

Literature Review for the Five High-Leverage Instructional Principles

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Purpose

The purpose of this literature review on the *Five High-Leverage Instructional Principles* is to explicate the foundational theories and research from which the principles are abstracted. The literature that this review draws from encompasses the areas of education and psychology, cognition and development, learning theory, metacognition, motivation, and formative assessment.

The Five High-Leverage Instructional Principles are:

1. New Learning is Connected to Prior Learning and Experience
2. Learning Tasks have High Cognitive Demand for Diverse Learners
3. Students Engage in Meaning-Making through Discourse and Other Strategies
4. Students Engage in Metacognitive Activity to Increase Understanding of and Responsibility for Their Own Learning
5. Assessment is Integrated into Instruction

The *Five High-Leverage Instructional Principles* is an interwoven set of high-leverage principles. While the principles are treated separately in this review, there is considerable overlap in the literature among the principles.

The five principles are intended to reflect the practice of effective teaching in the classroom. They are not intended to act as curriculum or standards. However, the principles are not enacted in a vacuum, but rather, they are interwoven and interact with curriculum and standards in teachers' classroom practice.

All cited literature in the document are included in the References, and Appendix A contains summaries of cited studies, research syntheses, and theoretical papers.

Methods

The literature search for the *Five High-Leverage Instructional Principles* was conducted using an iterative and concurrent multi-step method. To inform what the critical research for each area was (e.g., learning theory, motivation, formative assessment), seminal studies, theories, and the work of experts in the field were consulted. Next, literature reviews (e.g., from peer-reviewed journals such as *Review of Educational Research*) and meta-analysis studies were selected for their extensive breadth and number of studies included in such articles. Also included in the literature review search were studies that referenced seminal studies. That is, a search of studies that referenced a particular article—for example, Ames' (1985) article on classroom goals

and motivation was performed. This was done in order to take into account more recent studies based on seminal works. In addition, a snowball method was employed in which references in previously collected articles were reviewed for additional works. Searches of empirical studies were conducted using computerized databases, mainly Educational Information Center (ERIC) and PsychINFO, using key terms such as metacognition, prior knowledge, cognitive demand, diverse learners, integrated and formative assessment, student engagement, motivation, and discourse. The articles and books that resulted from the literature review search provided the theoretical and practical bases for the *Five High-Leverage Instructional Principles*.

Principle 1

New Learning is Connected to Prior Learning and Experience

Prior knowledge is a critical variable in learning (Dochy, Segers, & Buehl, 1999; Shapiro, 2004), and its influence on learning is well documented in the research literature. In particular, research in cognition has shown that what learners know and the extent to which their prior knowledge is activated during new learning has important implications for whether new information will make sense to them.

In their classic study, Bransford and Johnson (1972) found that prior knowledge was an important factor in both learning and memory. Researchers presented all study participants with cryptic text; some participants were given appropriate information before they heard passages, while others were given the same information after hearing the passages. Comprehension scores were significantly higher for participants who received information prior to listening to the passage. The authors concluded that prior knowledge itself does not guarantee its usefulness for comprehension unless it is activated in an appropriate context prior to the presentation of new knowledge.

Numerous studies have supported Bransford and Johnson's findings, especially in the area of text comprehension in various subject areas (e.g., Chiang & Dunkel, 1992; Clifton & Slowiaczek, 1981; Dochy et al., 1999; Johnston & Pearson, 1982; Matthews, 1982; McKeown, Beck, Sinatra, & Loxterman, 1992; McNamara, Kintsch, Songer, & Kintsch, 1996; Siegler, 1983; Siegler & Klahr, 1982; Willoughby, Waller, Wood, & MacKinnon, 1993).

Schema Theory

Schema theory is strongly represented in the prior knowledge literature. The term *schema* (plural *schemata*) was first used in 1926 by Piaget, who viewed schemata as the building blocks of thinking that included both a category of knowledge and a process for acquiring the knowledge (Woolfolk, 1987). Piaget theorized that when knowledge is acquired, schemata adapt to incorporate and organize the new learning. In a further elaboration, Jerome Bruner (1966) proposed a theoretical framework developed from research on cognition and child development. A major theme of his framework was that learners construct new concepts based on their current and prior knowledge. Learners select and transform information using existing cognitive structures *schemata* - that enable them to organize knowledge and experiences, and apply their knowledge to new situations. In further developments of schema theory, scholars have

identified qualitatively different phases of the learning process (Anderson, 1977; Rumelhart & Norman, 1978; 1982).

