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Learning About Learning

What Every New Teacher Needs to Know

National Council on Teacher Quality

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Letter of Support

We have spent much of our professional lives researching learning and cognition. In the course of that work, we have used and reviewed many textbooks of educational psychology and instructional methods — textbooks that are required reading in teacher preparation programs. We have been consistently frustrated by the lack of discussion in many of these textbooks of teaching strategies that are backed up by strong evidence, and by a frequent overemphasis on strategies for which evidence is anecdotal at best.

Teaching aspiring teachers how to maximize student learning and retention is the paramount task of their training. It is therefore of real consequence that the guidance given by textbooks on these topics makes only passing reference to essential knowledge about learning.

We are excited about this new study by the National Council on Teacher Quality, which documents and highlights these problems in a clear and compelling fashion. The study should trigger an overdue discussion among authors, publishers, and teacher educators about how teacher candidates can be taught empirically supported methods that promote student learning.

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Learning About Learning: What Every New Teacher Needs to Know

Executive Summary

Why this study?

Every year about 190,000 teacher candidates graduate from traditional teacher preparation programs believing they are ready to begin the relentlessly demanding career of teaching. Each of these aspiring teachers will have taken at least one education psychology course or instructional methods course (usually both) designed to teach them how children learn and how to create lessons whose content their students will remember. These topics then will be revisited in much of their other coursework. No other subjects will receive as much attention during teacher training as those that purportedly focus on how students learn.

This report contends that textbooks used in this coursework neglect to teach what we know about how students learn despite its central importance in training. Compelling cognitive research that meets scientific standards about how to teach for understanding and retention barely gets a mention in many texts, while anecdotal information is dressed up as science. Theories du jour and debunked notions are being passed on to new teachers as knowledge and best practice.

Put simply, publishers and authors are failing both aspiring teachers and the teaching profession. They are not ensuring that the core texts designed to produce our next generation of teachers are giving candidates the most fundamental information needed to make learning "stick." The transfer of knowledge — from researchers to publishers to teacher educators to aspiring teachers — is not happening while the need to impart it has never been more urgent.

In practice, what does that mean for aspiring teachers?

First, they're wasting a lot of money. Each teacher candidate likely will buy at least one often- pricey book for their ed psych course and another for their methods course, leading to upwards of $40 million in total spending by each year's crop of new teachers.[1]

But far more important, when teachers aren't trained well, they try to learn on the job — by guessing in the classroom. Being unprepared can overwhelm and even defeat novice teachers at the moment they're most vulnerable. Students are the losers.

The antidote, of course, is that teacher candidates should learn **research-proven instructional strategies** in their textbooks and practice them — again and again — during their training.

This report examines some of the most widely used textbooks in teacher preparation programs today. Specifically, it looks for the degree to which teacher candidates are taught instructional strategies that decades of research confirm can be the most effective.

How were these strategies determined?

In *Organizing Instruction and Study to Improve Student Learning: A Practice Guide*, the Institute of Education Sciences (IES), the research arm of the U.S. Department of Education, identified proven practices that promote learning for all students, regardless of grade or subject, and that are especially potent with struggling students. Six practices stand out for the research behind them. There is little debate among scholars about the effectiveness of these six strategies:

What are the six strategies that work?

The first two help students take in new information:

1. **Pairing graphics with words.**
   Young or old, all of us receive information through two primary pathways — words and graphic or pictorial representations. Student learning increases when teachers convey new material through both.
2. **Linking abstract concepts with concrete representations.**
   Teachers should present tangible examples that illuminate overarching ideas and also explain how the examples and big ideas connect.

The second two ensure that students connect information to deepen their understanding:

3. **Posing probing questions.**
   Asking students "why," "how," "what if," and "how do you know" requires them to clarify and link their knowledge of key ideas.
4. **Repeatedly alternating problems with their solutions provided and problems that students must solve.**
   Explanations accompanying solved problems help students comprehend underlying principles, taking them beyond the mechanics of problem solving.

The final two help students remember what they learned:

5. **Distributing practice.**
   Students should practice material several times after learning it, with each practice or review separated by weeks and even months.
6. **Assessing to boost retention.**
   Beyond the value of formative assessment (to help a teacher decide what to teach) and summative assessment (to determine what students have learned), assessments that require students to recall material help information "stick."

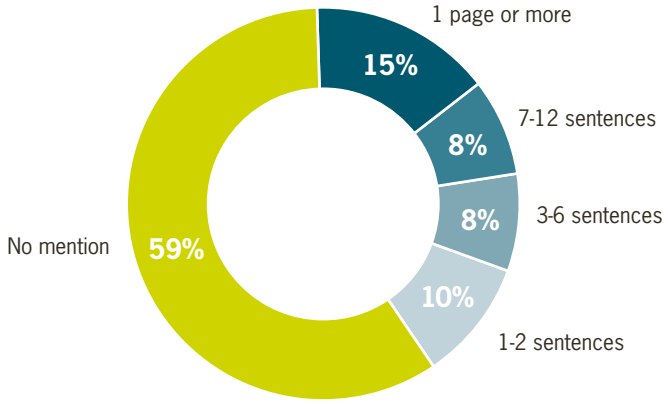
What's evident in textbooks and in teacher prep coursework?

To assess how well teachers are trained in these effective and well-supported instructional methods, we focused on reviewing course textbooks, though we also looked at class discussion and assignments and clinical practice associated with student teaching. Textbooks underpin most teacher preparation coursework, and they provide insights into the instructional approaches used by teacher educators. Specifically, we reviewed 48 relevant texts used in ed psych and general and subject-specific methods courses in 48 elementary and secondary teacher preparation programs.

The textbooks teach instructional topics, but the lack of emphasis on cognitive strategies that are most likely to be effective in the classroom is hard to overstate.

- None of the textbooks used in the sample accurately describes all six fundamental instructional strategies. At most, only two of the six strategies are covered in any particular text.
- When textbooks do mention the strategies (allowing for a broad range of terminology and descriptions), the discussion can be as brief as 1-2 sentences in a text that is typically several hundred pages in length.

Figure A. Frequency and length of mentions of any of the six fundamental instructional strategies (n=288)



Nearly 60% of the 288 mentions of the six strategies that the sample's textbooks should contain (if each textbook addressed all strategies) are simply not found. If a mention is found, in almost all cases it is much shorter than what's needed to adequately explain a strategy.

- Only one strategy, ***posing probing questions***, is found frequently in textbooks.
- Textbooks are detached from the field's bedrock research as identified by IES, indeed from reliable research in general. On average, among pages of references to sources of relatively little merit, textbooks cite only one of the seminal studies highlighted in *Organizing Instruction and Study to Improve Student Learning*.
- Instruction in the strategies also is virtually non-existent in coursework and clinical practice in programs in the sample. Again, ***posing probing questions*** is the only strategy in which candidates are prepared to any extent.

If teacher candidates aren't being taught the research-proven and workable practices that help students learn new content, they will flounder when they try to make learning last.

Important next steps for textbook authors and publishers, teacher prep programs, and state agencies are identified in our recommendations. All recommendations have a central theme: that teacher education needs to draw from the bedrock research in the field of learning.

Recommendations address how authors, publishers, educators, and regulators can ensure that candidates have the opportunity to learn about the fundamental instructional strategies in textbooks, practice the strategies in coursework, and demonstrate mastery of knowledge about the strategies in licensing tests.

Learning About Learning: What Every New Teacher Needs to Know

1. Introduction

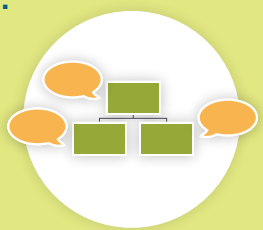
At the heart of teacher preparation programs is the need for teacher candidates to learn about learning. That's why, without exception, all programs dedicate more time to instructional strategies than to any other subject, requiring both educational psychology and instructional methods courses and returning to this topic throughout other coursework. The rationale is obvious: Teachers must know how to promote learning and *make it stick*. If students absorb something for the moment, but can't retain or recall information later, they haven't really learned.

This report argues that aspiring teachers are not being taught — in textbooks or in their coursework and training — the foundational knowledge about cognitive strategies that can help ensure children will learn.

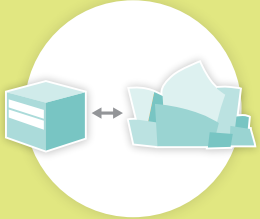
Hundreds of high quality studies have put to the test any number of practices that might help students learn and retain information. In 2007, the Institute of Education Sciences (IES), the research arm of the U.S. Department of Education, sifted through this research, culling the best and most valid studies. It then published *Organizing Instruction and Study to Improve Student Learning*, one of a series of authoritative and helpful practice guides pointing teachers to research-based practices.[2] The guide presents "fundamental instructional strategies" that benefit any teacher's instruction, regardless of the subject or grade level being taught.

The IES identified only six such strategies as having strong-to-moderate research support for helping students to learn and retain what they learn.[3]

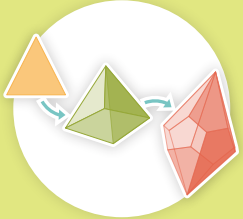
They are:



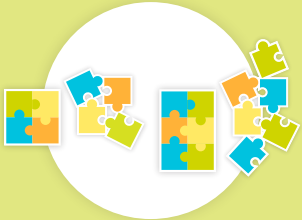
1. **Pairing graphics with words.**



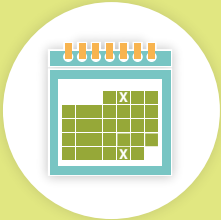
2. **Linking abstract concepts with concrete representations.**



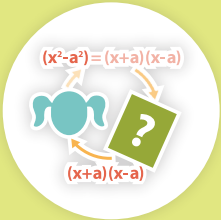
3. **Posing probing questions.**



4. **Repeatedly alternating solved and unsolved problems.**



5. **Distributing practice.**



6. **Assessing to boost retention.**

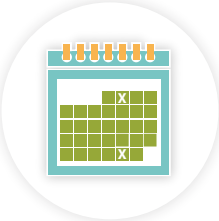
The strategies are fully described beginning on p. 19.

The power of the fundamental instructional strategies

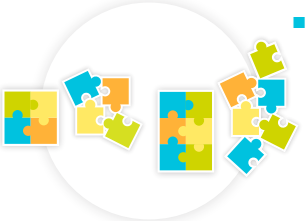
There is little debate among scholars about the effectiveness of these six strategies.[4] Since publication of the IES practice guide in 2007, support for the strategies has been further validated by dozens of strong studies cited in Appendix G.[5] In a general vein, Deans for Impact (a new organization dedicated to improving teacher preparation) published *The Science of Learning*, a six-page collection by Daniel Willingham, a prominent learning expert. This brochure provides "what we know about learning from a scientific standpoint" and features all six of the strategies.[6]

Each strategy is timeless, and impervious to change due to technological advances (in fact, they can and should be incorporated in educational technology) and other educational innovations. Teachers who know the fundamental instructional strategies will also be able to most effectively advise their students, so students can independently improve their own learning. For example, teachers who know the value of **assessing to boost retention** will advise their students that it is most effective to study material by self-testing rather than to reread, summarize, or highlight notes or text.

