ideas presented here through their ongoing dialogue with us. At Project Zero at the Harvard Graduate School of Education, we thank our colleagues David Perkins, Terri Turner, Becca Solomon, and Linor Hadar, who have been key in developing these ideas as part of the Cultures of Thinking Project. Shari Tishman and Patricia Palmer, who were part of the original Visible Thinking project in which an initial set of thinking routines were developed. Steve Seidel, Mara Kerschevsky, and Ben Mardell have all made us think about issues of visibility and documentation further and deeper through their work in the Making Learning Visible project. In addition, Tina Blythe and Julie Landvogt pushed our thinking forward on more than one occasion.

communities of practice for educators committed to being mindful students of those they teach and lead. In his work, Mark draws on his extensive and diverse teaching background, having taught elementary and middle school students in the United States, Japan, Germany, and The Netherlands.

After several years overseas, Mark returned to the United States to consult with ATLAS Learning Communities and Harvard Project Zero's Visible Thinking projects. Mark has also been an online course coach, developer, and instructor for WIDE World online learning at the Harvard Graduate School of Education as well as a faculty member for the annual Harvard Project Zero Summer Institute. Mark has presented on issues of thinking, learning, and understanding at conferences throughout the world, especially emphasizing classroom work with middle-years learners. Currently Mark is a district administrator supporting professional growth and development in the Traverse City Area Public Schools in northwestern Michigan. Additionally, he serves as a consultant for various Harvard University Project Zero Cultures of Thinking initiatives in the United States and abroad.

Karin Morrison is an enthusiastic and passionate educator interested in the thinking and learning of both teachers and children. Her work has focused on providing the environment and structures needed to support deeper thinking and greater understanding and engage students in learning in a relevant and meaningful way. She is currently director of the Development Centre at Independent Schools Victoria (ISV), Australia. Karin also serves as the instructor for the WIDE World online learning course, Making Thinking Visible, developed at the Harvard Graduate School of Education.

Karin was instrumental in developing the collaboration between Project Zero and Bialik College that led to the creation of the Cultures of Thinking project at Bialik. Karin was the in-school leader of this project for its first five years. While at Bialik, she was director of the Rosenkranz Centre for Excellence and Achievement in Education and director of Teaching and Learning. Karin has long been an avid supporter of thinking on the world scene. She was co-convenor for the Twelfth International Conference on Thinking in Melbourne in 2005, the Australian delegate to the World Council for Gifted and Talented Children, past president of the Victorian Association for Gifted and Talented Children, and a committee member of the Reggio Emilia Australia Information Exchange. Karin has also been a faculty member at the annual Project Zero Summer Institutes and the ATLAS Learning Communities Summer Institute in Vermont.

PART ONE

SOME THINKING ABOUT THINKING

CHAPTER 1

Unpacking Thinking

Our colleague Steve Seidel (1998) has written about both the importance and challenge of description when looking at student work. Because the mind is designed to detect patterns and make interpretations, slowing it down to fully notice and just describe can be extremely challenging. In contrast, one can test the ability of a paper airplane to fly, the accuracy of a proposed mathematical algorithm, or the strength of a toothpick bridge pretty quickly and easily.

What these examples illustrate is that it makes little sense to talk about thinking divorced from context and purpose. Furthermore, the idea of levels might best be considered with regard to the thinking itself. Rather than concerning ourselves with levels among different types of thinking, we would do better to focus our attention on the levels or quality within a single type of thinking. For instance, one can describe at a very high and detailed level or at a superficial level. Likewise, one can simply test something out to determine if it will fail, or one can fully test the limits and conditions of that failure. Analysis can be deep and penetrating or deal with only a few readily apparent features. Watch any major television news show and contrast it to the more in-depth stories one might hear on radio and see in print, and you will see different levels of analysis at play.

One can argue that there is a bit of category confusion in both of the Bloom's lists as well, since not all items seem to operate at the same level. This can most readily be seen in the way "understanding" is framed. Since the 1970s, many researchers and educational theorists have focused on the complexities of teaching and learning for understanding, as opposed to just knowledge retention (Bruner, 1973; Gardner, 1983, 1991; Skemp, 1976; Wiske, 1997). Some researchers have made the distinction between deep and surface learning (J. B. Biggs, 1987; Craik & Lockhart, 1972; Marton & Saljo, 1976). Surface learning focuses on memorization of knowledge and facts, often through rote practices, whereas deep learning has a focus on developing understanding through more active and constructive processes. Today, most educators would argue that understanding is indeed a very deep, or at least complex, endeavor and not in any way a lower-order skill as the revised taxonomy suggests (Blythe & Associates, 1998; E. O. Keene, 2008; Wiggins & McTighe, 1998). Indeed, understanding is often put forward as a primary goal of teaching.