Still in the context of schema theory, research on novice-expert performance, and of what constitutes expertise in a subject area, have helped to define the characteristics of knowledge and thought at advanced stages of learning and practice (Chase & Simon, 1973; Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Chi, Feltovich, & Glaser, 1981; Chi, Glaser, & Rees, 1982; Chi & Roscoe, 2002; Chi, Slotta, & deLeeuw, 1994; Chi & VanLehn, 1991; Glaser, 1984; Ferrari & Chi, 1998; Larkin, McDermott, Simon, & Simon, 1980; Newell, 1990). This body of research shows that experts have extensive stores of knowledge and skills, but most importantly they have efficiently organized this knowledge into well-connected schemata (NRC, 2001). It is this “organization of knowledge that underlies experts’ abilities to understand and solve problems” (NRC, 2005, p. 15). For example, when confronted with a mathematics or physics problem, novice students will try to relate it to a memorized theorem or formula (Good & Brophy, 1990). In contrast, experts identify the problem as a particular instance of the application of general principles, and are able to activate existing schemata organized around those principles and abstractions (Glaser, 1984; Good & Brophy, 1990; NRC, 2001). For the expert, these aspects of knowledge – principles, abstractions and applications- are organized in tightly connected schemata (Glaser, 1984). In the same vein, Good and Brophy (1994) argued that knowledge should be viewed as being “composed of networks structured around key ideas” (p. 416).

Misconceptions and Differences in Prior Knowledge

Prior knowledge also includes the incorrect understandings a student may bring to new learning. Misconceptions in prior knowledge and their effects on learning have been well documented, especially in the area of science learning. Of particular note is students’ resistance to altering their views in light of new information when it is inconsistent with their prior knowledge, even when the new information provides a better, more accurate account of the phenomenon (e.g., Alvermann & Hague, 1989; Alvermann & Hynd, 1989; Hynd & Alvermann, 1989). Because inaccuracies, misconceptions, or naïve understandings in students’ prior knowledge can be detrimental to future learning if they are not identified and directly addressed (Chinn & Brewer, 1993; Cohen, 1981; Guzzetti, Snyder, Glass, & Gamas, 1993; Mestre, 1994; Perkins & Simmons, 1988; Wandersee, 1983), researchers have suggested instructional techniques to promote conceptual change. Some techniques involve explicitly addressing misconceptions so students recognize differences between new information and existing knowledge (Beimans & Simmons, 1994; Guzzetti et al., 1993; Spires,

Donley, & Penrose, 1990), or encouraging students to restructure knowledge and revise existing conceptions through the use of metacognitive and motivational factors, such as developing learning goals, self-efficacy, and control beliefs (Pintrich, Marx, & Boyle, 1993). In situations where students' prior knowledge is not engaged and preconceptions are not revealed, students often retain new information long enough to perform well on tests, and then revert back to their preconceptions, correct or not (NRC, 2000).

Prior knowledge also includes the knowledge that learners acquire outside of school settings, such as in their homes and communities. This type of prior knowledge develops as a result of learners' social roles, including their race/ethnicity, culture, gender, and class (Cazden, 2001; Gee, 1989; Lave, 1988; Rogoff, 1998). Prior knowledge learned from social roles can both support and conflict with students' learning in schools (Greenfield & Suzuki, 1998). For example, Heath (1983) found that everyday family habits can be ignored or reinforced in schools by teachers, which in turn, affects how students learn. To connect new learning with prior knowledge, teachers need to be able to take account of the social and cultural prior knowledge with which students enter schools.

Eliciting Prior Knowledge

Research has shown that different ways of eliciting prior knowledge results in students showing different types and levels of prior knowledge. Studies in different content areas have employed a variety of techniques to assess learners' prior knowledge, such as questioning, free recall, association and recognition tests, and multiple-choice tests (Chiang & Dunkel, 1992; Chiesi, Spilich, & Voss, 1979; Dochy, 1996; Dochy, Segers, & Buehl, 1999; Hasselhorn & Korkel, 1986; Lambiotte & Dansereau, 1992; Sanbonmatsu, Sansone, & Kardes, 1991). In their study, Valencia, Stallmand, Commeyras, Pearson, and Hartman (1991) used four different methods to assess student prior knowledge and found that different assessment methods revealed different amounts and types of information. They concluded that multiple modes, forms, and methods should be used to get a complete characterization of students' prior knowledge.

In summary, prior knowledge is a critical variable in learning. The National Research Council (NRC) commissioned the report, *How People Learn* (NRC, 2000), to examine and synthesize theoretical and empirical evidence of learning and cognition. A key finding of the report is that teachers must work with students' preexisting understandings in order for them to learn new information. According to theoretical

and empirical literature documented in this review, learners construct knowledge by connecting new concepts and information to prior knowledge. As Shuell (1986) states, “Learning is cumulative in nature; nothing is learned in isolation” (p. 416).

Principle 2

Learning Tasks Have High Cognitive Demand for Diverse Learners

Teachers support student learning through the provision of learning tasks. Not all tasks are created equal; different tasks require different levels of thinking. It is the level of thinking in which students engage that determines what they will learn (Lin, 2005). Principle 2 addresses the idea that learning tasks should engage all students in high levels of thinking. Specifically, tasks with “high cognitive demand” generally have the following characteristics:

- 1) They engage students in important subject-matter content and processes that support deep learning (cf. the Common Core State Standards (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010); NRC, 2000; *Next Generation Science Standards*, n.d.; Shepard, 2013);
- 2) They progressively develop important subject-matter content that builds increasingly to more sophisticated and more complex understanding of concepts, which are organized into schema (Glaser & Chi, 1998; NRC, 2005), or to the acquisition of more complex and sophisticated skills;
- 3) They support students to learn in and through their Zone of Proximal Development (ZPD) (Vygotsky, 1978).