Other examples of how knowledge of these strategies can improve instruction include:



- **Distributing practice.**
  Practice is a regular part of most teachers' lesson plans. However, depending on the interval between instruction and practice, practice can have vastly different impacts on learning. A seminal study found big differences in performance in an 8th grade history class in which students were tested on material they had learned nine months earlier: Students who reviewed the material four months after they learned it remembered *twice* as much as students who reviewed the material just one week after it was taught.[7]



- **Alternating solved and unsolved problems.**
  It is common practice for teachers to spend the first part of a class period demonstrating problem solving and then have students solve problems for the remainder of the period, but it is not common for teachers to "interleave" solved and unsolved problems. How might interleaving be more effective? Students in a computer programming class who were given a set of 12 problems consisting of six solved problems *alternating* with six unsolved problems learned significantly more that students who were given the same set of 12 problems, but with all of the solved problems clumped together at the beginning of the set.[8]

Textbooks drive instruction

Examination of course materials from teacher preparation programs in the sample testifies to the importance of textbooks in disseminating knowledge and training teachers. Textbooks are the backbone of coursework and a critical resource for the teaching profession.

Although not all of the 219 educational psychology, general methods, and subject-specific methods courses reviewed for this study require a textbook to support instruction on how to design lessons, more than 85 percent do. In a sample of these courses, the vast majority (79 percent) of instructors who assign a text for their courses clearly organize instruction around that text — as evidenced by class discussions and/or assignments keyed to specific textbook chapters (e.g., sample below).[9] For example, the topics for individual class meetings listed in syllabi are often the same as the list of chapter titles in the table of contents of the assigned text.

An examination of lecture and discussion topics, assignments, and assigned readings in ed psych and general methods coursework in which instructors decide to assign a variety of articles and shorter pieces of reading instead of a text found that the courses typically address the same topics as courses with textbooks.[10]

In short, our analysis affirms common sense: Textbooks both capture and reinforce the consensus of the field as to what future teachers need to know about instructional strategies. What these textbooks fail to cover is by no means inconsequential.

Course Outline

Week	What is Due?	Topic of the Day
1/23		Chapter I – Learning, Teaching and Educational Psychology
1/30		Chapter 14 – Teaching Every Student

2. What textbooks teach about learning

All of the textbooks in this sample were selected by college faculty to teach about cognitively based strategies that should maximize student learning and retention.[11]

What would a future teacher learn by reading them?

What this textbook review is not

These textbook reviews have a singular focus: Do the texts cover the six fundamental instructional strategies?

Although many texts necessarily contain additional material, the premise of this analysis is that any text that purports to address the design of instruction is incomplete if it does not cover these strategies. A textbook purporting to cover instructional design to maximize learning and retention that fails to cover these six strategies is no less remiss than a botany textbook that fails to address photosynthesis or an American government text devoid of a discussion of the three branches of government.

All of the books examined contain a lot of other content, much of which could be useful to teachers, but that other content is not germane to this analysis.

The programs in which the textbooks are assigned were randomly selected from a pool of colleges and universities encompassing more than one-third of the teacher-producing institutions in the country.[12] Based on this broad sampling, the 48 relevant textbooks used in the programs' 219 educational psychology, general methods and secondary subject-specific methods courses constitute a representative sample whose features can be generalized to the universe of textbooks used by elementary and secondary teacher prep programs.[13]

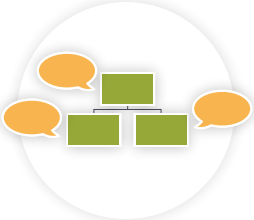
Two analysts independently examined each textbook in the sample to determine if any mention of the six instructional strategies was made, even if only in a single sentence. References were analyzed with the assistance of an expert in educational psychology, to determine if a textbook covered the most essential information about a strategy.[14]

Question:
Could analysts have interpreted the text erroneously, thereby failing to credit what should have been noted as discussion of one of the fundamental instructional strategies?

Response:
Misinterpretation was very unlikely. Two analysts, working independently, cast a very broad net to extract from texts any discussion of any instructional topic that bore even a slight similarity to any of the six strategies. It was only after review by a learning expert that even a portion of extracted text was rejected as not on point.

Findings

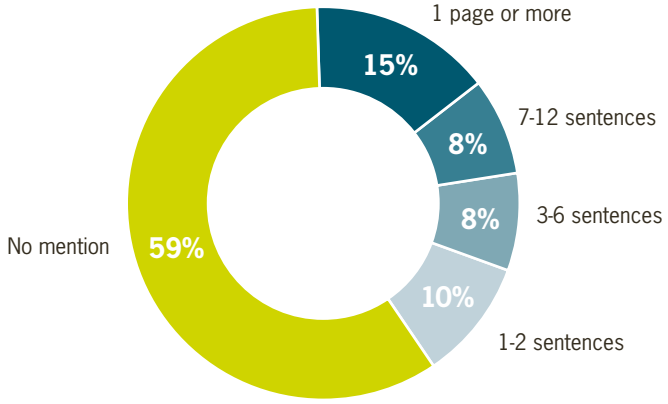
Looking for the six strategies in these textbooks is akin to looking for six needles in a haystack. Even a sentence dedicated to one of the research-based strategies is infrequent.[15] Given the paucity of attention focused on them, it is unlikely that most discussion found on the strategies will make an impression on teacher candidates, much less be remembered.



Guillaume's *K-12 Classroom Teaching* provides a great example of the haystack effect. In its 321 pages, the textbook includes only two scattered sentences that are directly related to the strategy of **pairing graphics with words**. The author advises, on page 104, "Present information verbally and through graphic representations" and notes on page 118, "Additionally, using graphic organizers, diagrams, and other nonlinguistic representations of the text supports student achievement."[16]

Despite being an admittedly low bar, "mentions" of this type were noted. If all 48 textbooks were to merely *mention* each of the six strategies once, there would be 288 references. In fact, the total references only number 118.

Figure 1. Frequency and length of mentions of any of the six fundamental instructional strategies (n=288)



Nearly 60% of the 288 mentions of the six strategies that the sample's textbooks should contain are simply not found. If a mention is found, in almost all cases it is much shorter than what's needed to adequately explain a strategy.

In the rare cases when a text mentions almost all of the strategies, the total amount text devoted to them is still relatively small. For example, despite devoting 285 pages to the topics of learning, instructional strategies, and assessment, Ormrod's *Educational Psychology* devotes a total of three pages spread over 15 pages of text to combined mentions of four of the six strategies.[17]

Will candidates learn the strategies?

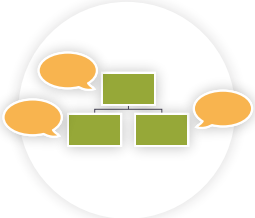
We also looked at the frequency with which textbooks adequately cover, not just mention, a strategy. We defined "covering a strategy" as:

1. A presentation of *most* of the key concepts necessary to understand the strategy. The text only had to present most, not all, of the key concepts. Further, the strategy did not need to be emphasized, just presented.

2. A message that is *consistent*. For example, if on one page a textbook states that **distributing practice** is most productive when practice immediately follows instruction, and on a different page there is a recommendation to space practice at greater intervals, the textbook was faulted for inconsistency.
3. Presenting each strategy in a way that conveys its *universality*. In referring to any of the six strategies, texts had to make it clear that the strategy could be applied no matter what the approach to instruction (i.e., teacher-directed instruction or cooperative learning).

The bar that we established for adequately covering a strategy is actually quite low. Roughly speaking, it would take about one page of text to meet the standard.

Even using a low bar, no single textbook in the sample covers more than two of the six strategies, while almost half fail to cover even a single strategy.

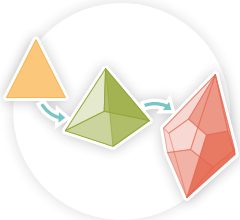


We found an example of the level of discussion that textbooks might ideally provide on each strategy in *Applying the Science of Learning* by Richard Mayer, a textbook not in the sample.[18] The explanation of the strategy of **pairing graphics with words** in this textbook is much more robust and impactful than any we found in the sample:

- The text provides strong general background on the importance and universal application of the strategy (p. 30 and p. 34).
- The text describes the basic outline of the strategy and explains its benefits, including a general example and more specific examples (pp. 66-71).
- The text provides detailed instructions on how to best use the strategy, including multiple diagrams of optimal placements of graphics and words near each other, simultaneously, and in small segments (pp. 66-71).

What's missing from textbooks – or just poorly explained?

Textbooks that mention a strategy were often not given credit for its coverage because key information needed by teachers is left out. For example, although Gunter, Estes, and Mintz's *Instruction: A Models Approach* states, "Periodic review of the material should be built into every instructional plan," the authors do not define "periodic" or give recommended (or not recommended) examples of the appropriate interval between exposures.[19] Given that appropriate intervals are generally much longer than anyone would guess (weeks or months, rather than days), teacher candidates need more explicit guidance on how to schedule practice.

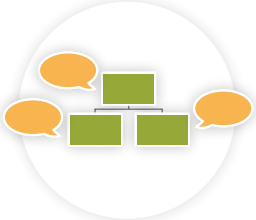


Similarly, more than half of the textbooks that mention the strategy of **posing probing questions** did not receive credit for covering it because they do not explicitly and accurately define the types of questions that deepen content understanding, as opposed to questions that have other purposes, such as fostering interaction among students. They also fail to provide clear examples of the types of questions that qualify as "probing."

For example, Cole's *Young Adult Literature in the 21st Century* states, "An environment in which students can ask and answer questions engages readers and deepens comprehension," but does not clarify the difference between the two, or explain which types of questions are more appropriate for engagement and which are most appropriate for deepening

comprehension.[20] Unless the text draws accurate distinctions between the two types of questions, teacher candidates are not likely to draw them on their own.

Frieberg and Driscoll's *Universal Teaching Strategies* provides more discussion of questioning, but little more clarity. On page 224 the text states, "The types of questions teachers ask can make a significant difference in student achievement… higher levels of teacher questioning produce greater student gains on standardized tests." But it takes another 20 pages for the text to return to the topic and then it does not adequately distinguish between opinion questions that are "higher level" (e.g., "Why do you think these chemicals are related?") and ones that are not (e.g. "Do you agree with Alison?").[21]

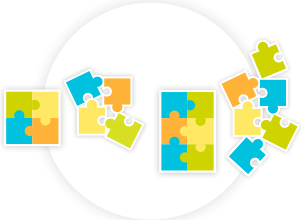


Inaccuracies and inconsistencies are particularly pronounced in textbook discussions of **pairing graphics with words**. This strategy tends to be confused or conflated with the advice to use multiple modalities to accommodate students' learning styles, even though "learning styles" is a debunked theory.[22] For example, Kellough and Kellough's *Secondary School Teaching: A Guide to Methods and Resources* says that research showing the benefits of presenting information graphically and verbally proves that the best learning "engages most or all of the senses" to accommodate individual students' preferred learning methods.[23] In fact, there is no research connecting the strategy and students' "preferred learning methods."

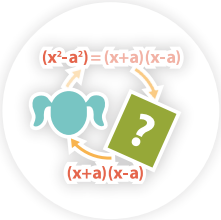
What strategy is covered most often?

Figure 2 allows for comparison of how frequently each strategy is covered in texts. **Posing probing questions** is clearly the most frequently covered. (However, the frequency with which mentions of this strategy were noted may be inflated by generously attributing some share of discussion of questioning to this strategy when, in fact, it arguably might be attributed to promoting the use of questioning to encourage student interaction.) Even so, **posing probing questions** is covered by fewer than half of the textbooks.

