Spider
Learning, Inc.

At Spider Learning, we are passionate in our commitment to putting kids first. Our innovative and continuously improving digital curriculum empowers all students and teachers to make personalized learning decisions.

Research support related to metacognitive prompts, strategic thinking, post lesson restatement of learning objectives and self-assessment:

Local research opportunities conducted with other clients have demonstrated the need to have a summary at the end of each lesson which reminds students of the learning objective. This has been shown to be directly proportional to their chronological age. Generally we know that as students get older their ability to retain, reflect and understand the original purpose of their study improves and their related feeling-of-knowing (FOK) what they are studying improves. At elementary and middle school levels students need post learning reminders as their FOK is often misdirected or completely inaccurate:

> "Hart found that **feeling-of-knowing** judgments were relatively accurate indicators of what is or is not stored in memory for the undergraduate students. **However, similar investigations using young children (e.g., Wellman, 1977) have shown that feeling-of-knowing judgments are much less accurate.** ...overall, studies examining FOK have shown a developmental pattern: With increasing age, knowledge about what is or is not stored in memory becomes increasingly accurate."

Excerpt above from: Hacker, Douglas J.,Dunlosky, John.,Graesser, Arthur C. "Metacognition in Educational Theory and Practice." Taylor & Francis Ltd. iBooks.

> "metacognitive research includes studies that have examined ways in which metacognitive theory can be applied to education. Broadly defined, these studies have focused on a fundamental question, **Can instruction of metacognitive processes facilitate learning? The researchers who have contributed to the present volume, along with many other researchers and educational practitioners, have responded to this question with a resounding "yes."** This volume contains many examples of the ways in which researchers have answered this question in specific educationally relevant domains: Davidson and Sternberg have provided answers in the domain of general problem solving; Dominowski in the domain of verbalization of cognitive processes; Vye, Schwartz, Bransford, Barron, Zech, and The Cognition and Technology Group at Vanderbilt in the domain of science; Carr and Biddlecomb in the domain of mathematics; Sitko in the domain of writing; both Otero and Hacker in the domain of reading; García, Jiménez, and Pearson in the domain of bilingual education; Maki in the domain of test prediction; Winne and Hadwin in the domain of studying;

> Pressley, Van Etten, Yokio, Freebern, and Van Meter in the domain of academic coping; McGlynn in the domain of rehabilitation; and Dunlosky and Hertzog in the domain of aging and problem[…]"

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The use of the metacognitive prompts and a reminder to reflect both, on learning strategies and the purpose of the lesson, become significantly more important with the lack of qualified instructors. We need consistent components within the lesson to ensure students have time to reflect and process what has been studied within each foundational lesson.

> "to enhance learning to the fullest, learners need to become aware of themselves as self-regulatory organisms who can consciously and deliberately achieve specific goals (Kluwe, 1982). In general, metacognitive theory focuses on (a) the role of awareness and executive management of one's thinking, (b) individual differences in self-appraisal and management of cognitive development and learning, (c) knowledge and executive abilities that develop through experience, and (d) constructive and strategic thinking (Paris & Winograd, 1990). **Thus, the promise of metacognitive theory is that it focuses precisely on those characteristics of thinking that can contribute to students' awareness and understanding of being self-regulatory organisms, that is, of being agents of their own thinking."**

Excerpt above from: Hacker, Douglas J.,Dunlosky, John.,Graesser, Arthur C. "Metacognition in Educational Theory and Practice." Taylor & Francis Ltd. iBooks.

Research supporting the use of Bloom/Webb cognitive rigor pedagogy to structure the lesson flow:

> A mainstay for over 50 years, Bloom's Taxonomy helps teachers formulate lessons that practice and develop thinking skills over a wide range of cognitive complexity. (Bloom, 1956) Although later revised by a team of education researchers headed by Anderson and Krathwohl (2001), the overall intent of the taxonomy remains: Categorize questions and activities according to their levels of abstraction. However, Bloom's Taxonomy suffers limitations when selecting test items and formulating questioning strategies because it uses verbs to differentiate taxonomy levels — many verbs appear at multiple levels and do not clearly articulate the intended complexity implied by the taxonomy. A new model of rigor, depth of knowledge (DOK), fills this void. The resulting combination of Bloom's Taxonomy and depth of knowledge — cognitive rigor — forms a comprehensive structure for defining rigor, thus posing a wide range of uses at all levels of curriculum development and delivery.