With respect to this principle, high cognitive demand does not refer to the hardness or difficulty of a task *per se*, but rather to the appropriate level of challenge that the task poses for each student so that an incremental forward movement of deep and important learning is achieved (e.g., Wineburg, 1991; 1998). Because this principle also focuses on high cognitive demand for **diverse** learners, the nature and level of the task will vary among students (Moll, 1990). Regardless of any variation in tasks among students, high cognitive demand is essential for all students and is not reserved for the more advanced.

Tasks that Support Deep Learning in Subject-Matter Content

In current reform efforts (for example, implementation and assessment of the Common Core State Standards and Next Generation Science Standards), high-level cognitive abilities are reflected across subject-matter content. These abilities and skills include:

- 1) Asking questions and defining problems;
- 2) Making sense of problems and solving them;
- 3) Reasoning abstractly and quantitatively;
- 4) Constructing viable arguments;
- 5) Engaging in arguments from evidence;
- 6) Obtaining, evaluating, synthesizing and communicating information (Cheuk, 2011).

The success of students in developing these kinds of cognitive abilities and skills is dependent on their engagement in deep and rich tasks that afford such opportunities (Lin, 2005; Stein, Grover, & Henningsen, 1996; Stigler et al., 1999). For example, in mathematics, Lesh, Hoover, Hole, Kelly, and Post (2000) proposed model-eliciting tasks, which they contrasted with traditional problem solving activities found in textbooks. The latter required students to produce an answer to a question that was formulated by someone else, whereas model-based activities required students to develop a model for interpreting the goals and potential solutions of an authentic, relevant problem. The approach of Cognitively Guided Instruction in mathematics (Carpenter, Fennema, & Franke, 1996; Carpenter, Fennema, Peterson, & Carey, 1988) provided students with learning tasks created from a model of student thinking that engaged them in high-levels of cognitive demand. This approach resulted in higher mathematics achievement.

There is consensus among scholars in the learning sciences that students attain deep knowledge when engaged in tasks that are authentically related to the everyday practices of professionals in the discipline. This is not to say that students' academic situations need to be identical to professionals, but rather that learning strategies and contexts are most advantageous to learning when they are similar to those within the discipline while also being age appropriate and retaining fundamental, disciplinary practices and beliefs (Sawyer, 2006).

A committee of the National Research Council (NRC, 2005) explicated the principles outlined in the Council's influential synthesis of cognitive research (NRC, 2000) and applied them to subject-matter content. The committee advanced the idea that students should be involved in learning concepts about the nature of the subject matter (for example, what it means to engage in doing history, math, or science) and concepts that are central to the understanding of the subject matter (for example, exploration of the new world, mathematical functions, or gravity) (NRC, 2005). In addition, some research has shown that regardless of the subject matter, students who

engaged in tasks with high cognitive demand that developed deeper, more generative understandings with respect to the ideas they are learning about learned and retained more (Glasnapp, Poggio, & Ory, 1978; Mayer, 1992; Peterson, Swing, Stark & Waas; 1984; Semb & Ellis, 1994; Semb, Ellis, & Araujo, 1993; Zohar & Nemet, 2002).

As discussed in the section on Principle 1, the development of schema is important for learning and for transfer. Schemata enable learners to apply what they have learned in a new situation and to acquire related new learning more quickly (Pellegrino, 2006; Glaser, 1984). Learning tasks that connect new learning to prior learning in networks structured around key ideas of the subject-matter can support the development of schema (cf. Good & Brophy, 1994).

The Zone of Proximal Development

In his still influential formulation, Vygotsky stated that instruction “must be aimed not so much at the ripe as at the ripening functions” (Vygotsky, 1986, p. 188). To aim instruction at the “ripening functions” teachers need an indication about a student’s *zone of nearest development* (also termed *the zone of proximal development – ZPD*).

Vygotsky described the ZPD as “those processes in the development of the same functions, which, as they are not mature today, still are already on their way, are already growing through, and already tomorrow will bear fruit” (Vygotsky, 1933/1935, p. 120). In this regard, Vygotsky also distinguished between two levels of development: 1) the level of actual development that the learner has already reached, the level at which the learner is capable of solving problems independently; and 2) the level of potential development (the ZPD), the level that the learner is capable of reaching under the guidance of a more knowledgeable other. Applied to the classroom context, this means that teachers engage students in learning that is within their ZPD, (not too hard and not too easy) through tasks and interactions that involve a gradual release of assistance so that the learning ultimately becomes part of the student’s independent achievement (Tharp & Gallimore, 1989).