Repeatedly alternating solved and unsolved problems and **assessing to boost retention** are not covered in any text.[24] The latter – often described as "the test effect" – is the strategy with the longest history of support from research.[25]



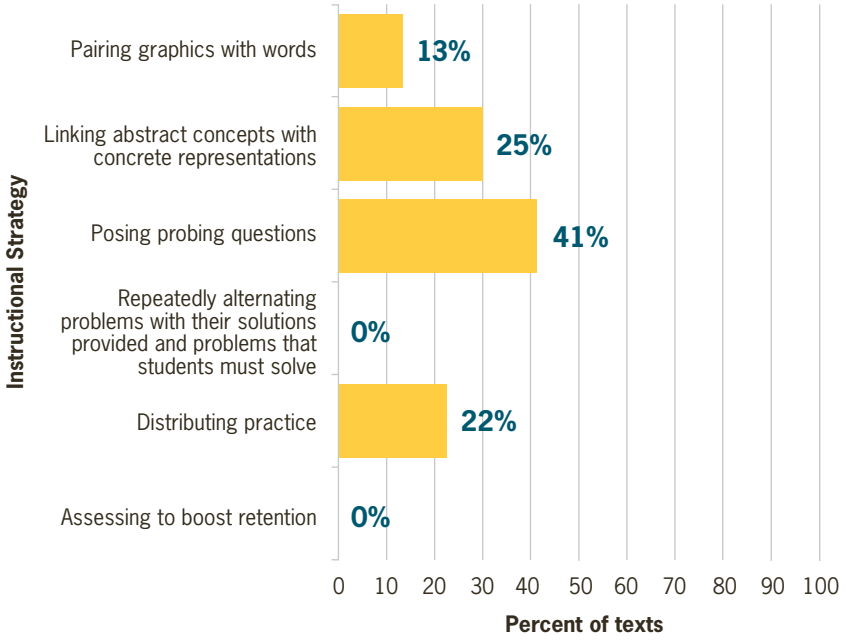
- In the 14,000 pages of the 48 textbooks, there is a single sentence mentioning **repeatedly alternating solved and unsolved problems**: "Research on worked examples generally finds that they are effective if they alternate with problems students do on their own (e.g. one worked example followed by several problems of the same type)."[26] (This statement was not credited with covering the strategy, however, because none of the numerous examples of problem sets provided in the text illustrate the critical practice of interleaving of solved and unsolved problems.)



- The concept behind **assessing to boost retention** — that testing can help students to remember what they are learning — is mentioned in a few books. No textbook, however, provides enough information about how this testing should be done to achieve the best effects (for example, with questions requiring active recall). Kellough and Carjuzaa's *Teaching in the middle and secondary schools* notes that "Tests are also used to…help students increase their understanding and retention of facts, principles, skills, and concepts," but doesn't explain that students need to receive immediate feedback so that only correct information is reinforced.[27]

Considering this near total absence of emphasis on research-driven strategies in any of the reviewed textbooks, even an instructor who requires multiple textbooks is unlikely to patch together textbook coverage of all six strategies.

Figure 2. Textbook coverage of fundamental instructional strategies (n=48)



No fundamental instructional strategy is covered by even half of the sample of 48 texts.

Methodology for evaluating textbooks on their coverage of the fundamental instructional strategies

The IES practice guide describes each strategy, identifies key underlying concepts, and describes how these concepts can be used most effectively.

Two trained analysts independently read each textbook, extracting any text related to each of the six strategies. An expert in learning strategies then reviewed the extracts and the proximal text.

A textbook was judged to cover a strategy if the answer to each of these three questions was "yes:"

1. Does the text present *most* of the key concepts necessary to understand the strategy?
2. Does the coverage of the strategy present a *consistent* message?
3. Is each strategy presented in a way that conveys its *universality*?

Results were sent to the authors and publishers asking them to correct errors or misinterpretations, and NCTQ offered to include their comments in this analysis. Responses from one author and one publisher can be found in Appendix M.

Appendix C provides additional information about the methodology and the scoring rubric. Appendix A lists final scores of each textbook on each of the six strategies.

Textbooks Categorized by Coverage of Fundamental Instructional Strategies

(Textbooks listed are those in the sample that are still in print)

3 textbooks do not *mention* even 1 of the 6 fundamental instructional strategies:	**Price**
Chappuis, J. (2009). *Seven strategies of assessment for learning*. Boston: Allyn and Bacon.	$40.40
Henniger, M. L. (2009). *Teaching young children* (4th ed.). Upper Saddle River, NJ: Merrill Prentice Hall.	$183.20
Probst, R. E. (2004). *Response and analysis: Teaching literature in secondary school* (2nd ed.). Portsmouth, NH: Heinemann.	$30.00

12 textbooks *mention* at least 1 of the 6 strategies but do not *cover* any of them:	**Price**
Burke, J. (2007). *The English teacher's companion: A complete guide to classroom, curriculum, and the profession* (3rd ed.). Portsmouth, NH: Heinemann.	$37.50
Donovan, M. S., & Bransford, J. D. (Eds) (2005). *How students learn: History in the classroom*. Washington, DC: National Academies Press.	$34.95
Drake, F. D., & Nelson, L. R. (2005). *Engagement in teaching history: Theory and practices for middle and secondary teachers*. Upper Saddle River, NJ: Pearson.	$69.20
Feinstein, S. (2004). *Secrets of the teenage brain: Research-based strategies for reaching and teaching today's adolescents*. Thousand Oaks, CA: Corwin Press.	$35.95
Guillaume, A. M., Yopp, R. H., & Yopp, H. K. (2007). *Fifty strategies for active teaching: Engaging K-12 learners in the classroom*. Upper Saddle River, NJ: Pearson.	$57.60
Joyce, B., Weil, M., & Calhoun, E. (2008). *Models of teaching* (8th ed.). Boston, MA: Pearson.	$178.20
Lindquist, T. (2002). *Seeing the whole through social studies* (2nd ed.). Portsmouth, NH: Heinemann.	$29.00
Maxwell, R. J., & Meiser, M. J. (2005). *Teaching English in middle and secondary schools* (4th ed.). Upper Saddle River, NJ: Pearson.	$154.40
Parkay, F. W., Hass, G., & Anctil, E. J. (Eds.) (2010). *Curriculum leadership: Readings for developing quality educational programs* (9th ed.). Boston, MA: Pearson/Allyn & Bacon.	$183.60
Texley, J., & Wild, A. (Eds.). (2004). *NSTA pathways to the science standards: Guidelines for moving the vision into practice* (2nd high school ed.). Arlington, VA: National Science Teachers Association.	$5.95
Tomlinson, C. A. (1999). *The differentiated classroom: Responding to the needs of all learners*. Alexandria, VA: Association for Supervision and Curriculum Development.	$29.95
Wong, H. K., & Wong, R. T. (2009). *The first days of school: How to be an effective teacher* (4th ed.). Mountain View, CA: Harry K. Wong Publications.	$25.95

15 textbooks *cover* 1 of the 6 fundamental instructional strategies:	**Price**
Arends, R. I. (2004). *Learning to teach* (8th ed.). Boston, MA: McGraw-Hill.	$155.00
Bass, J. E., Contant, T. L., & Carin, A. A. (2009). *Teaching science as inquiry* (11th ed.). Upper Saddle River, NJ: Pearson.	$101.00
Dick, T. P., & Hollebrands, K. F. (2011). *Focus in high school mathematics: Technology to support reasoning and sense making*. Reston, VA: National Council of Teachers of Mathematics.	$32.95
Eby, J. W., Herrell, A. L., & Jordan, M. L. (2009). *Teaching in the elementary school: A reflective action approach* (5th ed.). Upper Saddle River, NJ: Pearson.	$132.60
Guillaume, A. M. (2008). *K-12 classroom teaching: A primer for new professionals* (3rd ed.). Upper Saddle River, NJ: Pearson.	$71.00
Gunter, M. A., Estes, T. H., & Mintz, S. L. (2007). *Instruction: A models approach* (5th ed.). Needham Heights, MA: Allyn & Bacon.	$101.00
Hill, J. D., & Flynn, K. M. (2006). *Classroom instruction that works with English language learners*. Alexandria, VA: Association for Supervision and Curriculum Development.	$29.95

Kellough, R. D., & Kellough, N. G. (2011). *Secondary school teaching: A guide to methods and resources* (4th ed.). Boston, MA: Allyn & Bacon.	$165.20
Llewellyn, D. (2005). *Teaching high school science through inquiry: A case study approach*. Thousand Oaks, CA: Corwin.	$41.95
Moore, K. D. (2012). *Effective instructional strategies: From theory to practice* (3rd ed.). Thousand Oaks, CA: Sage.	$114.00
Santrock, J. W. (2009) *Educational psychology* (4th ed.). Boston, MA: McGraw-Hill.	$180.00
Silver, H. F., Strong, R. W., & Perini, M. J. (2007). *The strategic teacher: Selecting the right research-based strategy for every lesson*. Alexandria, VA: Association for Supervision and Curriculum Development.	$27.95
Tate, M. L. (2010). *Worksheets don't grow dendrites: 20 instructional strategies that engage the brain* (2nd ed.). Thousand Oaks, CA: Corwin.	$33.95
Thomas, E. J., Brunsting, J. R., & Warrick, P. L. (2010). *Styles and strategies for teaching high school mathematics: 21 techniques for differentiating instruction and assessment*. Thousand Oaks, CA: Corwin.	$38.95
Woolfolk, A. (2010). *Educational psychology* (11th ed). Columbus, OH: Pearson.	$101.00

11 textbooks *cover* 2 of the 6 fundamental instructional strategies:	**Price**
Bohlin, L., Durwin, C. C., & Reese-Weber, M. (2009). *EdPsych: Modules*. Boston, MA: McGraw Hill.	$233.33
Chiappetta, E. L., & Koballa, Jr., T. R. (2010). *Science instruction in the middle and secondary schools: Developing fundamental knowledge and skills* (7th ed.). Boston, MA: Allyn & Bacon.	$91.00
Eggen, P., & Kauchak, D. (2010). *Educational psychology: Windows on classrooms* (8th ed.). Upper Saddle River, NJ: Merrill.	$101.00
Elliott, D. C. (2005). *Teaching on target: Models, strategies, and methods that work*. Thousand Oaks, CA: Corwin.	$38.95
Kellough, R. D., & Carjuzaa, J. (2009). *Teaching in the middle and secondary schools* (9th ed.). Upper Saddle River, NJ: Pearson.	$161.60
Marzano, R. J., Pickering, D. J., & Pollock, J. E. (2001). *Classroom instruction that works: Research-based strategies for increasing student achievement*. Upper Saddle River, NJ: Pearson.	$29.95
Orlich, D. C., Harder, R. J., Callahan, R. C., Trevisan, M. S., & Brown, A. H. (2010). *Teaching strategies: A guide to effective instruction* (9th ed.). Boston, MA: Wadsworth.	$196.95
Ormrod, J. E. (2011). *Educational psychology: Developing learners* (7th ed.). Columbus, OH: Merrill Prentice Hall.	$213.20
Posamentier, A. S., Smith, B. S., & Stepelman, J. (2010). *Teaching secondary mathematics: Teaching and enrichment units* (8th ed.). Boston, MA: Allyn & Bacon.	$91.00
Slavin, R. E. (2009). *Educational psychology: Theory and practice* (9th ed.) Boston, MA: Allyn & Bacon.	$101.00
Wiggins, G., & McTighe, J. (2005). *Understanding by design* (expanded 2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.	$32.95

None of the books in the sample covers more than two strategies.

More detailed scores for the 48 textbooks in the sample are found in Appendix A.

