Jay McTighe and Frank T. Lyman, Jr.

Cueing Thinking in the Classroom: The Promise of Theory-Embedded Tools

Thinking tools bring sound instructional theory into the classroom in a practical form that students and teachers both enjoy using.

Photograph by Albert Tucci

Using the Thinktrix, students learn to generate their own questions, for example, by placing a marker on "facts or events" on the left, lined up with "evaluation" on top and bottom.

Throughout history, human progress has been propelled by our development and use of tools. The wheel, telegraph, microscope, computer—these and other tools greatly extend human capabilities. How can the concept of tools help to accelerate progress in education? Nathaniel Gage (1974) has proposed that teachers use "tools of the trade," tangible teaching/learning devices that are material embodiments of theoretically valid teaching/learning ideas. According to Gage, these tools should have:

- *psychological validity*—they reflect what is known about teaching and learning;
- *concreteness*—they embody knowledge in materials and equipment;
- *relevance to teachers*—they have practical value in the classroom;
- *differentiation by type of learning*—a relationship exists between the type of tool and the way that a skill, concept, process, or attitude is best learned.

Successful classroom applications demonstrate that tool-assisted instruction is indeed a medium for blending theory and practice. Here we describe six tools for creating classroom conditions conducive to thinking.

Think-Pair-Share

After the teacher asks a question, 1st graders think for 10 seconds and then talk in pairs as the teacher moves an arrow on a cue chart from think *to* pair.

Over 20 years of research on "wait time" has confirmed numerous benefits from allowing three or more seconds of silent thinking time after a question has been posed (Wait Time I) as well as after a student's response (Wait Time II). These benefits include longer and more elaborate answers, inferences supported by evidence and logical argument, greater incidence of speculative responses, increased student participation in discussion, and improved achievement (Rowe 1986). Also, the use of cooperative learning structures promotes student involvement and increased verbal interaction, resulting in positive effects on attitude and achievement (Slavin 1981, Johnson and Johnson 1984). The Think-Pair-Share method (Lyman 1981) combines the benefits of wait time and cooperative learning.

Think-Pair-Share is a multi-mode discussion cycle in which students listen to a question or presentation, have time to *think* individually, talk with each other in *pairs*, and finally *share* responses with the larger group. The teacher signals students to switch from listening to *think*, to *pair*, and to *share* modes by using cues (fig. 1).

Cueing enables teachers to manage students' thinking by combating the competitiveness, impulsivity, and passivity present in the timeworn recitation model. Both Wait Time I and Wait Time II can be consistently achieved with Think-Pair-Share, since students raise their hands only on signal, not directly after the question or a response. Students, individually and in pairs, may write or diagram their thoughts. Other cues give options for *how* students are to think or work in pairs. For instance, teachers may cue them to reach consensus, engage in problem solving, or assume the role of devil's advocate (fig. 2). The overall effect of these coordinated elements is a concrete, valid, and practical system, made manageable, and thereby acceptable to teachers, by cueing devices.

Questioning/Discussion Strategies Bookmark

During classroom discussion of the limits of First Amendment rights, a high school social studies teacher glances at a laminated bookmark he's holding and assumes the role of devil's advocate in response to student comments.

Over 2,000 years ago, Socrates demonstrated the power of questioning to stimulate thinking. Educators today know that the way a teacher structures a question influences the nature of the thinking required to respond. We also know that follow-up discussion strategies, such as asking for elaboration, influence the degree and quality of classroom discussion. Despite this knowledge, however, Goodlad (1983) reports that most classroom questions require only factual responses and that, in general, students are not involved in thought-provoking discussions.

Teachers can integrate effective questioning and discussion strategies into their daily repertoires by referring to a "cueing" bookmark (McTighe 1985), which features question starters on one side and discussion strategies on the other (fig. 3). During classroom discussion, the bookmark reminds teachers to use these promising strategies.

Thinking Matrix

After looking at a game board thinking matrix, a 5th grade boy asks his classmates: "What caused the hero's death ... I mean, what was there about his life that made you think he had to die that way?"

In addition to learning to ask questions that promote thinking (see Gall 1970, Hare and Pulliam 1980), teachers are recognizing a need to help students generate their own questions. Generating their own questions facilitates students' comprehension (Davey and McBride 1986) and encourages them to focus attention, make predictions, identify relevant information, and think creatively about content.