In summary, providing opportunities for all students to engage in tasks of high cognitive demand supports deep learning of important subject-matter content and can assist in the development of schema. Ensuring appropriate high cognitive demand for all students requires teachers to be aware of learner differences and match the tasks to the learners’ needs.

Principle 3

Students Engage in Meaning Making Through Discourse and Other Strategies

The core idea of this principle is that students are active learners who construct understanding for themselves (Piaget, 1970; Piaget & Inhelder, 1972). While teachers and peers can support learning, no one else can learn for students. Students should be active in making meaning during their own learning. Teachers can support students' meaning making by: 1) engaging them in productive discourse; 2) involving them in creating and interpreting multiple modes of representation; and 3) connecting what they are learning to what they already know.

Productive Discourse

Productive discourse is defined here as students engaging in dialogue that is interactive, externalizes thinking, and focuses on meaning making. Specifically, discourse involves developing arguments, explaining, critiquing, using logic, and giving evidence to support or refute a claim (Halliday & Martin, 1993; Kelly & Brown, 2003; Lemke, 1990). To engage students in active meaning making, these discourse patterns occur in classrooms in all domains, both orally and in written form (Jewitt, Kress, Ogborn, & Tsatsarelis, 2000; Kress, Charalampos, Jewitt, & Ogborn, 2001; Ogborn, Kress, Martins, & McGillicuddy, 1996; Mortimer, 1998; Mortimer & Scott, 2003; Roychoudhury & Roth, 1996; Scott, 1998; Scott, Mortimer, & Aguiar, 2006; Sutton, 1992). Productive discourse is also a central component of the Common Core State Standards (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010) and the Next Generation Science Standards (n.d.) (Bunch, Kibler, & Pimentel, 2012; Moschkovich, 2012; Quinn, Lee, & Valdés, 2012).

Language norms and uses are not generic, but instead change relative to the specific content and context. For example, speaking and writing have different levels of appropriate complexity, density, formality, and vocabulary depending on the situation. These are dynamic variables that are not always readily apparent to students (Fang & Schleppegrell, 2008; Halliday & Martin, 1993; Halliday & Matthiessen, 2004; Schleppegrell, 2004). Due to this inherent challenge in both understanding and using language in expected ways in classroom settings, discourse opportunities need to promote both language knowledge and deep content understanding (Heritage, Silva, Pierce, & Bailey, 2007; Van Lier, 2004; Walqui & Heritage, 2012). Students' use of meaningful academic language has been shown to be much more prevalent in

classrooms when teachers establish clear learning structures aligned with clear language expectations and provide appropriate scaffolding for students (Quinn, Lee, & Valdés, 2012).

Representations in Meaning Making

Research literature points to the importance of representation as ways for students to organize, externalize, extend, and manipulate their thinking (Moschkovich, 2012, Quinn, Lee, & Valdes, 2012). There is also considerable evidence that representational knowledge is related to and may affect complex problem solving, transfer of knowledge to novel situations, and understanding of high-level concepts (e.g., Dufour-Janvier, Bednarz, & Belanger, 1987; Greeno & Hall, 1997; Hiebert & Carpenter, 1992; Hiebert & Wearne, 1996; Kaput, 1987; Niemi, 1996; Putnam, Lampert, & Peterson, 1990; Skemp, 2012).

According to Peirce's semiotic theory (Peirce, 1955, 1991), which is relevant to a wide range of classroom activity, a representation is anything that stands for something else. In the classroom context representations include written and oral language, symbols, diagrams, maps, and pictures. In the case of mathematics, for example, teachers must use representations to first engage students in mathematical thinking. In turn, students use these representations to scaffold their understanding of emerging concepts (Moschkovich, 2012; Rittle-Johnson, Siegler, & Alibali, 2001; Sierpinska, 1994). In the case of science, students must engage in reading, writing, and visual representations of their ideas in order to develop models and explanations. Across disciplines, when participating in argumentation with peers around representations, students need to speak and listen to reach shared conclusions (Quinn, Lee, & Valdes, 2012).

In the same vein, the National Research Council (NRC, 2011) has advanced a series of practices foundational for effective learning that involve engaging students with representations and discourse. As the NRC makes clear, these practices are closely intertwined. Many researchers have shown that when engaged in learning processes which are driven by discourse about objects and ideas, students' can more effectively progress through increasingly complex stages of conceptual understanding (e.g., moving from observations to modeling observations to then explaining and defending models) (Quinn, Lee, & Valdes, 2012). To achieve high levels of understanding across content areas, students must learn not only how to manipulate representations (including text), but also what the meanings of the represented concepts and processes are (National Council of Teachers of Mathematics (NCTM), 2000; NRC, 2001).

