

Teaching Higher-Order Thinking

Chapter Five

- I. What Is Higher-Order Thinking?
- II. Why Do We Want to Teach Higher-Order Thinking?
- III. How Do We Teach Higher-Order Thinking?
- IV. The High Investment of Higher-Order Thinking

*Students do not **understand** in the most basic sense of that term. That is, they lack the capacity to take knowledge learned in one setting and apply it appropriately in a different setting. Study after study has found that, by and large, even the best students in the best schools can't do that.²⁶*

For decades, public schools prepared children to be good citizens—and good factory workers. Students were expected to sit, listen, and do exactly as they were told. In some respects, this model served high school graduates well since they learned to follow directions in ways that would be valuable to their future employers.

As economic and technological changes shape the occupational outlook of today's students, schools have begun to embrace the need to instill "higher-order thinking" to prepare the 21st century workforce. No longer is it enough for high school graduates simply to know basic facts and skills. To be successful, students must master decision-making, prioritizing, strategizing and collaborative problem solving.

This chapter explores the role of higher-order thinking in the classroom. After first attempting to define the concept, we will then discuss why teachers should strive for more and more demanding thinking from their students. In the final section of this chapter, we discuss specific techniques for fostering higher-order thinking in your classroom.

I. What Is Higher-Order Thinking?

In 1987, the National Research Council sponsored a project that attempted to synthesize all the many theories about higher-order thinking. The express goal of the project was to make recommendations about how to foster higher-order thinking in students. While lower-order thinking is more easily defined as mastering facts (such as being able to describe the parts of the water cycle) or completing a task with specific steps (such as being able to solve a two-variable equation), that study ultimately describes higher-order thinking as thinking that is (or involves):²⁷

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| "Non-algorithmic" | Involving paths of action for solving problems that are not specified in advance (creative problem solving) |
| Complex | Involving problem solving where multiple solutions are possible |
| Effortful | Involving considerable mental energy directed toward problem solving |
| Nuanced judgments | Involving subtle, less-than-obvious decisions about strategies |
| Application of multiple criteria | Involving transferal of some (sometimes conflicting) criteria to the problem solving process |

²⁶ Gardner, Howard, quoted by Ron Brandt. "On Teaching For Understanding: A Conversation with Howard Gardner." *Educational Leadership*. April 1993: Vol. 50 No. 7, p. 4.

²⁷ National Research Council, Committee on Research in Mathematics, Science, and Technology Education. "Education and Learning to Think." Report published 1987.

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| Uncertainty about what is known | Involving problems that do not provide a clear starting point |
| Self-regulation | Involving some degree of meta-cognition and self-awareness about strategies being employed |
| Imposition of meaning | Involving development and application of new theories onto sets of facts and problems |

Overall, “higher-order” thinking means handling a situation that you have not encountered before and is generally recognized as some combination of the above characteristics. It is thinking that happens in the analysis, synthesis, and evaluation rungs of Bloom’s ladder. By contrast, “lower-order thinking” is simple, reflex-like, transparent, and certain.

So, you know that your students are engaged in higher-order thinking when they:

- Visualize a problem by diagramming it
- Separate relevant from irrelevant information in a word problem
- Seek reasons and causes
- Justify solutions
- See more than one side of a problem
- Weigh sources of information based on their credibility
- Reveal assumptions in reasoning
- Identify bias or logical inconsistencies

Clearly, advanced forms of higher-order thinking may be out of reach for a kindergarten student who is not yet able to engage fully in abstract thought. (See chapter two.) Higher-order thinking in all its many forms is, however, an attainable goal in all classrooms at all grade levels. Kindergarteners can be problem solvers; you can still lead them to think about creative solutions to problems and to draw a diagram to help think about a puzzle.

Although some critical mass of lower-order thinking in the classroom is necessary as a foundation for reaching higher-order thinking skills, it does not justify the overwhelming emphasis in this nation’s classrooms on the lower-order knowledge and skills to the exclusion of higher-order thinking. “[W]e can safely say that an emphasis on facts is the ‘norm’ for the United States and the emphasis on thinking represents an occasional deviation from this norm.”²⁸ Byrnes also points out that these deviations seem to be a function of periodic public dissatisfaction with the standard approach of emphasizing facts, a dissatisfaction that is most commonly stoked by some major technological advance such as Sputnik, or the computer boom.

Among the primary reasons for this focus on lower-order thinking skills may be the simple fact that lower-order thinking skills are easier—easier to understand, easier to teach, easier to test, easier to learn. So, why do we want to leave this comfort zone to reach for higher-order thinking skills for our students?