The thinking matrix, or Thinktrix, is a device to aid teachers and students in generating questions and responses (Lyman 1987, see fig. 4). The vertical axis of the matrix contains symbols of types of thought; the horizontal axis lists categories that give points of departure for inquiry, which vary according to the subject area. For example, using the matrix in language arts, teachers or students point to an intersection such as *cause/effect* and *event* or *character* and ask a question about the cause of the hero's death; in social studies, they could point to the intersection of *idea to example* and *theme or concept* and ask for historical examples of balance of power.

The Thinktrix has many uses in the classroom. Students can analyze classroom questioning or discourse; or they can create, analyze, and answer their own questions using a desk-size matrix as a game board. Using a poster-size matrix, teachers can make up their own questions, teach ques-

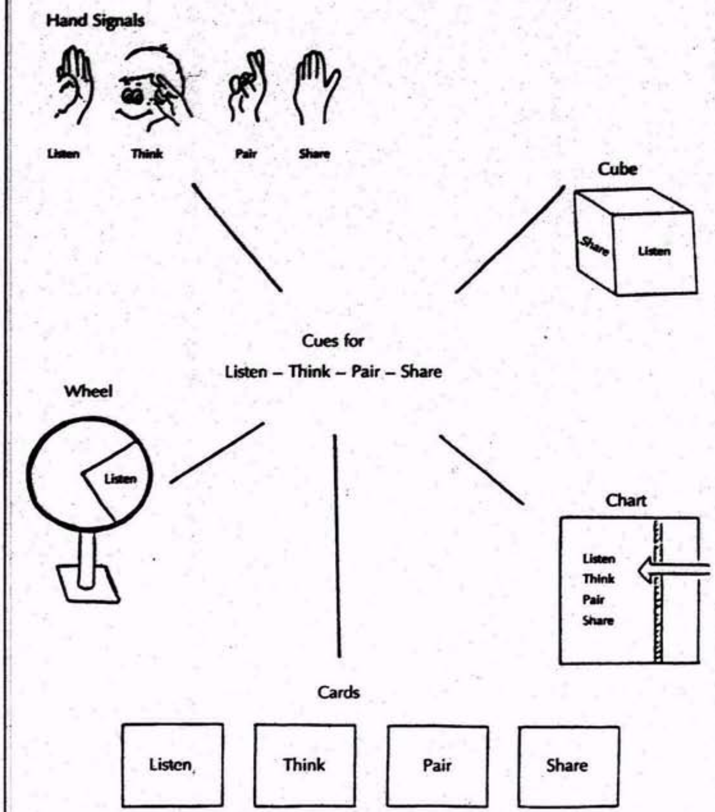

Fig. 1. Cues for Think–Pair–Share

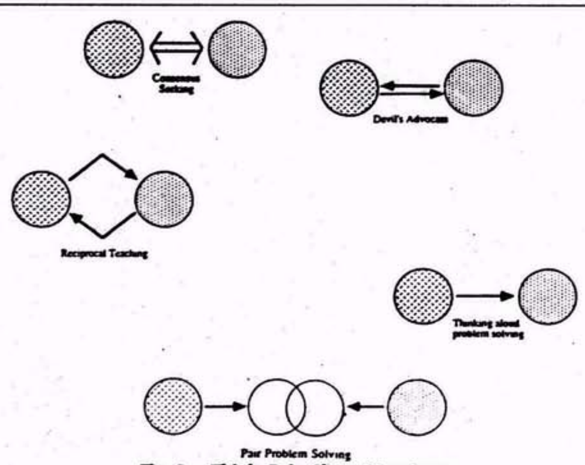

Fig. 2. Think–Pair–Share Structures

tion design to students, show students how to respond to information using different thinking types, and point out the possible visual representations, or cognitive mappings, of each thinking type. In essence, the thinking matrix allows for shared metacognition in which teacher and students have a common framework for generating and organizing thought as well as for reflecting upon it.

Ready Reading Reference

While reading an article about sea lions in a recent issue of National Geographic World, *a 5th grader looks at his bookmark and creates a visual image of what he has just read.*

Analysis of the differences between good and poor readers points out the importance of the strategic behaviors that good readers spontaneously employ before, during, and after their reading. For example, they concentrate on their purpose for reading, monitor their comprehension, and adjust their approach when necessary. Poor readers, on the other hand, are less mindful of such effective strategies. In fact, they tend to perceive reading as "decoding" rather than as the construction of meaning (Garner 1980, Garner and Reis 1981).

The Ready Reading Reference bookmark (Kapinus 1986) was developed to summarize knowledge about "good reader" strategies (Paris and Jacobs 1984). The bookmark serves as a tangible instructional tool and a concrete cue for students during independent reading (fig. 5).