Making Connections to Students' Existing Knowledge and Experience

In the development of schema (see section in Principle 1), one way that students create new knowledge is by establishing connections (NRC, 2000; Vygotsky, 1978). Pauline Gibbons (2009) suggests looking both forward and backwards with learners during academic activities to scaffold their learning. By this, she means that teachers should engage students' everyday language and prior experiences, from classrooms and beyond, in the process of sense making in school activities (Garcia & Gonzalez, 1995; Gibbons, 2009; Savignon, 1991). Student understanding then develops through the creation of connections and recognition of relationships with past and current representations, through which they gradually develop more sophisticated conceptions of already familiar ideas, and gain more academic language and literacies in the process (Gandara & Contreras, 2009; Greenfield, 2009; Heath, 1983; Rogoff, Paradise, Arauz, Correa-Chavez, & Angelillo, 2003).

While teachers may at times explicitly make connections between past and present learning for students, it is also important for teachers to support students to make their own comparisons and analogies between existing knowledge/past experiences and current learning, especially during problem solving efforts and independent work to more deeply understand concepts students are in the midst of learning (Clement, 1988; Lee, 2005; Halpern, Hansen, & Riefer, 1990; Lobato, 2008; Wong, 2006). In general, students' making use of analogies in their reasoning processes is beneficial for learning across domains ((Duit, 1991; Gentner & Kurtz, 2006; Jameson & Gentner, 2003; Kurtz, Miao, & Gentner, 2001; Loewenstein & Gentner, 2001, 2005; Simons, 1984).¹ In the case of science, for example, researchers have found that when students can spontaneously generate analogies for the scientific phenomenon they are learning, particularly in the process of overcoming misconceptions, their understanding greatly improves (Clement, 1989; Kaufman, Patel, & Magder, 1996; Spiro, Feltovich, Coulson, & Anderson, 1989; Stavy, 1991; Wong, 2006).

In reading, relating text content to analogous situations, environments, characters, or systems improves reading comprehension and memory (cf. Anderson & Pearson, 1984; Halpern et al., 1990; McVee, Dunsmore, & Gavelek, 2005; Pearson, 1992). For students who find it challenging to understand a target instructional concept, hearing peers' analogies can help them to create their own analogies and increase their conceptual

¹ Analogies are considered a type of representation (Podolefsky, Perkins, & Adams, 2010).

understanding (Brown & Clement, 1989; Sandifer, 2004). This demonstrates the positive impact on learning that occurs when peers share their understandings with one another in a community of practice (Palinscar, Magnusson, Marano, Ford, & Brown, 1998; Wenger, 2005).

Drawing on prior knowledge is also a critical aspect of summary writing. To transform text, students must rely on system knowledge outside or beyond that which exists in the source material they have encountered (Hood, 2008). In this effort of transforming text, students often need scaffolding from teachers, such as explicitly articulating, modeling, and practicing with students the ways in which content meanings can be generalized and abstracted before summarizing (Martin & Rose, 2005; Rose, 2006).

In learning history, by comparison, students need to become aware of their preconceptions before they can make sense of historical ideas (NRC, 2005). For example, young students often believe that an occurrence can only be known about if it is directly observed. Therefore, if an event happened in the distant past, they believe it is impossible to know if it really happened (Lee, Ashby, & Dickinson, 1996). Also, young students often get confused and apply the relationships they hold about the concepts old and new, and old and young to long ago and now. By teachers guiding students to uncover and examine these preconceptions, students have an easier time developing schema in relation to learning history (Brophy & VanSledright, 1997; Dickinson, 1978). Much recent research indicates that some key concepts in history are counterintuitive (also true in science) and contradict working assumptions which may have become deeply embedded after many years of studying history, especially if students are not instructed in how to recognize, examine, and check assumptions for validity (Barca, 1997; Barca, Magalhães, & Castro, 2004; Donovan & Bransford, 2005, NRC, 2005; Limón, 2002).

Community-centered Classroom Cultures

Community-centered environments foster norms for people learning from one another, and continually attempting to improve. In such a community, students are encouraged to be active, constructive participants. They are encouraged to make and then learn from mistakes. Intellectual camaraderie fosters support, challenge and collaboration (NRC, 2001).

Collaboration with peers encourages motivation and cognitive engagement. Collaboration involves working with others to obtain information, to share and discuss ideas and interpretations, and to receive feedback. (Blumenfeld, Kempler, & Krajcik,

2006). Collaboration can also encourage motivation (Wentzel, 1997), encourage shared effort, diminish feelings of inadequacy (Hickey, 1997), and can be beneficial to cognitive engagement as students explain, clarify, and critique ideas (Yackel, Cobb, & Wood, 1991). To fully benefit from collaborative learning opportunities, students need accountability structures that hold them responsible for their contributions to the group (Slavin, 1996). Additionally, for productive collaboration, students need to be supported in learning how to explain their ideas and critique the ideas of others (Webb & Palinscar, 1996). Interactions among students can be structured by assigning specific group roles and providing prompts to improve the quality of questions and discussion (King, 1997; Cohen, 1994).