Question:
Are the evaluated textbooks representative of the textbooks generally used in teacher education coursework today?

Response:
Yes. Although the sample does not contain the newest editions of textbooks, the IES practice guide was not reporting on recent cutting-edge research that would inevitably take time to permeate the field. The sample suggests that prior to the guide's publication, textbook authors largely paid little attention to the research on which the practice guide is based, and this did not change after publication of the guide in 2007. Despite the fact that it was a limited analysis, the review of six recent editions (see p. 14) indicates that textbook authors still have not begun to pay attention.

If not the fundamental instructional strategies, what are textbooks teaching about instruction?

Textbooks teach instructional topics, but by and large they do not emphasize the research-proven strategies that are most likely to be effective in the classroom. In fact, many of the topics featured prominently have little research support or have been found to have little effect.[28] Meanwhile, discussion of the six strategies amounts to less than one percent of the page content in the total textbook sample.

In general, most textbooks focus on:

- How teachers and students should organize themselves (e.g., inquiry learning, direct instruction, or cooperative learning).
- Importance of student engagement.
- Benefits of cooperative learning.
- Merits and/or pitfalls of homework.
- Mechanisms to activate prior knowledge (e.g., "KWL" or "know/want to know/learned" charts).

For example, six of the fourteen chapters in Shalaway's *Learning to Teach… Not Just for Beginners* describe different models of teaching, such as direct instruction and problem-based learning, but the book includes only two sentences on **linking abstract concepts with concrete representations** and slightly less than one page on **posing probing questions**.[29]

Similarly, Frieberg and Driscoll's *Universal Teaching Strategies* includes a 40-page chapter on the use of technology and resources outside the classroom, but devotes only three sentences to the importance of **distributing practice**.[30] The text says only, "Studies have shown that review must be incorporated into your teaching for the following reasons: 1. to promote reflection, 2. to develop a whole picture when learning has been conducted in small pieces or steps, 3. to diagnose strengths and needs for teaching and learning, 4. to boost self-confidence" (p. 269).[31] Note that none of the four reasons given by the authors for **distributing practice** pertains to its powerful impact on students' ability to retain the material.

Textbooks also put forward strategies that appear to be similar to the fundamental instructional strategies, but leave out important underlying elements.

For example, many texts discuss how students can develop graphic organizers. Moore's *Effective Instructional Strategies* states, "Graphic organizers form visual pictures of information and allow people to process information more intensely, which improves recall. They help students organize information into a simple-to-read, structured display that presents complex information in an easy-to-understand manner."[32] But Moore, like other authors, suggests use of graphic

organizers and other visual tools to help students make connections between concepts *after* those concepts have been introduced. Textbooks ignore the underlying idea behind **pairing graphics with words**, which is that teachers should use both verbal and visual means *when first presenting* new information to their students.

Finally, the pervasive emphasis in textbooks on teaching to students' "learning styles" is particularly counter to research evidence. This debunked theory holds that students are, for example, visual, auditory, or kinesthetic learners, and that lesson plans should include instruction directed at these "learning styles." There is no evidence that considering learning styles in planning and delivering instruction produces learning gains,[33] but fully 59 percent of texts advocate planning instruction around learning styles.

Why doesn't textbook content align with research?

It's a mystery why the six fundamental instructional strategies appear to be virtually missing from the sample of textbooks — and presumably the universe of like textbooks. We suggest that the neglect stems from the fact that publishers use less demanding standards than the IES in choosing textbook content.

While the textbooks we reviewed cite hundreds of studies on how students learn and retain information, none references more than 10 of the 114 seminal studies cited in the IES practice guide. More than half of the textbooks cite none of these studies.[34]

To be cited by the IES practice guide, a study has to present the results of a well-designed experiment that evaluates the effect of a particular instructional strategy on student learning — a standard that textbook publishers don't have or don't enforce.[35]

Institute of Education Sciences (IES) standards for judging effective classroom strategies

The IES takes a two-step approach in evaluating research on instructional practices.

Most importantly, it requires that the practice be supported by studies with solid results on a treatment group and with a control group that is either randomly selected or is equivalent to the treatment group. This design ensures that results can be attributed to the practice and are not affected by confounding factors.

Second, the IES checks that a practice's effectiveness can be generalized because it has been shown to boost learning in a variety of settings and with students of differing characteristics.

The practice guides produced by the IES are not unlike the "practice guidelines" issued by medical associations on treatment protocols established on the basis of scientific findings.[36]

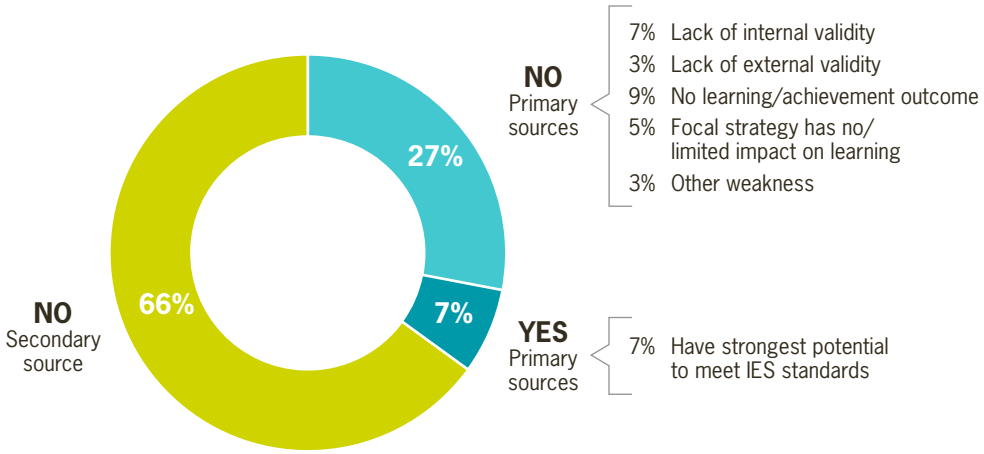
In addition, many of the texts overwhelmingly rely on secondary sources. We selected a sample of citations dealing with instructional topics,[37] and found that two-thirds of the citations do not reference an actual study but instead reference another textbook that in turn cites some unspecified primary source.[38] For example, instead of referring to primary research in support of particular points about instruction, several texts cite the Marzano *et al.* text, *Classroom Instruction That Works*.[39] Readers who then consult the Marzano text will find that it cites 265 sources on a variety of topics, leaving the question: Which of those 265 sources is relevant to the point that originally sent readers on this search?

Of the primary sources that are included by texts, more than half report on studies whose designs limit the general applicability of their findings, with flaws such as extremely small sample sizes, lack of a control group, or the use of a teaching strategy only on students with special characteristics (such as gifted students). Other primary sources are not really studies of the application of a teaching strategy at all, but are instead simply descriptions of the strategy.

Figure 3 shows that only a small proportion (7 percent) of the sample of 58 citations examined satisfy the standards for research established by the IES.

This lack of rigor in judging what constitutes evidence-based knowledge misleads teacher educators and teacher candidates about what the science of learning tells us.

Figure 3. Scientific rigor behind textbook references (n=58)



Almost all of a sample of references (n=58) used to support discussion of instructional methods would not meet IES standards for research.

Do more recent textbook editions cover the fundamental instructional strategies better?

Although we saw no pattern of improvement in more recent books in the sample, we reviewed six of the most recent editions of textbooks in the sample, looking for additions or changes that would affect our findings.[40] We found that two of the textbooks did not make any substantive changes between editions in the extent to which they address the fundamental strategies and three improved the presentation of a single strategy in minor ways.

As an example of a minor improvement, a text that had not previously mentioned **assessing to boost learning** added a reference to the strategy — but assessment is described only as a study strategy that students could use on their own, not as something that a teacher could use with her class.

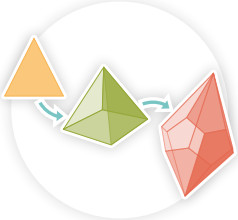
The sixth textbook made a substantial change, arguably for the worse, citing only one study's finding as the basis for indicating that **pairing graphics with words** is much less effective than previous editions had indicated.

Additional statistics and graphics on coverage of the strategies in the full sample of textbooks and selected more recent editions are found in Appendix D.

3. What coursework teaches about learning

All teacher preparation programs teach candidates about lesson planning and instructional strategies, and require candidates to demonstrate their understanding of these essential skills.

However, rarely, if ever, are candidates taught the six specific instructional strategies that make for effective and potent lessons. We know this from examining lecture and discussion topics and candidate assignments, as described in syllabi. To assess whether a program actually "prepares" candidates, we looked for an introduction of the strategies during class time through lecture and/or discussion, plus whether candidates are required to practice the strategies at least once in a class assignment or in student teaching.[41]



We found:

- 46 percent of programs prepare their candidates in only one strategy.
- 35 percent don't require future teachers to learn about and practice *any* of the strategies.
- **Posing probing questions** is virtually the only strategy that is emphasized.[42]

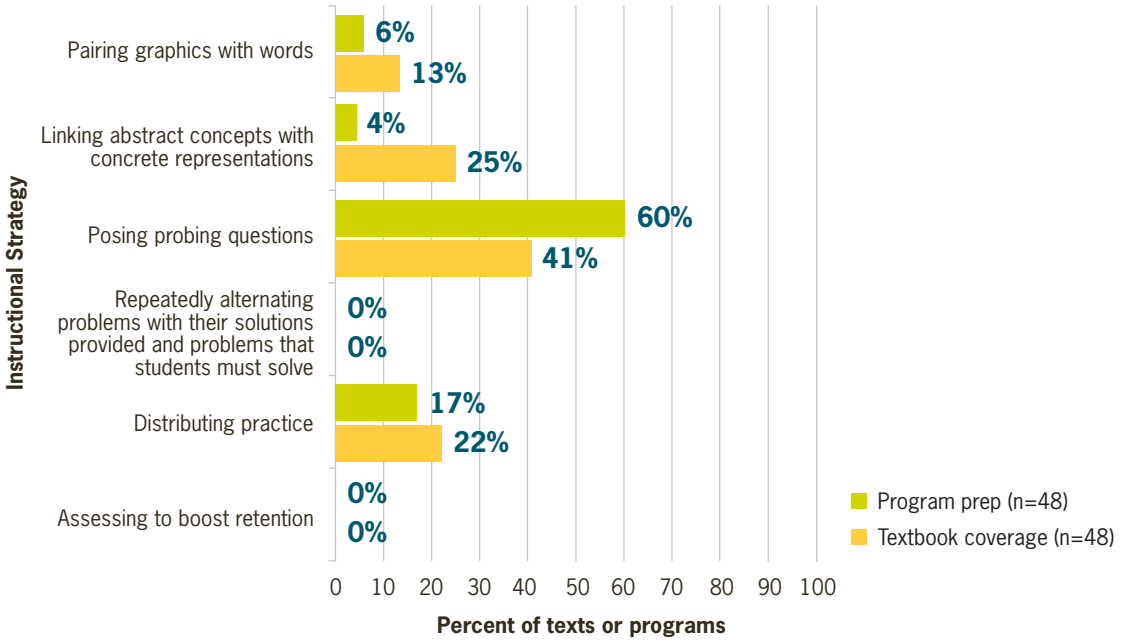
Course syllabi reveal the important influence of textbooks in framing coursework and teacher training.[43] Teacher educators effectively mirror textbooks in the assignments they make and in how (or if) they evaluate the presence of these strategies in their candidates' practices.