Research into understanding, much of it conducted with our colleagues at Project Zero, indicates that understanding is not a precursor to application, analysis, evaluating, and creating but a result of it (Wiske, 1997). Recall the brief illustration of the young girl painting mentioned earlier. The understanding or insight she develops into painting are the direct result of much and varied activities and the associated thinking that went

along with those activities. Thus, we might consider understanding not to be a type of thinking at all but an outcome of thinking. After all, one cannot simply tell oneself to understand something or direct one's attention to understanding versus some other activity. Ellin Keene (2008) writes about the complexity of the process of understanding in the process of reading and the need to develop explicit thinking strategies to support those efforts. Likewise, James Hiebert et al. (1997) write about how learning mathematics for understanding is fundamentally a different task than memorizing procedures.

The same argument put forth about understanding—that it is a goal of thinking rather than a type of thinking—applies equally well to the process of creating. How does one go about the process of creating anything? It is not necessarily a single direct act but a compilation of activities and associated thinking. Decisions are made and problems are solved as part of this process. Ideas are tested, results analyzed, prior learning brought to bear, and ideas synthesized into something that is novel, at least for the creator. This creation can be simplistic in nature, as with the child creating a new color; useful, as in the invention of a new iPhone app; or profound, such as new methods of producing energy from never before used materials.

As these brief critiques point out, the idea of levels is problematic when it comes to parsing thinking and ultimately less useful than one might hope. Thinking doesn't happen in a lockstep, sequential manner, systematically progressing from one level to the next. It is much messier, complex, dynamic, and interconnected than that. Thinking is intricately connected to content; and for every type or act of thinking, we can discern levels or performance. Perhaps a better place to start is with the purposes of thinking. Why is it that we want students to think? When is thinking useful? What purposes does it serve? We pick up on these issues in the following section of the chapter.

BEYOND MEMORIZATION, WORK, AND ACTIVITY

In the preceding discussion of Bloom's taxonomy, we made the argument that understanding isn't a type of thinking one does but is in fact a chief goal of thinking. As most teachers are aware, understanding is one of the major thrusts of current educational practices. The Teaching for Understanding (TfU) framework (Blythe & Associates, 1998) and Understanding by Design (UBD) (Wiggins & McTighe, 1998) are two current curricular planning tools that help teachers focus on understanding. It would be nice if we could merely take for granted that all teachers adopt this goal and strive to teach for understanding, but we all know that the reality of most schools and classrooms is quite different. Within the high-stakes testing environments in which educators today operate,

there is often pressure to cover the curriculum and to prepare for the test (Ravitch, 2010). Although lip service may be paid to the idea of teaching for understanding, there are pressures that work against it. These pressures aren't necessarily anything new. Schools, having been built on an industrial model, have long focused on imparting skills and knowledge as their chief goal.

In most school settings, educators have focused more on the completion of work and assignments than on a true development of understanding. Although this work can, if designed well, help to foster understanding, more often than not its focus is on the replication of skills and knowledge, some new and some old. Classrooms are too often places of "tell and practice." The teacher tells the students what is important to know or do and then has them practice that skill or knowledge. In such classrooms, little thinking is happening. Teachers in such classrooms are rightly stumped when asked to identify the kinds of thinking they want students to do because there isn't any to be found in much of the work they give students. Retention of information through rote practice isn't learning; it is training.

The opposite side of this same coin is a classroom that is all about activity. In the often misunderstood notion of experiential or inquiry-based learning, students are sometimes provided with lots of activities. Again, if designed well some of these activities can lead to understanding, but too often the thinking that is required to turn activity into learning is left to chance. Other times, the activity itself is little more than a more palatable form of practice. Playing a version of *Jeopardy* to review for a test may be more fun than doing a worksheet, but it is still unlikely to develop understanding.

At the heart of this view of teaching is the notion that curriculum is something that teachers deliver to students and good teachers are those most effective at that delivery. Reflecting on his own evolution as a teacher, Mark Church recounts how prevalent this view was in his own teaching:

> In my early years of teaching I was "the fun teacher" bursting with confidence and more than a bit of hubris. I kept my students entertained. They liked me. They liked my class. Whatever was to be covered became an object of knowledge that I, as the expert, would deliver by way of gimmicks and glamour to my students. Consequently, I judged my teaching by the ease with which I was able to transmit information along a linear, one-way path of knowing. My idea of good teaching was to focus on the creation and delivery of palatable, hands-on, though not necessarily minds-on, activities. Becoming a good teacher meant mastering a set of delivery techniques and knowing all the answers to my students' questions. In those years it had not yet occurred to me that good teaching hinged upon what I knew and understood about

> the learners themselves and about how learning happens. However, it was not until I really examined the issue of what is understanding and how does it develop that I actually began the process of becoming a teacher. Only then did I recognize that work and activity are not synonymous with learning.

Let's return to the key question with which we began this chapter: "What kinds of thinking do you value and want to promote in your classroom?" And the associated question, "What kinds of thinking does this lesson force students to do?" When classrooms are about activity or work, teachers tend to focus on what they want their students to do in order to complete the assignments. These physical steps and actions can be identified, but the thinking component is missing. When this happens, the learning is likely to be missing as well.