²⁸ Byrnes, James P. *Cognitive Development and Learning In Instructional Contexts*, 2d ed. Allyn and Bacon: Boston, 2001, p. 91.

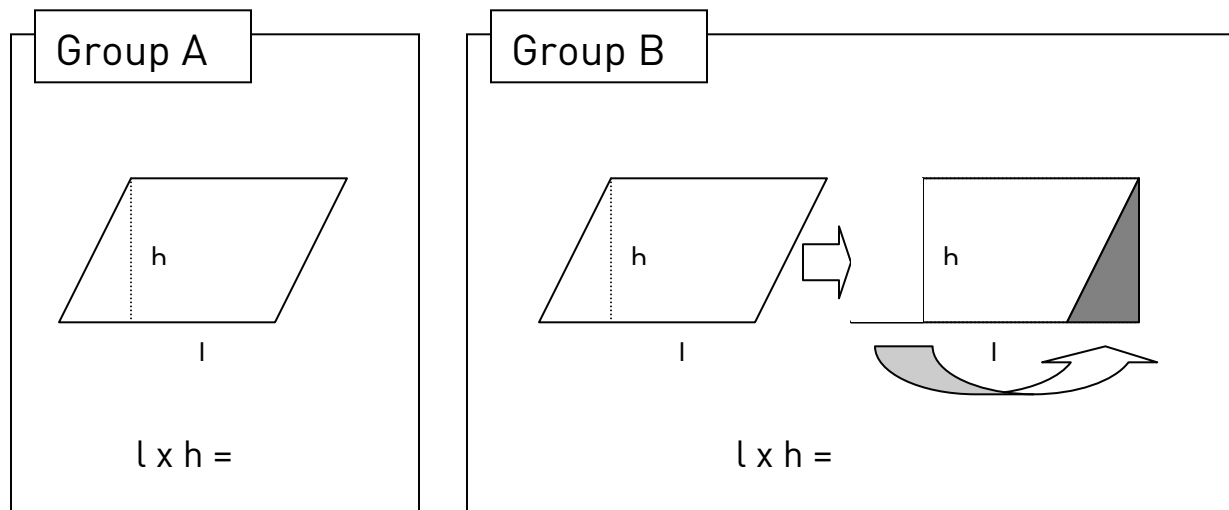
II. Why Do We Want to Teach Higher-Order Thinking?

We push toward higher-order thinking skills in the classroom because they have enormous benefits for our students.

The reasoning here is similar to the rationale for pushing knowledge into our long-term memory. First, information learned and processed through higher-order thinking processes is remembered longer and more clearly than information that is processed through lower-order, rote memorization. Consider for example, the difference between memorizing a formula and explaining the derivation of the formula. Or, the difference between memorizing the definition of a new word and internalizing strategies for discerning the probable definition of the word from its context. Or, the difference between mere memorization of the multiplication tables and a deeper understanding that the multiplication tables represent short cuts for addition. Or, the difference between reciting the events included in a history textbook and drawing inferences from a number of historical documents. In each case, a student who has the latter-type of understanding will carry that knowledge longer.

Moreover, the student with the deeper conceptual knowledge will be better able to access that information for use in new contexts. This may be the most important benefit of high-order thinking. Knowledge obtained through higher-order thinking processes is more easily transferable, so that students with a deep conceptual understanding of an idea will be much more likely to be able to apply that knowledge to solve new problems.

In a well known study showing that students are more likely to apply a skill to solve new problems when they have a deep conceptual understanding of that skill than when there is a lack of this conceptual understanding, one researcher used two methods to teach children the “drop-perpendicular” method for computing the area of a parallelogram.

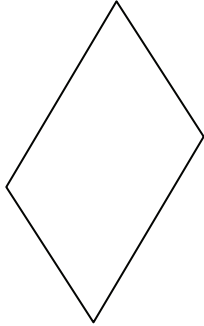


Students in Group A simply memorized by rote the “drop perpendicular” method and applied it to the shape, successfully finding the area of the parallelogram.

Students in Group B were provided the *reasoning* behind the process. They were shown how one could cut off a triangular portion of a parallelogram and re-attach it at the other end to make a rectangle. The students were led to understand that the method is actually a simple variation on the “(length) x (width) =

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[area]" formula that they already knew for rectangles. This set of students, Group B, then applied the method and, like Group A, successfully found the area of the parallelogram.



Then, when children were presented with a parallelogram in an unusual orientation, the Group A children incorrectly applied the process, arriving at an incorrect answer. The Group B students, having an understanding of why the formula works, adjusted the method to fit the new orientation and derived the right answer.