For example, the same two strategies not covered in any textbook, **repeatedly alternating solved and unsolved problems** and **assessing to boost retention**, also don't show up in class assignments or feedback given to student teachers. The proportion of textbook coverage of **pairing graphics with words** and **linking abstract concepts with concrete representations** appears greater than the proportion of programs in which we find candidate preparation, but if preparation only considered class discussion rather than discussion and practice, this would not be the case: these strategies are discussed in class in 27 percent and 40 percent of programs, respectively.

Question:
Given that they date from 2009-2012, are the syllabi and other coursework materials in the study still a reliable source of current teacher education practices?

Response:
Yes. The fundamental instructional strategies do not receive increasing attention in coursework in the part of the sample that is more recent. As is the case with textbooks, the pattern of their neglect in coursework does not appear to be changing over time.

Figure 4. Comparing coverage of strategies in textbooks and prep in coursework



Comparing attention to the fundamental instructional strategies, teacher educators largely mirror textbooks.

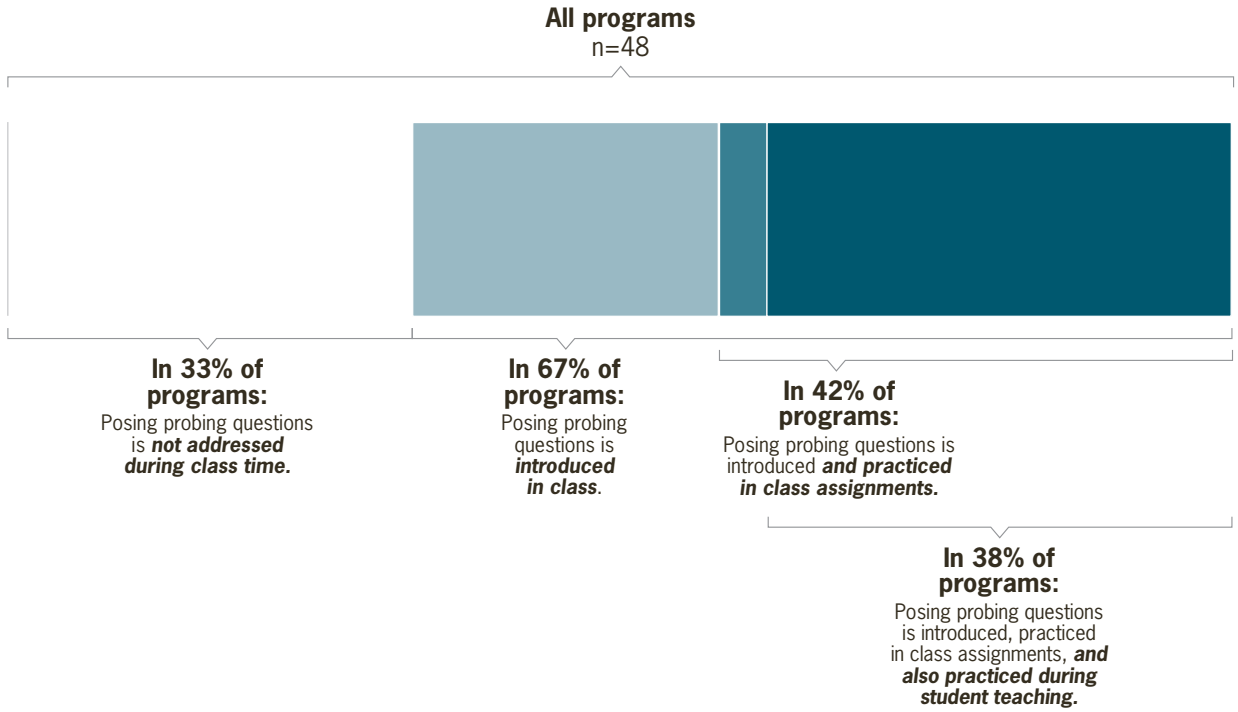
Little evidence of sufficient practice

Like any skill, repeated practice and considerable feedback is necessary for teacher candidates to gain proficiency in applying the fundamental instructional strategies in an actual class. Candidates who simply read about any of the fundamental instructional strategies, or read about a strategy and practice it only once, are probably not going to master its use.

The extent to which practice may be needed is illustrated by a study that followed 35 elementary teachers as they learned three of the six strategies discussed here in a two-week intensive summer graduate course.[44] These teachers needed multiple rounds of feedback and revision before they could produce a lesson plan that used the strategies effectively. *Simply reading about the strategies and discussing them was not sufficient for teachers to understand and use them.*[45]

In our analysis of teacher prep programs, **posing probing questions** is the only strategy for which any evidence of practice was found during student teaching, the period of preparation in which practice opportunities are most frequent and intense.[46] However, in only 38 percent of programs are candidates introduced to the strategy in class and then asked to practice it both in class assignments and during student teaching, thus providing a real opportunity for them to achieve some proficiency by the end of student teaching.[47]

Figure 5. Looking across preparation, how intensely do programs train candidates on **posing probing questions**?



*There is continuity in program training of candidates only on the strategy of **posing probing questions**, but only in just over a third of programs (38%).*

In another example of mirroring the misalignment with research found in textbooks, preparation programs do require considerable practice on a pseudo-science throughout teacher prep: two-thirds (67 percent) of programs in the sample prepare candidates to deal with the discredited idea of "learning styles," generally requiring that every lesson plan address how instruction accommodates students in their so-called learning styles.

A New Standard for the *NCTQ Teacher Prep Review*

NCTQ's focus on the quality of teacher preparation across a range of subjects has motivated our reporting on a wide variety of preparation issues through the *Teacher Prep Review* (http://www.nctq.org/teacherPrep/review2014.do) and *Path to Teach* (http://www.pathtoteach.org), a guide and consumer guide respectively to more than 2,500 of the nation's elementary, secondary, and special education teacher preparation programs. The *Review* evaluates each program against a set of standards related to selection criteria, content preparation requirements, professional coursework, and clinical experiences. Many standards have grown out of examinations of teacher preparation similar to that found in this report. This study will generate a new standard (described in Appendix L) for evaluation of secondary programs in NCTQ's forthcoming *Teacher Prep Review 2016* and findings will also be available on *Path to Teach*.

Additional summary statistics and graphics on program preparation in strategies are found in Appendix F.

4. The fundamental instructional strategies

Why are the fundamental instructional strategies fundamental?

How all people, including children, learn and retain information is described by what cognitive psychologists term an "information processing model." New material is taken in through the senses and placed in working memory. Working memory can only hold information for a brief time, and its capacity is limited, so unless information is transferred to long-term memory, it will be forgotten. Information in long-term memory can also fade away, but it is more likely to be retained if it is retrieved periodically.

From science to the classroom

In recent years, researchers have made great strides in identifying instructional strategies that leverage how the brain takes in and stores information.

The six instructional strategies identified in the IES practice guide as having the strongest levels of research support are *fundamental* because, while their mode of application may vary, they all can be used by teachers in any classroom activity, in any subject, and at all grade levels. Teachers can use these strategies to maximize student learning and retention of knowledge, to stimulate transfer, and to create opportunities for retrieval.

Teachers can now make more informed, scientifically based instructional decisions, such as determining whether it would be more productive to ask one type of question instead of another, or whether to schedule practice exercises on a topic four weeks after the topic is introduced rather than a few days later. The same reasoning can apply whether the topic is World War II or basic addition, and whether the audience is kindergarteners, middle schoolers, or high school seniors.

Teachers should employ these six strategies as often as each naturally fits into instruction — and it is especially important to utilize them in the design of instruction for students who have weak foundations in a subject. The merits of the strategies include:

- Their use does not depend on technology, nor do they require special materials or resources.
- They can be integrated in a variety of ways whether instruction is teacher-directed, student-centered, project-based, inquiry-based, and so on.
- They don't impose curriculum straitjackets that limit a teacher's creativity.

- They allow for differentiation. For example, problem sets used by some students may be more difficult than those used by others while still implementing the strategy of **repeatedly alternating solved and unsolved problems** with fidelity.

Lessons that have only superficial similarities to lessons using the fundamental instructional strategies could miss the boat for improving student learning and retention. In the examples that follow, a specific use of each strategy is contrasted with a "missing the boat" approach that fails to capture one or more of its essential qualities.

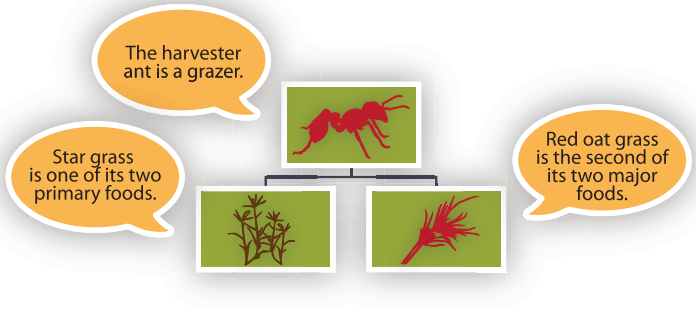
The six fundamental instructional strategies every teacher needs to know

Two strategies that help students take in new information

1. Pairing graphics with words.

Because people receive information through two primary pathways — words and graphics — student learning increases when teachers convey new material through both of these means. For example, graphics that convey concepts and ideas are more effective when paired with written labels, spoken explanation or both. Graphics include illustrations, diagrams, and flow charts, as well as animation or video. Simple images in drawings or photos are not sufficient, unless they are carefully chosen to convey entire concepts.[48]

Instructional goal: Teaching middle-school students about the Sub-Saharan savanna food web

Effective: *Pairing concept-rich graphics with words when introducing new material*	Missing the boat: *Producing graphics only after information is presented*
While introducing material about the savanna, the teacher discusses a labeled flow chart showing interactions among all of the organisms living in the savanna.  	After showing her class photos of a variety of organisms that live on the savanna and discussing the organisms' interactions, a teacher asks students to create concept maps that summarize what they have learned about producers, consumers, decomposers, and other elements of the food chain.

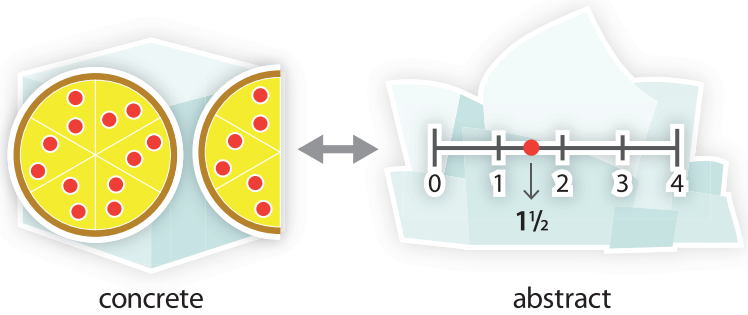
Note: *Student production of graphics is a valuable learning experience, but it doesn't substitute for the instructional use by teachers of paired graphics and verbal descriptions.*

2. Linking abstract concepts with concrete representations.

Presenting concrete examples helps students understand new ideas, while connecting those examples to abstract ideas allows students to apply concepts in new situations. For example, teaching young students the general principle that all organisms are adapted to their environments will help them to see that squirrels — and not just more exotic animals like polar bears — must cope with their local weather.

Despite the common belief that young children can only understand concrete information (which implies that concrete examples are most important in elementary grades and less so later), some appropriately presented abstractions can be understood by young children and concrete examples can be important learning tools for individuals of all ages.