In community-centered classrooms, students' meaning making can be supported by engaging in discourse and in the development of representations with peers, as well as with their teachers. Teachers need to accept a variety of styles in which students present their ideas, using whatever experiential and language resources are available to them at the time (Garcia & Gonzalez, 1995; Gonzalez, Moll, & Amanti, 2005; Moll, 1992; Moschkovich, 2012). Teachers can be attuned to students' understandings of concepts, facilitating shared sense making, while scaffolding language use and deepening students' content knowledge in a safe environment (Gibbons, 2006).

The need for psychological safety among students is central to creating a learning environment (cf. Steele, 1997). Psychological safety can be defined as a "sense of comfort, willingness to take risks, and be oneself and a feeling of acceptance" (Nasir, Rosebery, Warren, & Lee, 2006, p. 491). To enhance feelings of psychological safety, a community-centered classroom is characterized by the norms of mutual trust between teacher and students and among students, demonstrations of respect and caring and an interest in each student's well-being, and supportive, collaborative relationships (Battistich, Solomon, Watson, & Schaps, 1997; Davis, 2003, Wentzel, 1997). For example, identifying students' ideas publically as being wrong or right can inhibit students' intrinsic motivation to learn and cultivate a non-productive, competitive environment (Ames, 1992; Ames & Archer, 1988; Dweck & Elliott, 1983). Yet many common teaching practices, for example, the I-R-E questioning approach (Investigation, Response, Evaluation) identify student responses as correct or incorrect. In order for students to be open to engaging in discourse and other forms of communication, teachers need to have students participate in discussions that respectfully engage their cognitive abilities (Lemke, 1990; Nee-Benham, 2002).

Researchers who work in this field admit that there is a challenge in moving away from an I-R-E type framework of communication and towards one that facilitates productive discourse (Chin, 2006, 2007), especially in classrooms with high percentages of students who may be reluctant to talk, such as those without fluent English language resources, or those whose ideas have been shut down in the past (Nee-Benham, 2002).

In summary, engaging in productive discourse and other strategies, such as creating and interpreting representations and generating analogies from prior experience, is critical in students' process of making meaning of their learning. To facilitate this, teachers can create community-centered classroom cultures where students feel comfortable sharing their learning status and participating in a community of practice.

Principle 4

Students Engage in Metacognitive Activity to Increase Understanding of and Responsibility for Their Own Learning

Metacognition is a foundational cognitive process for effective learning in all disciplines. At its most basic, it is “thinking about thinking” (Flavell, 1979). It includes knowledge people have about themselves as learners and an awareness of factors that might impact their performance in various tasks. Educational psychologists and researchers have long believed in the importance of metacognition in learning, in part, because of its supportive role in other aspects of cognition (Ennis, 1985; Facione, 1990; Halpern, 1998; Paul, 2006; Schraw, Crippen, & Hartley, 2006). Metacognition is considered to have two components: metacognitive knowledge and metacognitive regulation (Flavell, 1979).

Metacognitive Knowledge

Metacognitive knowledge includes knowledge of factors that might impact performance, knowledge of learning strategies, knowledge about oneself as a learner, awareness and management of personal cognition, and knowledge of others. Knowledge of performance factors and of oneself-as-learner work together to advance a variety of important learning attributes, including self-appraisal ability, person and task knowledge, declarative knowledge, and epistemological understanding (Cross & Paris, 1988; Schraw et al., 2006; Schraw & Moshman, 1995).

Metacognitive knowledge incorporates knowledge about learning strategies, including why to use strategies, when to use strategies, and how to use strategies (Kuhn & Dean, 2004; Schraw et al., 2006). Use of metacognitive strategies can: 1) improve persistence and motivation in the face of challenging tasks; 2) facilitate an understanding of when use of a particular strategy should be appropriately continued, terminated, or modified based on strategy consequences (Davis, 1983; Levelt, 1983); and 3) perhaps most importantly, have permanent effects on learning ability (Pressley et al., 2010). Appropriate strategy use can be improved with increased metacognitive regulation.

Metacognitive Regulation

Metacognitive regulation refers to the act of monitoring one’s own cognition (Flavell, 1979). Through this monitoring, one can become aware of one’s own strengths and weaknesses and take responsive action based on that evaluation (Paris & Winograd,

1990; Schraw et al., 2006; Schraw & Moshman, 1995; Whitebread, Coltman, Pasternak, Sangster, Grau, et al., 2009).

Students who monitor their own thinking and take action are more successful than their peers in academic activities (Bransford et al., 1982; Slife, Weiss, & Bell, 1985; Zimmerman & Martinez-Pons, 1992; Zimmerman & Schunk, 1989). This success is related to a variety of factors, including playing a more active role in learning, processing new information more effectively, relating new information to previous information, using elaboration techniques to better understand new material, setting goals, planning one's learning strategies, seeking assistance when needed, and monitoring one's own performance (Bandura, 1986; Bransford et al., 1982; Puntambekar, 1995; Slife et al., 1985; Zimmerman & Martinez-Pons, 1992).