Problem-Solving Strategies Wheel

As students in an algebra II class struggle to solve a word problem, their teacher points to a poster of problem-solving strategies and suggests that they consider strategy #5, Draw a diagram.

Math and science teachers often experience frustration when students who demonstrate an understanding of basic facts and concepts cannot apply this knowledge to word problems. Fortunately, inquiry into the problem-solving behaviors of experts and novices has revealed important strategic

Front

QUESTIONING FOR QUALITY THINKING

Knowledge—Identification and recall of information
- Who, what, when, where, how ______?
- Describe ______.

Comprehension—Organization and selection of facts and ideas
- Retell ______ in your own words.
- What is the main idea of ______?

Application—Use of facts, rules, principles
- How is ______ an example of ______?
- How is ______ related to ______?
- Why is ______ significant?

Analysis—Separation of a whole into component parts
- What are the parts or features of ______?
- Classify ______ according to ______.
- Outline/diagram/web ______.
- How does __ compare/contrast with __?
- What evidence can you list for ______?

Synthesis—Combination of ideas to form a new whole
- What would you predict/infer from ___?
- What ideas can you add to ______?
- How would you create/design a new ___?
- What might happen if you combined ___ with ______?
- What solutions would you suggest for __?

Evaluation—Development of opinions, judgments, or decisions
- Do you agree ______?
- What do you think about ______?
- What is the most important ______?
- Prioritize ______.
- How would you decide about ______?
- What criteria would you use to assess __?

Back

STRATEGIES TO EXTEND STUDENT THINKING

- **Remember "wait time I and II"**
  Provide at least three seconds of thinking time after a question and after a response
- **Utilize "think-pair-share"**
  Allow individual thinking time, discussion with a partner, and then open up the class discussion
- **Ask "follow-ups"**
  Why? Do you agree? Can you elaborate? Tell me more. Can you give an example?
- **Withhold judgment**
  Respond to student answers in a non-evaluative fashion
- **Ask for summary (to promote active listening)**
  "Could you please summarize John's point?"
- **Survey the class**
  "How many people agree with the author's point of view?" ("thumbs up, thumbs down")
- **Allow for student calling**
  "Richard, will you please call on someone else to respond?"
- **Play devil's advocate**
  Require students to defend their reasoning against different points of view
- **Ask students to "unpack their thinking"**
  "Describe how you arrived at your answer." ("think aloud")
- **Call on students randomly**
  Not just those with raised hands
- **Student questioning**
  Let the students develop their own questions
- **Cue student responses**
  "There is not a single correct answer for this question. I want you to consider alternatives."

Fig. 3. Cueing Bookmark

Source: Language and Learning Improvement Branch, Division of Instruction, Maryland State Department of Education.

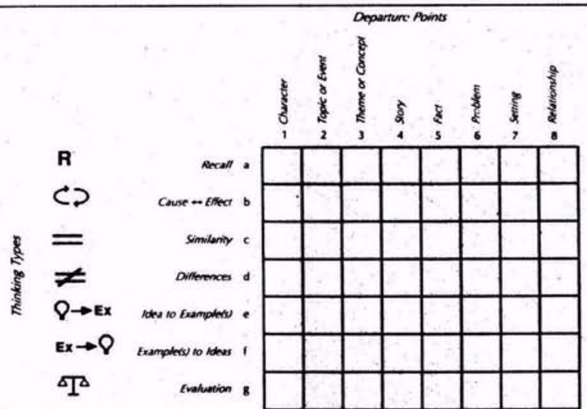

Fig. 4. Thinktrix

distinctions with implications for problem-solving instruction. Effective problem solvers spend time understanding a problem before attacking it. To this end, they may create various representations or models. Expert problem solvers also report using problem-solving strategies, or heuristics, such as breaking the problem into subproblems. They also engage in metacognitive behaviors, including monitoring progress and checking the final solution (Schoenfeld 1979, 1980; Mayer 1983; Suydam 1980).

Teachers who wish to improve student problem solving can spend classroom time examining the solution *process* along with the final answer, model their own strategic reasoning by "thinking aloud," and provide explicit instruction in problem-solving heuristics, using a Problem-Solving Strategies Wheel (fig. 6). Frequently found in the form of a large classroom poster, such an instructional tool is a visible cue that reminds teachers and students of the strategies of experts.