Instructional goal: Teaching elementary students about fractions

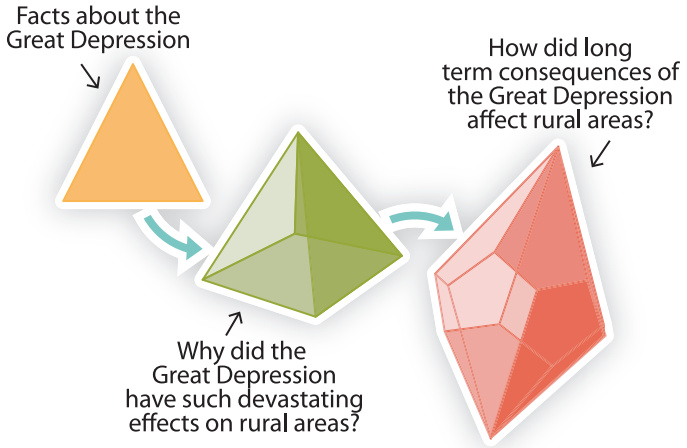
Effective: *Using concrete and abstract representations in concert*	Missing the boat: *Using concrete representations that do not connect readily to important abstractions and failing to explicitly make that connection*
Students work problems with pizza slices in which fractions of several wholes add up to a fraction greater than one whole pizza; they also demonstrate each calculation on a number line. The teacher emphasizes that all fractions are numbers.  	Students repeatedly practice fraction problems using fraction bars, but only to show parts of a whole. Because these problems do not help them understand that fractions are numbers and can be greater than 1, they are confused when the teacher asks a question about the fraction "4/3."

Two strategies that connect information to deepen students' understanding

3. Posing probing questions.

Asking "why," "how," and "compare and contrast" questions helps clarify and strengthen students' knowledge of concepts. These questions require more than mere factual knowledge by forcing students to examine causal mechanisms, evidence for arguments, and comparisons of key ideas. Students must go beyond an exchange of opinions or feelings, which may or may not be rooted in knowledge or understanding. Probing questions can be part of instruction or class discussion, or self-administered as part of independent work.

Instructional goal: Foster an understanding in high-school students of the Great Depression

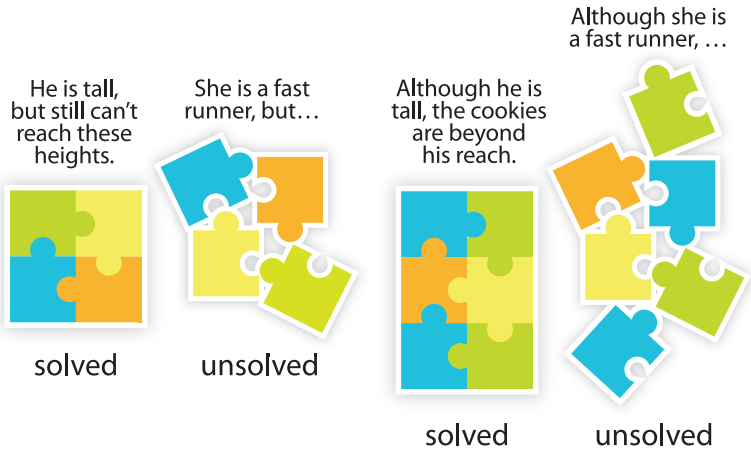
Effective: *After students have acquired basic knowledge, asking questions that require students to synthesize information and extract key concepts*	Missing the boat: *Asking questions that depend on opinions or feelings*
After students have read excerpts from a diary of a girl growing up in rural Iowa in the 1940s and 50s as well as a series of newspaper articles spanning the Great Depression to the 50s, the teacher asks, "How did long-term consequences of the Great Depression affect rural areas?"  	After students read a diary entry written by a teenager living in the Dust Bowl during the Great Depression, the teacher asks how students think they would have felt if they had lived during that period.

4. Repeatedly alternating problems with their solutions provided and problems that students must solve.

Teachers often demonstrate how to do a few problems (whether writing compound sentences or adding fractions), and then ask students to complete a set of similar problems on their own. Students learn more, however, when they are given incremental guidance on problem solving. In a type of "interleaving," problems with written-out solutions should alternate repeatedly with problems that the students will solve. Solved problems help students focus on the underlying principles that apply to each situation, instead of promoting mechanical solution of problems.

Especially for difficult content, giving several written-out solutions for each unsolved problem is helpful. As students become more skilled, teachers can increase the number of problems that students solve on their own following each solved example.

Instructional goal: Teach elementary students how to construct sentences with two clauses

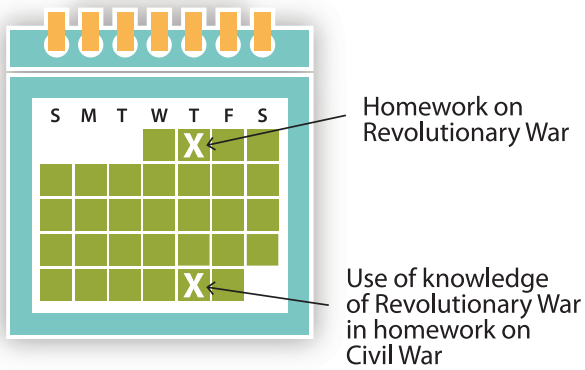
Effective: *Repeatedly alternating solved problems and problems to be solved*	Missing the boat: *Following a short demonstration of problem solving with independent practice*
Elementary language arts students work in cooperative learning groups on a sentence construction assignment that includes eight problems. All of the odd problems have solved examples. The even problems are left to the students to solve.  	A teacher shows two examples of accurate sentence construction and then provides each cooperative learning group with a set of eight sentence construction problems to be solved.

Two strategies that require retrieval and thereby improve student retention

5. Distributing practice.

All learners remember information better when they are exposed to it multiple times in practice sessions spaced over significant intervals. To foster long-term retention, teachers should expose students to important material at least twice and plan review opportunities weeks and then months after information is first introduced.[49]

Instructional goal: Ensure that high-school students retain information learned in a history class

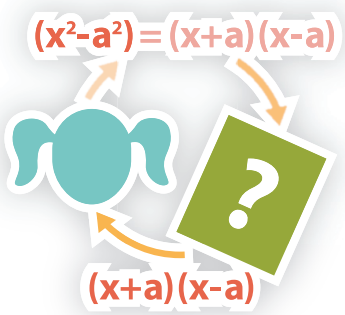
Effective: *Exposing students at least twice to material and delaying review*	Missing the boat: *Reviewing too soon after first exposure and allowing student recall to be prompted*
In late October, a history teacher includes questions in a homework assignment on the Civil War that require students to use their knowledge of the Revolutionary War (last refreshed in a homework assignment in early October) to compare the two conflicts.  	Each Friday, a teacher in an American history class has students do an open-book warm-up exercise on material learned that week.

6. Assessing to boost retention.

The adage "use it or lose it" is based on a scientific fact. Every time a person is asked to retrieve information from memory, the retrieved information becomes more cemented in memory. Assessments of any nature — a low-stakes quiz or a high-stakes test, final exam, medical board, bar exam, or driver's test — are all useful not only to determine if someone knows or has learned material but also to boost learning and retention, especially when hints or prompts are minimized.

In addition, timely and substantive feedback on the correct answers reinforces learning. Without this feedback, assessments will strengthen memories of incorrectly remembered information as well as correct information.

Instructional goal: Ensure that middle-school students retain information learned in an algebra class

Effective: *Assessing frequently, using assessments that force students to recall information on their own, and providing feedback on correct answers*	Missing the boat: *Not forcing students to recall information on their own and not providing feedback*
A teacher who gives weekly quizzes to gauge her students' progress concentrates on questions about factoring "the difference of two squares" that force students to devise answers with no outside assistance (for example, avoiding multiple-choice questions that minimize recall) and provides feedback on correct answers.[50]  	A teacher has students answer a question as a class "exit ticket." Students are allowed to refer to their notes to answer the question, and the teacher does not review the results with the class.

5. Recommendations and conclusion

Research on what teacher education textbooks teach is virtually non-existent, notwithstanding that textbooks are considered to be authoritative and reliable repositories of the best science and knowledge that exists for aspiring teachers and teacher educators. The sole exceptions are a 2009 article on conformance of reading textbooks to the recommendations of the National Reading Panel,[51] a 2011 article that reported on the tendency of teacher education textbooks to rely on secondary sources,[52] and a 2013 article on learning techniques that surveyed six textbooks and found minimal coverage of effective techniques.[53]

Textbooks are a critical and indispensable means for applying the best work by education researchers to teacher training, and for preparing those on whom we depend to educate our children. It is beyond disheartening that there is not a closer examination of textbook content along with higher standards around the science and knowledge textbooks are pushing into the field. In fact, we might go so far as to suggest that pushing weak, even junk science on aspiring teachers is educational malpractice.

Recommendations

For textbook authors and publishers

Make textbooks a "how to" guide for teachers, presenting what teachers need to know about effectively implementing the fundamental instructional strategies in the classroom.

Textbooks should present the six fundamental instructional strategies as the cognitive bedrock of effective instructional design. The strategies should be presented in depth, and their universal applicability should be clear.

In some cases, discussions of the strategies could be grafted onto existing material. Consider these three "quick fixes:"

- The widespread emphasis on the importance of formative assessment provides a perfect opportunity to include information about **assessing to boost retention**, a discussion that is now almost entirely absent.
- Similarly, when discussing the importance of review and practice, it is easy to add an explanation of appropriate intervals for **distributing practice**.
- While discussing the use of "visuals," include and refine recommendations for their use when **pairing graphics with words**. Make it clear that not all visuals are equally effective teaching tools.

While adding information about the fundamental instructional strategies and embracing the power of them is critical, publishers should also insist that:

- The majority of references for discussions of all instructional topics be primary sources connected to well-designed studies meeting IES standards.
- Textbook authors clearly qualify any discussion of instructional topics that have little to no support from such well-designed studies.

Two well-known books that are not designed as textbooks contain as much or more information about the fundamental instructional strategies as texts used in coursework in the sample. Hattie's *Visible Learning: A Synthesis of Over 800 Meta-analyses Relating to Achievement* covers two strategies and mentions three others.[54] Willingham's *Why Don't Students Like School: A Cognitive Scientist Answers Questions About how the Mind Works and What it Means for the Classroom*, which is designed to address how to study rather than how to teach, covers the two strategies most relevant to studying (**distributing practice** and **assessing to boost retention**).[55] **Posing probing questions** is also mentioned.

For teacher prep programs

Teach how to implement the fundamental strategies and why cognitive science finds them so important and universal.

Teacher candidates should be taught both the cognitive science that underlies the fundamental strategies of instruction and the strategies themselves in coursework that addresses instruction broadly, such as ed psych or general methods courses.[56] Subject experts will provide the best guidance and feedback about actually using the strategies, and teacher candidates can engage in lesson planning and practice instruction that incorporate the strategies in subject-specific methods course assignments and in student teaching.

Teacher educators should not assign textbooks that promote instructional strategies that are supported by weak research or that rely heavily on secondary sources, or where the fundamental instructional strategies are presented inaccurately or not at all. Unfortunately, if this were the standard all of the textbooks in this study's sample would no longer be used.

As a primary text for covering the fundamental strategies, consider using the IES practice guide, *Organizing Instruction and Study to Improve Student Learning* (available free online at http://ies.ed.gov/ncee/wwc/practiceguide.aspx). Supplement the guide with a 2013 article by Dunlosky *et al.* that provides additional cognitive science background and practical considerations surrounding use of four of the strategies (reprints available): **posing probing questions**, **repeatedly alternating solved and unsolved problems**, **distributing practice**, and **assessing to boost learning**.