This sort of higher-order “transfer” of understanding is the key to good thinking and problem solving. Good thinking and problem solving skills make learned knowledge applicable in the real world. As teachers of students who are often lagging behind their peers in better resourced schools, we have a mandate to do all that we can to ensure that our students are engaging new knowledge at a level that will allow them to transfer it to new real-world applications. If our students can add numbers with decimal points, can they add prices in a store? If our students can write a persuasive essay, can they write a letter to their banks requesting a loan, their senators arguing policy points, or, someday, their children’s teachers calling for high expectations for their children? If our students can list the steps in the scientific method, can they also recognize that the conclusions drawn by a polluting company failed to be reached using that scientific method?

III. How Do We Teach Higher-Order Thinking?

The importance of higher-order thinking makes it a priority in our classroom, but how does one teach towards higher-order thinking? How does one foster the kind of deep conceptual understanding that is transferable to various academic contexts and, perhaps more importantly, to real-world problems? We have gathered here various strategies for doing just that:

- (1) Teach skills through real-world contexts.** Because higher-order thinking is difficult—after all, you are asking students to make decisions, rather than simply follow a prescriptive path—it will help your cause if you build motivation for the tasks you have developed. If you are teaching your students when to use the various arithmetic operations, set up a store in your classroom. If you are studying persuasive writing, have all students write a letter to a local leader on some hot-button topic in your community. If you are considering how to teach the scientific method, look for community issues that will simultaneously motivate your students and provide them an authentic context for applying the skills you are teaching.

Heuristics: Tools for Solving Problems

Heuristics are general problem-solving strategies that may help students tackle difficult questions. You can practice these techniques with your students and then provide novel situations for them to apply their newly acquired skills

- (1) Do not focus only on the details; try to see the forest as well as the trees.
- (2) Do not rush to a solution rashly.
- (3) Try working backwards by starting with the goal.
- (4) Create a model using pictures, diagrams, symbols or equations.
- (5) Use analogies: “What does this remind me of?”
- (6) Look for unconventional or new ways to use the available tools.
- (7) Discuss a problem aloud until a solution emerges.
- (8) Keep track of partial solutions so you can come back to them and resume where you left off.
- (9) Break the problem into parts.
- (10) Work on a simpler version of the problem.

[Note that this strategy is—like all others in this chapter—a variation on “getting inside your students’ heads.” Successful teachers think carefully about how students will hear and receive information, and they consider the various contexts within which their students could use a new skill or knowledge.]

(2) Vary the context in which students use a newly taught skill. Another prerequisite for higher-order thinking is flexible approaches to problem solving. In addition to an emphasis on one real-world application of skills, a teacher should work to introduce students to a variety of real-world contexts in which a particular skill is used. The more settings in which a student uses some new element of knowledge, the more the student internalizes the deeper conceptual implications and applications of the knowledge. (For example, to teach addition of numbers with decimal points, have students work with and add decimal-laden temperatures, metric-based measurements of the lengths of walls, and the scores from skating competitions.) By coming at a skill from many different angles, you will loosen the contextual grip that a student’s mind may have linking a particular skill with a particular circumstance.

(3) Throughout your instruction, take every opportunity to emphasize the building blocks of higher-order thinking. Teach content in ways that require students to:

- **Build background knowledge.** The more your students are gaining and retaining information about the world around them, the more they bring to the table when solving complex problems. Help students tap into what they already know, which might just be the information needed to answer a challenging question.
- **Classify things into categories.** You might, for example, have your first graders develop and create categories for a series of words based on their structure. (Students might come up with categories based on first letter, ending letter, or vowel sound.)
- **Arrange items along some dimension.** As you are teaching students to write persuasive essays, you might provide students with five different essays of different qualities, asking the students to rank them and explain their ranking.
- **Make hypotheses.** In any type of “discovery learning,” ask students to mentally conduct the experiment before you actually do conduct it. “What do you think will happen when I tape this weight to the side of the ball and throw it?”
- **Draw inferences.** “Having now read these three letters from American soldiers in Vietnam, what can we tell about the experience of being there?”
- **Analyze things into their components.** “What sound does ‘shout’ start with? How do you write that sound?” or “What influences do you think were weighing on the President’s mind when he made that decision?”