Revised Bloom's Taxonomy levels	Webb's Depth-of-Knowledge Levels Level 1 Recall and Reproduction	Level 2 Skills and Concepts	Level 3 Strategic Thinking/ Reasoning	Level 4 Extended Thinking
Remember Retrieve knowledge from long-term memory, recognize, recall, locate, identify	Recall, recognize, locate basic facts, ideas, principles Recall or identify conversions: between units of measure Identify facts/details in texts			
Understand Construct meaning, clarify, paraphrase, represent, translate, illustrate, give examples, classify, categorize, summarize, generalize, infer a logical conclusion, predict, compare/contrast, match like ideas, explain, construct models	Compose/decompose numbers Evaluate an expression Locate points on a grid Symbolize math relationships Write simple sentences Describe/explain how or why	Specify and explain relationships Give non-examples/examples Make and record observations Summarize results, concepts, ideas Infer or predict from data or texts Identify main ideas	Explain, generalize, or connect ideas using supporting evidence Explain phenomena in terms of concepts Write full composition to meet specific purpose Identify themes	Explain how concepts or ideas specifically relate to other content domains or concepts Develop generalizations of the results obtained or strategies used and apply them to new problem situations
Apply Carry out or use a procedure in a given situation; carry out (apply to a familiar task), or use (apply) to an unfamiliar task	Follow simple/routine procedures Solve a one-step problem Calculate, measure, apply a rule Apply an algorithm or formula Represent in words or diagrams a concept or relationship Apply rules or use resources to edit spelling and grammar	Select a procedure according to task needed and perform it Solve routine problem applying multiple concepts or decision points Retrieve information from a graph and use it solve a multi-step problem Use models to represent concepts Write paragraph using appropriate organization, text structure	Use concepts to solve non-routine problems Design investigation for a specific purpose or research question Conduct a designed investigation Use reasoning, planning, and evidence Revise final draft for meaning or progression of ideas	Select or devise an approach among many alternatives to solve a novel problem Conduct a project that specifies a problem, identifies solution paths, solves the problem, and reports results Illustrate how multiple themes (historical, geographic, social) may be interrelated
Analyze Break into constituent parts, determine how parts relate, differentiate between relevant-irrelevant, distinguish, focus, select, organize, outline, find coherence, deconstruct (e.g., for bias or point of view)	Retrieve information from a table or graph to answer a question Identify or locate specific information contained in maps, charts, tables, graphs, or diagrams	Categorize, classify materials Compare/ contrast figures or data Select appropriate display data Extend a pattern Identify use of literary devices Identify text structure of paragraph	Compare information within or across data sets or texts Analyze and draw conclusions Generalize a pattern Organize/interpret data Analyze author's craft or viewpoint	Analyze multiple sources of evidence or multiple works by the same author, or across genres Analyze complex/abstract themes Gather, analyze, and organize information Analyze discourse styles
Evaluate Make judgments based on criteria, check, detect inconsistencies or fallacies, judge, critique			Cite evidence and develop a logical argument for concepts Describe, compare, and contrast solution methods Verify reasonableness of results Justify conclusions made	Gather, analyze, and evaluate relevancy and accuracy Draw and justify conclusions Apply understanding in a novel way, provide argument or justification for the application
Create Reorganize elements into new patterns/structures, generate, hypothesize, design, plan, construct, produce	Brainstorm ideas, concepts, or perspectives related to a topic or concept	Generate conjectures or hypotheses based on observations or prior knowledge	Synthesize information within one source or text Formulate an original problem Develop a complex model for a given situation	Synthesize information across multiple sources or texts Design a model to inform and solve a real-world, complex, or abstract situations

Students learn skills and acquire knowledge more readily when they can transfer their learning to new or more complex situations, a process more likely to occur once they have developed a deep understanding of content (National Research Council, 2001). Therefore, ensuring that a curriculum aligns to standards alone will not prepare students for the challenges of the twenty-first century. Teachers must therefore provide all students with challenging tasks and demanding goals, structure learning so that students can reach high goals, and enhance both surface and deep learning of content (Hattie, 2002).

Excerpt above from: "Cognitive Rigor: Blending the Strengths of Bloom's Taxonomy and Webb's Depth of Knowledge to Enhance Classroom-level Processes" found here in its entirety.

Research to support the use of frequent formative assessment in the lesson model:(TEQ results/data being utilized to formulate and drive learning opportunities for individual students)

Study findings reinforce the power of formative assessment, or at least one important element of it: Students whose teachers spend more time and who more frequently engage in analyzing and providing feedback on student work achieve higher learning than students whose teachers spend less time and who less frequently do so. Teachers' attention to student learning as evidenced in classroom work—whether through observations of students in classroom discussions or analyses of student responses in science notebooks, other written responses, or end-of-investigation assessments—is associated with higher student performance.

The strength of this relationship is striking in light of the weaknesses in teachers' initial content-pedagogical knowledge, as documented in pre-test scores for this study. It seems obvious that sound formative assessment practice requires adequate content-pedagogical knowledge. In other words, it is hard to imagine how teachers with weak knowledge of subject matter content and of the nature of students' progression through the content can appropriately analyze student work, or make appropriate decisions for next steps. Path analysis results from this study weakly support this supposition, as *teachers' content knowledge showed an indirect relationship with student learning through teachers' use of assessment.*

Excerpt above from: "Relationships between Teacher Knowledge, Assessment Practice, and Learning--Chicken, Egg, or Omelet?" found here in its entirety.