Cognitive Mapping

Upon completing a Character Analysis Map as part of a "prewriting" activity, an 8th grader comments, "I like graphic organizers because they help me see what I'm thinking."

The ability to organize information and ideas is fundamental to effective thinking. Cognitive maps and other visual organizers are effective tools for helping students improve their organizational ability. Cognitive maps provide a visual, holistic representation of facts and concepts and their relationships within an organized framework. They help students to:

- represent abstract or implicit information in more concrete form,
- depict the relationships among facts and concepts,
- generate and elaborate ideas,
- relate new information to prior knowledge,
- store and retrieve information.

Cognitive mapping techniques show demonstrated success in improving retention of information (Armbruster and Anderson 1980, Dansereau 1979, Davidson 1982, Vaughn 1982); and teachers using the process approach to writing often use cognitive mapping during prewriting (Gemake and Sinatra 1986).

Cognitive map prototypes are now in use in classrooms from kindergarten through university levels. Perhaps the most widely used design is the web. Others include sequence steps or chains, vector charts for cause and effect, story maps, analogy links, and flow charts for decision making and problem solving (figs. 7, 8, 9). Such cognitive maps become blueprints for oral discourse and written composition, particularly when used in conjunction with Think-Pair-Share and metacognitive cues, such as those on the Thinktrix and the bookmarks (Lyman et al. 1986).

Through their regular use of cognitive mapping, students come to recognize that thought can be shaped, teachers discover a set of powerful tools for rendering the invisible process of thinking visible, and both experience the benefits of shared metacognition.

Why Instructional Tools Are Effective

The tools just described serve as catalysts for creating a responsive "thinking" classroom. At least four factors may help explain the success of these and similar instructional tools. They provide an aid to memory, a common frame of reference, a practical incentive to act based on sound educational theory, and an inherent permanence.

1. *An aid to memory*. Thinking tools serve as tangible cues for teachers and students. They provide immediate access to theoretical knowledge when it is needed most: at the point of decision making. In the complex and distracting dynamics of school, the concreteness and stability of these tools remind teachers and students to use what they know to enhance their thinking.

2. *A common frame of reference*. Thinking tools provide a mutually understood frame of reference for teachers and students by offering common terminology (e.g., the thinking types on the Thinktrix) and specific cues for action (e.g., the signals associated with Think-Pair-Share). The tools provide

Fig. 5. Ready Reading Reference Bookmark

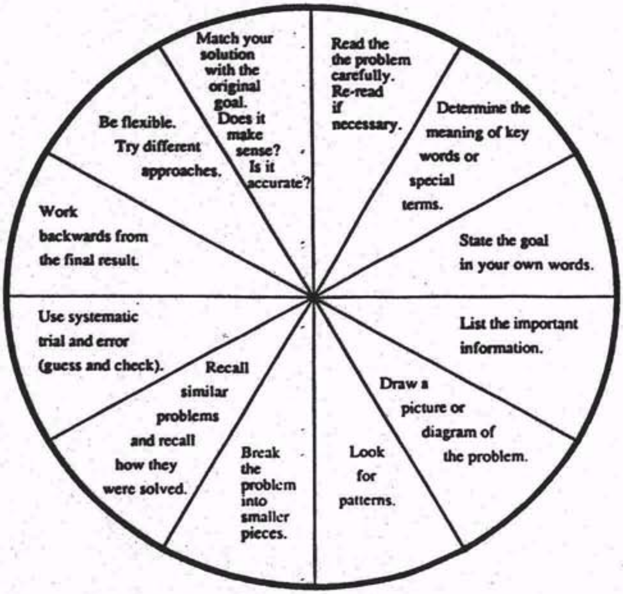

Fig. 6. Problem-Solving Strategies Wheel

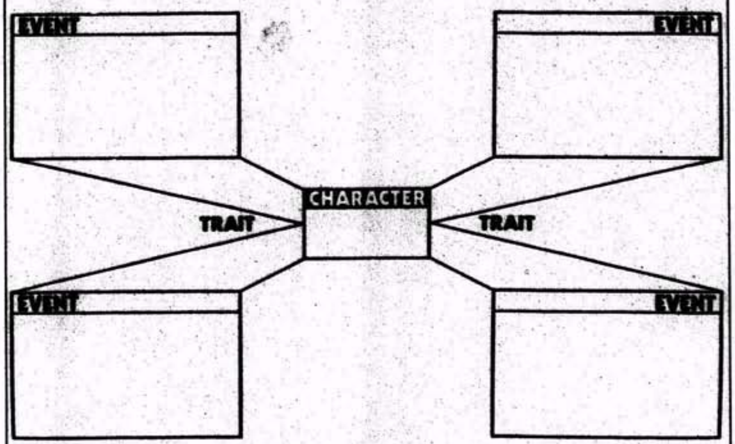

Fig. 7. Flow Chart

congruence that can improve carryover from one classroom and subject area to others, resulting in consistency of approach within a school.