Higher order thinking is a very difficult to teach. I have found that thinking aloud is the most effective. Whenever students are being pushed to their academic levels, or being forced to apply what they know, they often need to be shown how to think. They need to be aware that there should be something going on in their head. I always model my thinking aloud. I pretend to be a student in the class and put on a special hat. When that hat is on, I use hypothetical questions that I ask myself out loud. The students know that they are not to interrupt me when I am in this “brain talking” stage. They also know that some of the questions I am asking myself are very easy and should not be answered for me. Students love it and it is an amazing way to model what should be going on in their heads. I try to include higher order thinking in every task. I call them my challenges. Sometimes they are harder for my lower students, but they benefit from them just as much as my higher students.

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- **Solve problems.** Puzzles and problems can be designed for any age level and any subject matter.

(4) Encourage students to think about the thinking strategies they are using. That is, when a student is using context-clues to find the meaning of a word, the student should recognize and think about that strategy as well as the fruits of that strategy. Among the benefits of this sort of “meta-cognitive” approach is that it encourages students to:

- Think analytically about problem definitions (“What do I have to accomplish? What am I allowed to do? What skills can I transfer to this problem? What information is relevant to the problem?”)
- Think about planning (“How should I approach this problem? What additional resources or information do I need?”)
- Purposefully allocate time and energy (“How do I prioritize my tasks in order to most efficiently solve this problem?”)

Specifically, for a teacher, this means delineating and teaching specific problem-attack strategies, giving students time to ponder difficult answers for themselves, and modeling those strategies by thinking aloud to solve problems during guided practice.

Susan Asiyandi, New Jersey '01, realized that many of her fourth grade math students lacked proficiency in open-ended questions because of their lack of reading comprehension:

As a result, I had them break down any higher-order problem into five steps: Q (Question), F (facts), St (Strategy), S (solve), and Ch (Check). After modeling how to break down sample problems into these five steps, I required my students to identify and write down the questions asked by the problem, the important facts and the strategy they would use to solve the problem. Only *then* could they solve the problem. Once done, they went back to the question and made sure they answered every part. Children are very quick to solve a problem and often do not recognize that they have not finished all the steps or are not answering the question being asked. These basic five steps ensured me that *all* of my students could feel successful, regardless of reading and/or math level.

Once Susan got her students accustomed to this method of conceptualizing the overall task, she helped them learn different strategies for solving a problem:

We would begin with word problems that could be easily solved by drawing a picture, and I would model how a picture could represent the problem and thus help them solve it. After my students became confident with using this strategy, I would make the problems more difficult with larger numbers, which would make the “Draw a Picture” strategy pretty arduous. Inevitably, a student would mention that he or she knew another way the class could tackle it. The child would explain the strategy, and the other students would nod in agreement and appreciation. From there, I would give a name to the next strategy, which was often either “Develop an Equation” or “Make a Table,” and we’d use this strategy to tackle a series of problems. After a while, my students were proficient in using all sorts of strategies (Draw a Picture, Guess and Check, Make a Table, Recognize a Pattern or Sequence, Solve a Simpler Problem, Work Backwards, Restate the Problem in Your Own Words, Use Logical Reasoning, Develop an Equation, Use Manipulatives to Model the Information).

At this point, my task was to make sure that they could decipher the best time to use a particular strategy in terms of ease and time. It became their job not only to answer a problem, but also to explain how they

answered it, why they chose that particular strategy, and if there was another way that it could be done. Eventually, students were using multiple strategies as a way to check their work!

*My eleventh grade English students must be aware at all times that learning is a very real process that is taking place in their lives. Using Reciprocal Teaching has enabled them to be active participants. They constantly annotate the reading process in the margins, noting areas of difficulty or lingering questions. Also, they play "teacher" as much as possible, coming up with questions and answering those questions. It gives them ownership over their learning while forcing them to ask questions at different levels and answer them. One teaching highlight came for me the day we had a Holocaust survivor as a guest speaker during our unit on *Night*. At the end of the question/answer segment he responded, "Wow, you students ask such great, teacher-like questions."*

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Make A Difference

Keep in mind that these techniques can be implemented in all classrooms at all levels. Do not make the mistake of thinking that higher-order thinking should be reserved for older students, or for high performing students, or for supplemental activities. In fact, one of the recommendations from the National Research Council's study of higher-order thinking was that we not wait to move to higher-order. The Council suggested that we teach content at the earliest grades through open-ended complex problems. While some degree of common sense is obviously called for with younger students who may not have the capacity for all forms of higher-order thinking, research indicates that even the youngest of students can be prepared for higher-order thinking through an emphasis on basic problem solving skills. As Byrnes points out:

All of the developmental approaches have emphasized the fact there is a natural progression in thinking from lower forms to higher forms with age or experience. This developmental progression implies that students need to

have a certain amount of education, experience, or practice before they can become capable of the highest forms of thought. . . . And yet, each approach also reveals that it is wrong to assume that teachers should do nothing to promote thinking until students reach a certain age.²⁹

This also means that the "lower-level" mastery of basic facts and skills plays a critical role in supporting the development of higher-order thinking. Teachers must give their students a lot of experience making a data table if they are going to expect them to be able to access that strategy to their toolbox when tackling open-ended problems.