Here's a quick exercise to help you identify the possible discrepancy between students' classroom activity and teaching that is likely to lead to understanding. Begin by making a list of all the actions and activities with which your students are engaged in the subject you teach (if you are an elementary school teacher, pick a single subject to focus on, such as math, reading, or writing). You might want to brainstorm this list with a couple of colleagues or teammates. Now, working from this list, create three new lists:

1. The actions students in your class spend most of their time doing. What actions account for 75 percent of what students do in your class on a regular basis?
2. The actions most authentic to the discipline, that is, those things that real scientists, writers, artists, and so on actually do as they go about their work.
3. The actions you remember doing yourself from a time when you were actively engaged in developing some new understanding of something within the discipline or subject area.

To the extent your first list—what students spend the bulk of their time doing—matches the other two lists, your class activity is aligned with understanding. If the three lists seem to be disconnected from one another, students may be more focused on work and activity than understanding. They may be doing more learning *about* the subject than learning *to do* the subject. To develop understanding of a subject area, one has to engage in authentic intellectual activity. That means solving problems, making decisions, and developing new understanding using the methods and tools of the discipline. We need to be aware of the kinds of thinking that are important for scientists (making and testing hypotheses, observing closely, building explanations . . .), mathematicians (looking for patterns, making conjectures, forming

generalizations, constructing arguments . . .), readers (making interpretations, connections, predictions . . .), historians (considering different perspectives, reasoning with evidence, building explanations . . .), and so on, and make these kinds of thinking the center of the opportunities we create for students. Furthermore, these kinds of thinking need to be among the primary expectations we hold for students: that they can and that they will engage in the kinds of thinking necessary to build disciplinary understanding.

A MAP OF THINKING INVOLVED IN UNDERSTANDING

In the preceding section we listed a few types of thinking that were central to different subject areas, such as making and testing hypotheses in science or considering different perspectives in history, but are there particular kinds of thinking that serve understanding across all the disciplines? Types of thinking that are particularly useful when we are trying to understand new concepts, ideas, or events? When you thought about the kinds of thinking you did to develop your own disciplinary understanding, you probably identified some of these. Ron Ritchhart and colleagues David Perkins, Shari Tishman, and Patricia Palmer set themselves the task of trying to identify a short list of high-leverage thinking moves that serve understanding well. Their goal was not to come up with all the different kinds of thinking that were involved in understanding but to identify those kinds of thinking that are essential in aiding our understanding. They wanted to identify those thinking moves that are integral to understanding and without which it would be difficult to say we had developed understanding. They came up with the following six:

1. Observing closely and describing what's there
2. Building explanations and interpretations
3. Reasoning with evidence
4. Making connections
5. Considering different viewpoints and perspectives
6. Capturing the heart and forming conclusions

We feel that these six all play important roles in fostering understanding of new ideas. If we are trying to understand something, we have to notice its parts and features, being able to describe it fully and in detail. Identifying and breaking something down into its parts and features is also a key aspect of analysis. The process of understanding is integrally linked to our building explanations and interpretations. In science, we label

The answer is that a structured reflection—that is, reflection that goes beyond voicing one's opinion or feelings—involves describing the object of reflection and noticing its key features, connecting what is new to what one already knows, and examination of the event or object of reflection through various lenses or frames, which is perspective taking (Colby, Beaumont, Ehrlich, & Corngold, 2009).

OTHER KINDS OF THINKING

Of course, understanding is not the sole goal of thinking. We also think to solve problems, make decisions, and form judgments. Many of the eight key thinking moves come in handy when we are doing those activities as well. Looking at things from new perspectives, identifying the parts, and reasoning with evidence certainly play a role. Making connections to our prior knowledge so that we can draw on it and use it effectively is useful as well. Forming conclusions and identifying the essence are also important. Some additional types of thinking we haven't mentioned that seem useful in the areas of problem solving, decision making, and forming judgments include:

1. Identifying patterns and making generalizations
2. Generating possibilities and alternatives
3. Evaluating evidence, arguments, and actions
4. Formulating plans and monitoring actions
5. Identifying claims, assumptions, and bias
6. Clarifying priorities, conditions, and what is known

Again, these six are not meant to be exhaustive, merely useful moves in terms of directing our mental activity and planning our instruction. Each of the six could be further elaborated with associated kinds of thinking. For instance, brainstorming is a useful strategy to help one generate possibilities and alternatives, and taking stock would be a part of clarifying priorities, conditions, and what is known. Formulating plans and actions connects with the idea of being strategic just as evaluating evidence is a part of being skeptical. Reviewing this list, one might get the impression of a very thoughtful mathematics or science classroom in which problem solving plays a central role. In learning mathematics and science actively, it is important that one gets used to looking closely, noticing patterns, and generalizing from those patterns to create procedures, algorithms, and theories. Of course, these theories and conjectures must be carefully evaluated and tested.