Another potential supplement for the practice guide is Mayer's *Applying the Science of Learning*,[57] a textbook not in the sample. This textbook covers two strategies and mentions three more, with a particularly strong presentation of **pairing graphics with words**. Moreover, unlike any other textbook in the sample, nothing in Mayer's text contradicts the six strategies, and all of the content on learning, instruction, and assessment is genuinely research-based.

Require teacher candidates to practice instructional strategies to the point of mastery.

To truly learn how to use the strategies, teacher candidates must practice them to mastery. Programs can ensure adequate practice in both coursework and student teaching by using a lesson-planning

template with strategy-related prompts in all courses throughout teacher candidates' preparation. A sample lesson plan template is provided in Appendix H.

Cooperating teachers and university supervisors should give feedback to teacher candidates on their use of the strategies in lesson delivery by adding their evaluations to institutional observation forms. For example, did the candidate adequately discuss graphic images, convey the linkage between abstract and concrete representations, engage students with thought-provoking conceptual questions, and help students smoothly transition through a problem set with alternating worked and unworked problems? Sample indicators for a student teaching observation form are provided in Appendix I.

For state departments of education

Revise licensing tests to address all six fundamental strategies and remove references to practices for which there is no research basis.

What gets tested gets taught. States can encourage teacher educators to emphasize the six fundamental instructional strategies by putting them on their licensing tests.

All teacher candidates take one or more pencil-and-paper tests to be licensed, and many states also require, or are on the cusp of requiring, a "performance assessment."[58] Those tests mirror textbooks in their failure to require future teachers to know the instructional strategies cited by the IES.

For example, each of the three relevant Educational Testing Service's pencil-and-paper "Learning and Teaching" tests fails to address more than one strategy. As in textbooks and program instruction, **posing probing questions** is the only strategy that is covered — and this assumes that the purpose of asking questions to deepen understanding is at least implicitly addressed in the test guide's list regarding the purposes of questioning: "preparing students for what is to be learned; guiding thinking; developing critical and creative thinking skills; engaging students in discussion; checking for level of comprehension."[59]

As for performance assessments, the foremost among them is the edTPA. **Posing probing questions** is addressed to some extent in the "deepening understanding" rubric common to all subject-specific edTPAs, but none of the other five strategies is accurately reflected.[60]

Using the IES standards for research, states should first review all licensing tests that address methods of instruction to determine the research basis for those approaches. Practices without sufficient evidence (such as those about accommodating students' learning styles) should be removed. Assessment of each of the six fundamental instructional strategies then should be added to all pencil-and-paper and performance assessments addressing teaching methods.[61]

Conclusion

Every year, about 190,000 teacher candidates graduate from the 1,400 colleges and universities offering traditional teacher prep programs nationwide, having enrolled in a least one ed psych or methods course, usually both.[62] Most candidates will have to buy at least one textbook that addresses instruction for each of those courses, spending in the range of $170 – $225. Purchases total upwards of $40 million for textbooks that purport to impart reliable information on how to teach so that students learn and remember.[63]

Are these teacher candidates getting what they need? Our study says they are not.

Why are the fundamental instructional strategies ignored in the textbooks that largely set the instructional and coursework agenda at teacher prep programs nationally? We propose two complementary hypotheses.

Teacher education tolerates small-scale studies, often based on description and case histories, rather than endorsing only studies where the design produces reliable findings. A 2010 editorial in the Journal of Teacher Education said:

> *This more qualitative, individualized inquiry tradition in research on teaching and teacher education also had several important effects.... [I]t encouraged teacher educators to establish a distinct research identity that differed from that of their academic colleagues in the hard science by not adhering to the same rules and processes of "scientifically based" knowledge production.*[64]

This all-too-accommodating definition of research in this field has limited the creation of real knowledge. Moreover, because this acceptance of failure to follow basic scientific principles has been long accepted, publishers do not, and need not, vet textbooks to ensure that only findings from well-conducted studies are presented.

Perhaps nowhere is this clearer than in the case of these fundamental instructional strategies. One would expect that required textbooks would not just address and cite, but also emphatically focus on, findings from studies that meet the high standards established by the IES. In fact, however, there is almost no overlap in studies cited in the IES practice guide and what appears in the textbook sample.[65]

If we expect teachers to succeed in the classroom, both teacher educators and aspiring teachers are entitled to real knowledge and information that is supported by the science of learning. They deserve to know that publishers are requiring their authors to separate reliable from specious education research.

A second hypothesis for the vacuum is that educators are encouraged to practice and preach their own preferred instructional approaches, foregoing any universal training imperatives. Seeing no consensus about what constitutes effective instruction, teacher candidates themselves are then encouraged in their assignments to develop their own personal approaches to teaching. The result is that candidates demonstrate knowledge that is often self-defined and situational.[66] Therefore, although teacher educators overseeing these efforts and the candidates themselves may pour considerable time and energy into training, it is to little effect.

If, on the other hand, teacher educators incorporated techniques and strategies supported by seminal studies into the instruction and practice assignments that are the linchpins of teacher preparation, the task of preparing candidates would be much more exacting and considerably more rigorous. (The extent to which practice is likely needed is illustrated by the study discussed on p. 16.)

The knowledge that today's teachers need is exploding. The fundamental instructional strategies discussed in this report are imperative for their training because they are the foundation for successful learning. Textbook publishers and authors, and teacher educators, bear the important responsibility for ensuring that aspiring teachers have what they need — but this is a responsibility they are simply not fulfilling.

Endnotes

1 This estimate takes into account annual teacher production as reported by the US Department of Education; the average number and cost of textbooks required in educational psychology, general methods and subject-specific methods courses in the sample; and the National Association of College Stores' findings on the proportion of sales represented by used textbooks (30 percent) and the price of used textbooks relative to new ones (75 percent). See p. 29 for more discussion.

2 Pashler, H. et al. (2007). *Organizing instruction and study to improve student learning: IES practice guide*. Washington, DC: National Center for Education Research. See p. 13 for more on the criteria used by IES to sift through research studies and select those that have produced strong evidence about student learning.

3 The guide lists nine strategies in all, with six identified as having "strong" or "moderate" support. The three other strategies identified in the guide as having lower levels of evidence are not discussed in this report.

4 Researchers associated with the National Research and Development Center on Cognition and Mathematics Instruction are field-testing ways to incorporate **pairing graphics with words**, **repeatedly alternating solved and unsolved problems**, and **distributing practice** into the popular *Connected Mathematics* middle school textbook series; initial results suggest positive effects on student learning. See Sparks, S. (2015, May 6). Researchers target ways to design better mathematics text materials. *Education Week*.

5 Appendix G describes the studies cited by the IES and additional on-point studies that have been published subsequent to the publication of the IES guide.

6 *Science of Learning*. (2015). Austin, TX: Deans for Impact.

7 Carpenter, S. K., Pashler, H., & Cepeda, N. J. (2009). Using tests to enhance 8th grade students' retention of US history facts. *Applied Cognitive Psychology, 23*(6), 760-771.

8 Trafton, J.G., & Reiser, B.J. (1993). The contributions of studying examples and solving problems to skill acquisition. In M. Polson (Ed.), *Proceedings of the 15th Annual Conference of the Cognitive Science Society* (pp. 1017-1022). Hillsdale, NJ: Erlbaum.

9 Based on a sample of 42 educational psychology, general methods and subject-specific methods courses whose instructors assigned texts.

10 Nineteen educational psychology and general methods courses in the sample do not use any textbooks focused on instruction. It appears that all of these courses require some other kind of reading instead. In some cases it was difficult to ascertain the nature of the reading assignments, but we examined eight courses for which the readings could be identified and found that coverage of the six fundamental strategies in the readings for those classes was similar to coverage in texts. A similar analysis of supplementary readings assigned in courses with textbooks found only one instance in which the readings introduce a fundamental instructional strategy that is not also covered in the textbook.

11 Not all of the textbooks required in the coursework in the sample were selected for analysis in this study. The title, table of contents, and other elements of the books were examined to see if they included sections on how to design instruction to maximize learning. *Educational Psychology* and *Models of Teaching* made the cut, while *The Things They Carried* did not, although it was required reading in a social studies methods course. In addition, if the text addressed multiple topics (for example classroom management as well as instruction), we confirmed that the sections relevant to instruction were assigned.

12 The 48 programs in the sample were randomly selected from approximately 490 institutions for which NCTQ had obtained full sets of syllabi for professional coursework and student teaching. The sample is generally representative of the national population of traditional teacher preparation programs, except that the proportion of public IHEs is greater than the national average because only public IHEs are obligated to comply with NCTQ's open records requests for data.

13 The sample of texts comprises 9 educational psychology, 24 general methods, and 15 secondary subject-specific methods textbooks. Although it is difficult to ascertain sales figures for instructional methods textbooks, the textbook sample includes three of the top five most purchased ed psych textbooks on Amazon.com: Santrock's *Educational Psychology*, Slavin's *Educational Psychology* and Woolfolk's *Educational Psychology*. Courses of three types were included in analysis because they are the most strongly focused on instructional techniques: 1) educational psychology, 2) general methods, and 3) methods specific to teaching in the four core subjects (English/language arts, math, science, history/social studies). Course titles, descriptions, class topics, and assigned readings were considered when judging course relevance. Because teacher candidates should learn that the fundamental instructional strategies are applicable to all the subjects they will teach, we examined single-subject methods courses in elementary programs with a careful eye to discern how strategies were presented; because they were not presented in a manner that suggested universal applicability, in only seven courses of 85 was credit provided for any relevant preparation, and in most cases this was because the program required all courses to use the same lesson-planning

template. However, because secondary teachers will only teach a single subject and the suggestion of universal applicability has fewer pragmatic implications, we reviewed coursework and relevant textbooks assigned in secondary subject-specific methods courses regardless of the context in which they were introduced. What examination we did of textbooks unique to elementary subject-specific coursework provided no indication that their coverage of the fundamental instructional strategies would differ from coverage of the strategies in secondary subject-specific methods textbooks, either in terms of coverage of the strategies or of their presentation of the strategies as universally applicable, so they were not evaluated. Appendix B lists the programs evaluated in this report, and Appendix E provides more detail on program and coursework selection procedures and rationales.

14 More information on the methodology of textbook evaluation can be found in the textbox on p. 9 and in Appendix C.

15 Only text that directly and accurately (even if cryptically) addresses the strategies was counted; a sentence that describes the "dual coding theory" would be noted as a potential mention of **pairing graphics with words**, but a sentence that indicates that visuals help students to learn but that does not specify the types of visuals that are most effective would not. For example, Bohlin, Durwin and Reese-Weber's *EdPsych/modules* encourages teachers to "Provide visual aids such as photos, graphs, concept maps, and charts" (p. 198); these and other similar statements suggesting that photos are as effective as concept maps do not accurately describe the strategy and would not be included in the count of mentions or coverage.

16 Guillaume, A. M. (2008). *K-12 classroom teaching: A primer for new professionals* (3rd ed.). Upper Saddle River, NJ: Pearson.

17 Ormrod, J. E. (2011). *Educational psychology: Developing learners* (7th ed.). Columbus, OH: Merrill/Prentice Hall.

18 Mayer, R. E. (2011). *Applying the science of learning*. Boston: Pearson/Allyn & Bacon.

19 Gunter, M. A., Estes, T. H., Mintz, S. L. (2007). *Instruction: A models approach* (5th ed.). Needham Heights, MA: Allyn & Bacon.