Metacognitive regulation also includes the evaluation of monitoring processes and strategies and assessing one's learning, and revisiting and revising learning goals. These attributes of metacognitive regulation all promote effective planning of future learning (Cross & Paris, 1988; Paris & Winograd, 1990; Schraw et al., 2006; Schraw & Moshman, 1995; Whitebread et al., 2009). Effectively planning future learning steps involves goal setting, activating background knowledge, and budgeting time (Chi, Glaser, & Rees, 1981; Pressley et al., 2010).

As metacognitive regulation becomes more fully developed in learners, it incorporates the evaluation of their monitoring processes and gauging the success of various learning strategies in increasing learning (McLeod, 1997; Schneider & Lockl, 2002). Researchers have also demonstrated that affective self-regulation (the ability to properly regulate one's emotions) is related to academic success through motivation, a state supported by metacognition (Eisenberg, Valiente, & Eggum, 2010; Ray & Smith, 2010). Metacognitive regulation, along with other aspects of metacognition, can improve with instruction (Baker & Brown, 1984; Markman & Gorin, 1981). Motivation is also closely related to metacognition.

Motivation

Motivation, an affective state, is, “the attribute that moves us to do or not do something” (Lai, 2011, p. 4), and includes the enjoyment of school learning (Gottfried, 1990). Motivation is highly correlated with self-efficacy, the confidence in one's ability to perform a specific task. It is also closely connected to attribution tendencies and effortful control (Bandura, 1986; Eisenberg et al., 2010; Ray & Smith, 2010).

Attribution tendencies refers to the causal links a person makes to create sense out of

their success (e.g., “I won the race because I trained in a new way.”) and effortful control is the ability to regulate responses to external stimuli (e.g., resisting shouting out answers in class).

Motivation is also greatly influenced by students’ and teachers’ goal orientation (Ames, 1992; Ames & Archer, 1988; Dweck & Elliott, 1983).² A learning goal orientation supports adaptive motivational patterns that promote the establishment, maintenance, and attainment of personally challenging and valued learning goals (Dweck & Leggett, 1988; Elliott & Dweck, 1988). This adaptive pattern is characterized by challenge seeking, persistence in the face of setbacks, enjoyment in putting forth effort, risk taking, (for example, being willing to risk making mistakes in front of others in order to learn), having a sense of “belonging,” and being better able to transfer one’s skills/knowledge to novel activities or problems (Elliott & Dweck, 1988; Weiner, 1972).³

Metacognition in the Classroom Context

Metacognition can be supported in the classroom through the provision of learning tasks that are designed to have novelty, variety, and diversity (Ames, 1992; Corno & Mandinach, 1983; Corno & Rohrkemper, 1985; Marshall & Weinstein, 1984). Such tasks facilitate interest in learning and a learning orientation while reducing social comparisons (Ames, 1992; Nicholls, Cheung, Lauer, & Patashnick, 1989; Rosenholtz & Simpson, 1984). Using these task structures can foster students’ self-regulation in learning and affective self-control (Paris & Winograd, 1990). To further support students’ self-regulation, students should be enabled to participate in decision-making processes where they make choices about activities or actions based on considerations of the effort they will need to exert (e.g., if the task is manageable) and not on evaluations of their abilities (Ames, 1992; Bandura, 1986; Brophy, 1987; Brophy, Rohrkemper, Rashid, & Goldberger, 1983; Garner, 1990; McCombs, 1984; Paris &

²Having a learning goal orientation, which promotes motivation, is characterized by seeking to increase one’s abilities for the sake of learning versus trying to gain positive judgments by others and/or trying to avoid other’s negative judgments.

³Additionally, motivation is greatly influenced by beliefs about intelligence (Dweck, 1986; Meyer, Folkes, & Weiner, 1976; Nicholls, 1984). Children and adults who believe intelligence is a fixed trait tend to have a performance goal orientation. People who believe intelligence is a malleable quality, which is called a growth model, tend to orient toward developing that quality in themselves and in others, e.g., teachers (Bandura & Schunk, 1981; Schunk & Zimmerman, 1998). These findings have been often misinterpreted to mean that frequent praise for small units of behavior promotes motivation. Praise can instead decrease intrinsic motivation and the pursuit of longer-term challenges (Brown, Palincsar, & Purcell, 1986; Dweck, 1986).

Winograd, 1990). In this situation, students are given opportunities to develop responsibility and independence, which are necessary 21st century skills.