Research to support the use of technology-enhanced items throughout the lesson:

TEIs offer many potential benefits over SR (selected-response) items. The most significant is that TEIs have the potential to provide improved measurement of certain constructs, specifically high-level constructs, because they require students to produce information, rather than simply select information, which is often a more authentic form of measurement (Archbald & Newmann, 1988; Bennett, 1999; Harlen & Crick, 2003; Huff & Sireci, 2001; Jodoin, 2003; McFarlane, Williams, & Bonnett, 2000; Sireci & Zenisky, 2006; Zenisky & Sireci, 2002). A second benefit is that TEIs reduce the effects of test-taking skills and random guessing (Huff & Sireci, 2001). A third benefit is that TEIs have the potential to provide richer diagnostic information by recording not only the student's final response but also the interaction and thought process that lead to that response (Birenbaum & Tatsuoka, 1987). CR items have always offered these benefits, but TEIs allow these benefits to be leveraged on items administered via computer that can be automatically and instantly scored. A fourth potential benefit of TEIs is a possible reduction of cognitive load from non-relevant constructs, such as the reading load for items designed to measure mathematics or science, and the cognitive load required to keep various item constructs in memory (Mayer & Moreno, 2003). Finally, TEIs tend to be more engaging to students, an important consideration in an era when students frequently feel over-tested (Strain-Seymour, Way, & Dolan, 2009; Dolan, Goodman, Strain-Seymour, Adams, & Sethuraman, 2011).

More recently, a group of researchers explored SR (selected-response), CR (constructed-response), and TE (technology-enhanced) items in the context of seventh grade mathematics and Algebra I. The CR/TE test was reviewed by experts and found to be similar to the SR test in terms of measuring the intent of the standards and the depth of knowledge. The CR/TE test was found to be significantly more reliable and to provide more information than the SR test (Winter, Wood, Lottridge, Hughes, & Walker, 2012). “These results indicate that tests incorporating CR/TE items can measure some mathematics content with less error than tests comprising only [SR] items (ibid, p. 53).”

Excerpt above from “Conducting Research on Technology-Enhanced Assessment: Lessons Learned from the Field” found here in its entirety.

When students are learning online, there are multiple opportunities to exploit the power of technology for formative assessment. The same technology that supports learning activities gathers data in the course of learning that can be used for assessment. … An online system can collect much more and much more detailed information about how students are learning than manual methods. As students work, the system can capture their inputs and collect evidence of their problem-solving sequences, knowledge, and strategy use, as reflected by the information each student selects or inputs, the number of attempts the student makes, the number of hints and feedback given, and the time allocation across parts of the problem. (U.S. Department of Education 2010a, p. 30)

These online or adaptive learning systems will be able to exploit detailed learner activity data not only to recommend what the next learning activity for a particular student should be, but also to predict how that student will perform with future learning content, including high-stakes examinations. Data-rich systems will be able to provide informative and actionable feedback to the learner, to the instructor, and to administrators. These learning systems also will provide software developers with feedback that is tremendously helpful in rapidly refining and improving their products. Finally, researchers will be able to use data from experimentation with adaptive learning systems to test and improve theories of teaching and learning.

Excerpts above from “Enhancing Teaching and Learning Through Educational Data Mining and Learning Analytics: An Issue Brief” found here in its entirety.

Research supporting the use of short instructional sessions and guided practice followed by a check for understanding:

One strategy that greatly facilitates reteaching is to present the content in small increments; I call this approach chunking. For example, a teacher presenting new content about the human skeletal system might present a few selected characteristics and then allow students time to process this new information by having them ask questions or summarize what it means. He or she would then present a few more characteristics, and so on. After exposing students to each small chunk of information, the teacher can ask students to rate their confidence in their understanding or ask them questions to verify their understanding. If confusion, errors, or misconceptions surface, the teacher would immediately re-address the content. In many cases, reteaching might simply involve providing alternative examples or explanations.

For example, Rosenshine (2002) notes the following: The most effective teachers presented only small amounts of material at a time. After this short presenting, these teachers then guided student practice . . . guided practice is the place where students—working alone, with other students, or with the teacher—engage in the cognitive processing activities of organizing, reviewing, rehearsing, summarizing, comparing, and contrasting. However, it is important that all students engage in these activities. (p. 7)

Figure 3.1. Research Results for Practice

Synthesis Study	Focus	Number of Effect Sizes	Average Effect Size	Percentile Gain
Bloom, 1976[a]	General effects of practice	13 8	0.93 1.47	32 42
Feltz & Landers, 1983	Mental practice on motor skills	60	0.48	18
Ross, 1988	General effects of practice	12	1.26	40
Kumar, 1991[b]	General effects of practice	5	1.58	44

[a]Multiple effect sizes are listed because of the manner in which effect sizes are reported. Readers should consult that study for more details.

[b]This study used student engagement as the dependent measure.

Excerpt above from “The Art and Science of Teaching”, by Robert J. Marzano and found here.