20 See page 281 in Cole, P. B. (2009). *Young adult literature in the 21st century*. New York, NY: McGraw-Hill.

21 Freiberg, H. J., & Driscoll, A. (2005). *Universal teaching strategies* (4th ed.). Boston, MA: Allyn & Bacon.

22 Although the idea of teaching to individual students' learning styles is extremely popular, there is no evidence that it is effective. Among other problems with the use of learning styles, it is hard to identify each student's style since styles are difficult to assess and students themselves can't reliably self-label. See Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2009). Learning styles: Concepts and evidence. *Psychological Science in the Public Interest*, 9(3), 105-119. More discussion of the strategy of accommodating students' learning styles is found on p. 17.

23 See p. 292 in Kellough, R. D., & Kellough, N. G. (2011). *Secondary school teaching: A guide to methods and resources* (4th ed.). Boston, MA: Allyn & Bacon.

24 The topic of assessment is addressed at length in many textbooks. What is not addressed is the role that assessment can play in learning. Instead, textbooks address the use of assessment to inform teachers on how to plan instruction to address students' learning needs (formative assessment) and to determine what students have learned (summative assessment).

25 The test effect, although missing entirely from nearly all of the texts we examined, receives attention in the popular press, most recently in Emanuel, E. Tests Make Kids Smarter. Let's Give Them More. *New Republic, September 24, 2013* and Lahey, J. Students Should Be Tested More, Not Less. *The Atlantic*, January 21, 2014.

26 P. 206 of Slavin, R. E. (2009). *Educational psychology: Theory and practice* (9th ed.) Boston, MA: Allyn & Bacon.

27 P. 336 of Kellough, R.D., & Carjuzaa, J. (2008). *Teaching in the middle and secondary schools* (9th ed.). Upper Saddle River: Pearson.

28 For example, for a critique of study techniques commonly addressed in textbooks (such as summarizing and forming mental images), see Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving students' learning with effective learning techniques promising directions from cognitive and educational psychology. *Psychological Science in the Public Interest, 14*(1), 4-58.

29 Shalaway, L. (2005). *Learning to teach…not just for beginners*. The Essential Guide for all Teachers. NY: Scholastic.

30 Freiberg, H. J., & Driscoll, A. (2005). *Universal teaching strategies* (4th ed.). Boston, MA: Allyn & Bacon.

31 Also on p. 270: "The timing of reviews is critical. Intermittent reviews throughout a unit are more effective than a long summarizing review."

32 Moore, K. D. (2012) *Effective Instructional Strategies* (3rd ed.), Washington, DC: Sage Publishing.

33 Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2009). Learning styles: Concepts and evidence. *Psychological Science in the Public Interest, 9*(3), 105-119.

34 We grouped slightly different versions of studies under one study title while looking for shared citations among textbooks and

the IES practice guide, and also accounted for the fact that some textbooks were published before some of the studies cited in the IES practice guide. See Appendix J for more detailed information.

35 Although the IES practice guide includes only a sample of studies that could be cited to support the fundamental instructional strategies, there is no evidence that textbooks are relying on equally credible alternate research supporting the same strategies.

36 For example, in 2008 the American Heart Association updated its 1997 guidelines for doctors and dentists on how to prevent infective endocarditis in patients undergoing dental or gastrointestinal tract procedures. In posting the guidelines, the association noted that they reflected new research data (http://circ.ahajournals.org/content/116/15/1736.full).

37 The sample included 58 references used to support recommendations about instruction, selected because they were cited in two or more of the four ed psych and general methods texts assigned most often by the programs in the sample.

38 Another study also finds that approximately two-thirds of citations in educational psychology and methods textbooks are to secondary sources. Sylvester Dacy, B. J., Nihalani, P. K., Cestone, C. M., & Robinson, D. H. (2011). (Lack of) support for prescriptive statements in teacher education textbooks. *The Journal of Educational Research, 104*(1), 1-6.

39 Marzano, R. J., Pickering, D. J., & Pollock, J. E. (2001). *Classroom instruction that works: Research-based strategies for increasing student achievement*. Upper Saddle River, NJ: Pearson.

40 The most recent textbook in the sample was published in 2012.

41 To be deemed to "prepare" candidates on a strategy, programs had to expose candidates to the strategy at least once in a class lecture/discussion, AND require candidates to practice the strategy at least once during class time or student teaching. Tests were counted as practice opportunities because they require candidates to demonstrate their knowledge; tests accounted for a large fraction of practice opportunities deemed to address the fundamental strategies. For more information on the methodology used for program evaluation, see Appendix E. Program-specific ratings are not supplied in this report, but will be provided to programs in the sample.

42 However, this figure on preparation represents an upper bound since a considerable share of the credit for preparing candidates in this strategy is based on instruction that may be addressing another topic related to questioning: how to use questions to stimulate classroom interaction rather than how to use questions to deepen understanding.

43 Also notable is the fact that even when textbooks are not assigned, substituted readings address the same topics as textbooks – and also omit the six fundamental instructional strategies.

44 Ding, M., & Carlson, M.A. Elementary teachers' learning to construct high-quality mathematics lesson plans: A use of the IES recommendations. *Elementary School Journal* 113.3 (2013): 359-385. The strategies addressed were **linking abstract concepts with concrete representations**, **posing probing questions**, and **repeatedly alternating solved and unsolved problems**.

45 When asked to construct a lesson plan that included "probing questions," 71 percent of the teachers in this study turned in a lesson plan with shortcomings. More than half of the teachers submitted a lesson plan that did not contain sufficient discussion of "solved problems" as they tried to implement the strategy of **repeatedly alternating solved and unsolved problems**. When **linking abstract concepts with concrete representations** in addition and subtraction problems, most teachers' lesson plans used stories to convey concrete representations (for example, a story about elevators) that they did not then connect to abstract problem representations (equations).

46 Our analysis of practice opportunities during student teaching focused on lesson planning requirements and evaluation forms used to give feedback on observations. The indicators on these documents convey the essential skills that programs believe teacher candidates should demonstrate at the conclusion of preparation.

47 The percentage of programs in which candidates are introduced to **posing probing questions** during class time and given an assignment related to the strategy as part of their coursework is exactly the same as the percentage of textbooks that cover the strategy. However, the percentage of programs counted as preparing candidates in the strategy is larger, because credit is also given to programs in which candidates practice the strategy during student teaching, instead of as part of coursework. This accounts for what may appear to be data discrepancies in Figures 4 and 5.

48 As described in Mayer, R. E. (2009). *Multimedia learning* (2nd ed). New York: Cambridge University Press and Mayer, R. E. (Ed.). (2014). *The Cambridge handbook of multimedia learning* (2nd ed). New York: Cambridge University Press, not all graphics are equally effective. For example, illustrations that organize the material (such as a matrix diagram or a labeled map) and illustrations that explain the material (such as a flow chart or a series of frames) are more effective than illustrations that decorate the page or simply show one object. Also, it is best to place the printed words next to the part of the graphic they describe, to exclude unneeded detail in the graphics, and to break complicated graphics into manageable parts.

49 The most efficacious intervals for review and practice are discussed in Dunlosky, J. *et al*.

50 Types of questions that require students to recall information on their own include short-answer questions, fill-in-the-blank

questions (if potential answers are *not* provided), essay questions, etc. These questions can be used as part of a formal test or informally – for example, in a game-show-style review. Multiple choice tests can also be effective if they are properly designed to avoid prompting student recognition of correct answers and instead require active recall of information.

51 Joshi, M.R., Binks, E., Graham, L., Ocker-Dean, E., Smith, D.L., Boulware-Gooden, R., Do Textbooks Used in University Reading Education Courses Conform to the Instructional Recommendations of the National Reading Panel? *Journal of Learning Disabilities, 42*(5), 458-463.

52 Sylvester Dacy, B. J. *et al*.

53 Dunlosky, J. *et al*.

54 Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*, New York, NY: Routledge.

55 Willingham, D. (2010). *Why don't students like school: A cognitive scientist answers questions about how the mind works and what it means for the classroom*. San Francisco, CA: Jossey-Bass.

56 The information processing model is most likely to be explained in ed psych courses, and only 60 percent of programs in the sample require such a course. The result is that only 65 percent of programs appear to present the cognitive science behind the fundamental instructional strategies by introducing candidates to the information processing model. Without this foundation, candidates will have difficulty appropriately integrating the fundamental instructional strategies into their lessons. For example, teachers who do not understand the nature of recall and the role it plays in retention of information will be less likely to choose questions for their assessments that provide opportunities for active recall.

57 Mayer, R. E. (2011). *Applying the science of learning*. Boston: Pearson/Allyn & Bacon. This book is available for $46–$55. See p. 7 for more on this textbook. Dr. Mayer is a signer on the report's Letter of Support.

58 About half of the states require pencil-and-paper tests created by the Educational Testing Service (ETS), with the other half using myriad other tests, most obtained from the Pearson National Evaluation Series (NES), but some developed in-house by state agencies. Because the ETS tests are used most frequently, our examination focused on three different ETS "Learning and Teaching" pencil-and-paper tests for teachers in three grade spans (K-6, 5-9 and 7-12). The edTPA is at the forefront of several performance assessments. More information on the edTPA (available from Pearson) can be found at http://www.edtpa.com. (A Praxis Performance Assessment for Teachers [PPAT] is available but not in wide use. Another teacher performance assessment, the National Observational Teaching Exam or NOTES, will not be available until spring 2016. See http://www.ets.org/note/about.

59 Study Companions that outline the contents of these tests can be found at https://www.ets.org/praxis/prepare/materials.

60 Indicators on the subject-specific pedagogy rubrics for both elementary and secondary math address "using representations," but only in a general way and not with specific reference to either **pairing graphics with words** or **linking abstract concepts with concrete representations**. Guidance to scorers posted by teacher prep programs does not align the indicators with the strategies. In fact, scoring guidance may muddle even the alignment of the rubric to the strategy of **posing probing questions** by introducing the suggestion that the scorer give high marks for elementary candidates' questions about students' personal experiences. For example, see p. 9 and p. 12 of https://www.uww.edu/Documents/colleges/coeps/academics/MTH Eval Rubric completed_Feb 2013.pdf and p. 11 and p. 15 of http://www.uww.edu/Documents/colleges/coeps/academics/Elementary Eval Rubric completed Feb 2013.pdf

61 Although each strategy may not be evident in a performance assessment's teaching episodes, the assessment of candidates can require that all strategies be addressed in planning documents.

62 U.S. Department of Education: *Preparing and Credentialing the Nation's Teachers: The Secretary's Ninth Report on Teacher Quality 2013*, p 13. Available at https://title2.ed.gov/Public/Home.aspx

63 See note 1 for more information.

64 Lin, E., Wang, J., Kleck, C. L., Odell, S. J., & Spalding, E. Judging Research in Teacher Education. *Journal of Teacher Education, 61*(4), 295-301.

65 The failings of textbooks are not unique to research on how students learn and retain information. Since 2006, NCTQ has documented in reviews by experts that less than 10 percent of nearly 1,000 early reading textbooks are based on scientific evidence about how to teach reading.

66 More information about assignments and their general lack of rigor is provided in Appendix K. As discussed in an earlier report (*Easy A's and What's Behind Them*, accessible at http://www.nctq.org/dmsStage/EasyAs), teacher preparation assignments should be "criterion-referenced," meaning that they are anchored in specific content and skills. Appendix K illustrates how to create anchored assignments that include use of the fundamental instructional strategies.

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