IV. The High Investment of Higher-Order Thinking

Teaching to higher-order thinking requires more work from the teacher. Higher-order thinking takes considerable time to develop through lots of practice in different contexts. As researcher Jere Brophy emphasizes, teaching higher-order thinking requires a commitment to class discussion, debate, and problem-solving, all of which take time:

Teaching involves inducing *conceptual change* in students, not infusing information into a vacuum, [and this] will be facilitated by the interactive *discourse* during lessons

²⁹ Byrnes, James P. *Cognitive Development and Learning In Instructional Contexts*, 2d ed. Allyn and Bacon: Boston, 2001, p. 80.

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and activities. Clear explanations and modeling from the teacher are important, but so are opportunities to answer questions about the content, discuss or debate its meanings and implications, or apply it in authentic problem-solving or decision-making contexts.³⁰

More specifically, in addition to the mental rigor involved in developing lesson plans that incorporate higher-order thinking, there are two additional challenges that a teacher takes on. The first is motivation. It almost goes without saying that students are more likely to engage in higher-order, critical thinking when they are highly motivated to do so. Creative teachers capitalize on this connection and therefore (a) use real-world problems that are of genuine concern to students to foster their critical thinking skills, and (b) engage students with compelling challenges to their pre-existing biases, drawing them into analytical debates about difficult issues.

Second, to truly encourage higher-order thinking, a teacher must design assessments and exercises that actually use new and novel situations and problems. This is no small task. But, if at the core of our concept of higher-order thinking is students' ability to apply knowledge to new situations, teachers have to be constantly creating opportunities for that sort of transfer of knowledge. That means *creating* those new situations.

Higher-Order Thinking In Practice—One Classroom's Story

The following reflection by seventh-grade language arts teacher Andrew Mandel, RGV '00, demonstrates one teacher's determination to infuse higher-order thinking into his students' writing:

I noticed that my students were not generating effective support for their paragraphs; their "reasons" to bolster an opinion ("we need to be able to leave campus to buy snacks") were often repetitive or unconvincing ("it's not fair"). So I used the principles of memory theory and higher-order thinking to help them generate stronger ideas. First, by examining successful paragraphs, listing their supporting sentences and categorizing those sentences according to "type," we created a menu of potential reasons that students could use when writing persuasive pieces, including facts ("according to my research, our vending machines charge more than any other cafeteria in the district"), anecdotes ("once, I bought gum from our machine that was so hard that my teeth hurt trying to chew"), and causes and effects ("because we cannot leave campus to buy snacks elsewhere, Candy Incorporated has full control over our urge for food and has no reason to improve"). By creating these categories, students felt much more comfortable trying to generate their own reasons for the various assignments we pursued; they had a framework for accessing their ideas, rather than feeling overwhelmed in one giant pool of thought.

The second piece of the puzzle was showing students the common errors in reasoning that muddled their writing. I explicitly taught potential pitfalls, such as overgeneralizations ("all students hate the dress code"), false cause and effect ("because I have to wear a uniform, I can't concentrate in school"), false assumptions of your audience ("if you get rid of the dress code, then everyone will like you"), and circular reasoning ("I think the uniforms are ugly because I don't like the way they look.") We practiced recognizing these pitfalls in new situations, and my students began noticing quirks in their own writing and thinking. One of my golden moments of teaching was Michael saying, "no one likes that you give homework," and then stopping himself and saying, "well, maybe that's an overgeneralization."

Conclusion and Key Concepts

Having read this chapter, you should understand what is meant by **"higher-order thinking."** You should recognize *why* we want to teach higher-order thinking, understanding that a deeper conceptual understanding of ideas is **remembered longer** and is more **transferable** to other contexts. You should also understand that higher-order thinking is best taught through **real-world contexts** and by varying the scenarios in which students must use their newly-acquired skills. You should emphasize the **building**

³⁰ Brophy, Jere. "Probing the Subtleties of Subject-Matter Teaching." *Educational Leadership* (April 1992), p. 5.

blocks of higher-order thinking and encourage students to think about the strategies they are using to solve problems.

As victims of the achievement gap, our students need to make significant academic gains just to catch up with many other students and to have an even chance at life's opportunities. One of the ways that you can help provide that chance is to lead, draw, and push students toward higher-order thinking.