3. *Incentive to act.* Teachers are bombarded by advice and mandates, many of which appear to complicate their work. On the other hand, they welcome new ideas and materials that they think have practical value. The thinking tools described here have been enthusiastically received, in part because they are ready for immediate use.

4. *Permanence.* Even successful innovations are difficult to maintain in schools. These thinking tools, visible and concete, may help to hold an innovation in place. Another dimension of permanence may be achieved through "mental templating": teachers and students frequently remember the message embedded in the tool even when the tool itself is not present. As a result, memories of ways to think and act may persist beyond the classroom.

"In the complex and distracting dynamics of school, the concreteness of tools reminds teachers and students to use what they know to enhance their thinking."

The Promise of Theory-Embedded Tools

Instructional tools present a concrete, practical, and valid system for involving students from nursery school through graduate school in the active processing of ideas. Their use enables teacher educators to send novice teachers into the field with practical embodiments of theory. Staff developers who encourage the invention and use of instructional tools will see the

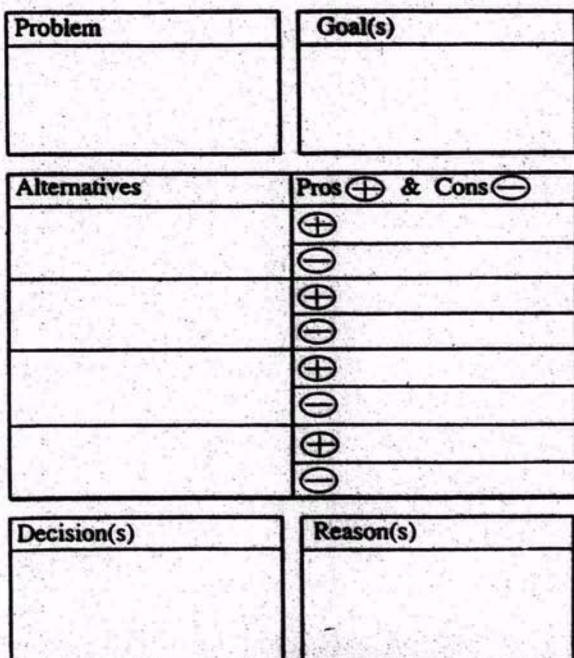

Fig. 8. Decision-Making Model

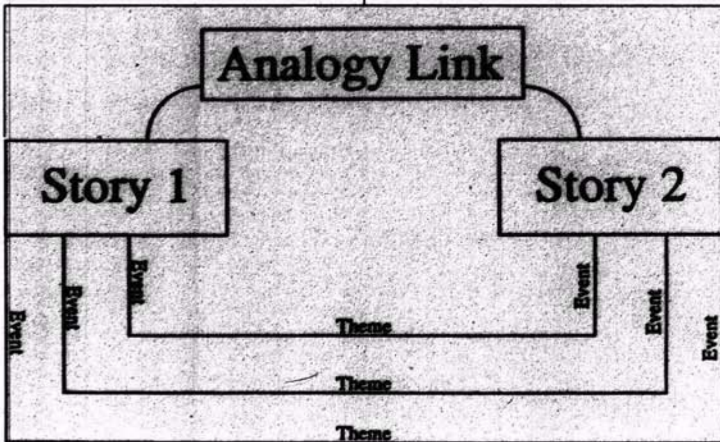

Fig. 9. Analogy Link

elusive theory-into-practice connection made and maintained.

Furthermore, as Gage (1974) suggests, research on tools will test theory in practice and expand the knowledge base. These theory-embedded cueing devices promise to bring classroom teaching into closer harmony with known principles of effective instruction, thereby improving the quality of thinking and learning for all students.☐

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Jay McTighe is Education Specialist, Thinking Improvement Program, Division of Instruction, Language and Learning Improvement Branch, Maryland State Department of Education, 200 W. Baltimore St., Baltimore, MD 21201-2595. **Frank T. Lyman, Jr.**, is Coordinator, Southern Teacher Education Center, University of Maryland/Howard County, 6000 Tamar Dr., Columbia, MD 21045.