Tasks should also have personal relevance to students. Personal relevance includes a meaningful reason to engage in the activity, an appropriate level of challenge, and specific, short-term, and self-referenced goals (Ames, 1992; Schunk, 1989; Zimmerman, Bandura, & Martinez-Pons, 1992). Within this task context, students frequently perceive that they have more control over the learning processes they engage in and in the products they produce. Students also tend to have a greater sense that they can accomplish tasks with reasonable effort (Schunk & Zimmerman, 1998). It is likely that students within these contexts will be more willing to apply effort and plan, organize, and monitor strategies (Ames & Archer, 1988; Corno & Mandinach, 1983; Corno & Rohrkemper, 1985). Metacognitive instruction in these areas can lead to a greater capacity for students in successfully meeting task-learning goals (Ames, 1984; Ames, Ames, & Felker, 1977; Covington, 1984; Covington & Omelich, 1984).⁴

Instructional strategies for teaching metacognition and encouraging motivation to use metacognitive strategies need to occur at a meta-level instead of performance level (Kuhn, 2000). They should be aimed at increasing awareness and control of a meta-task, rather than completing procedures. This type of instruction can best promote self-efficacy, learning attribution, and a learning goal orientation. Without these characteristics, students may have the necessary strategy knowledge to solve problems and other challenges they come across in their learning processes, yet still not use this knowledge appropriately (Schraw, 1998). Additionally, explicit instruction in metacognition can lead students to more actively process information, for example, by decontextualizing, abstracting and restructuring it (Delclos & Harrington, 1991; Lodico, Ghatala, Levin, Pressley, & Bell, 1983; Palincsar et al., 1998; Puntambekar, 1995; Sawyer, Graham, & Harris, 1992). These skills are also linked to greater achievement (Corno & Mandinach, 1983; Lodico et al., 1983; Pressley, 1986).

Another important aspect of effective metacognitive instruction is that it is part of the larger process of making students' reasoning, concepts, and beliefs visible (Hennessey,

⁴Positive reinforcement for students should be geared towards celebrating effort rather than any innate intelligence, and should focus on individual improvement. Feedback to students should provide information about ways in which student work did or did not meet the learning goal and criteria for success and encourage a view of mistakes as part of learning. Evaluations are best made in private and not public in order to avoid comparisons. They should provide opportunities for improvement for students (Ames, 1984).

1999). This is accomplished by assisting students to construct conceptual or mental models, which can be represented verbally, visually, or through other representations (see Principle 3 for more information). The construction of mental models can facilitate conceptual changes for students holding inappropriate conceptions, especially if the process of defining and refining models produces cognitive disequilibrium or conflict (Schraw et al., 2006).

In summary, metacognition is critical in learning. Metacognition is the cognitive mechanism in which learners monitor and regulate their learning. Students can be supported to develop metacognitive skills through effective instructional strategies.

Principle 5

Assessment is Integrated into Instruction

Assessment has two fundamental functions. The first is to provide information on students' current levels of achievement. Such assessments serve a summative function; they sum up what students have learned after a more or less extended sequence of teaching and learning, for example, at the end of a unit which may last several weeks, at the end of a quarter, or annually. The second purpose of assessment is to inform what students and teachers do day-by-day to ensure that students make progress toward desired outcomes. Assessment for this purpose serves a formative function and occurs when teachers engage in a continual "taking stock" of learning by paying close, first-hand attention to specific aspects of students' developing understanding and skills as teaching and learning is taking place in real time (Erickson, 2007). Principle 5 addresses how teachers effectively integrate gathering and using evidence of learning into on-going instruction.

Assessment Integrated into Instruction

In 1969, Benjamin Bloom wrote: "Evaluation which is directly related to the teaching-learning process as it unfolds can have highly beneficial effects on the learning of students, the instructional process of teachers, and the use of instructional materials by teachers and learners" (Bloom, 1969, p. 50). Since then, several studies have investigated the effects of integrating assessment with instruction as Bloom proposed. For example, in the Cognitively-Guided Instruction (CGI) project, teachers were trained to use evidence they collected during instruction to meet their students' learning needs. Students taught by CGI teachers had higher mathematics achievement than those students not taught by CGI teachers (Carpenter, Fennema, Peterson, Chiang, & Loef, 1989). More recently, in a project designed to improve teachers' use of formative assessment (integrating assessment into instruction), Black, Harrison, Lee, Marshall, & Wiliam (2003) found beneficial effects on student achievement.

Several research syntheses have documented the positive impact of assessment integrated into instruction on student learning. A review by Fuchs and Fuchs (1986) synthesized findings from 21 different research studies on the use of assessment to inform the instruction of students with special needs. They found that regular assessment (two to five times per week), with follow-up action, produced a substantial increase in student learning.

In their landmark review, updating reviews by Crooks (1988) and Natriello (1987), Black and Wiliam (1998) examined 250 studies addressing aspects of formative assessment and concluded that formative assessment yielded improvements in student achievement. They suggested that formative assessment, when effectively implemented, could impact student achievement as much or more than any other instructional interventions. Research has supported Black and Wiliam’s conclusion, and although methodologies and the range of reported effect sizes vary widely from study to study, collective results indicate that when teachers engage in the practices of formative assessment student achievement is improved in positive, significant ways (cf. Hattie, 1999; Hattie, 2009; Hattie & Timperley, 2007; Kingston & Nash, 2011; Kluger & DeNisi, 1996; Ruiz-Primo & Li, 2013; Shute, 2008).

In their report, the authors of *How People Learn* (NRC, 2000) stressed formative assessment as an essential factor in supporting learning. A further NRC report, *Knowing What Students Know (KSWK)* (NRC, 2001), synthesizing decades of research on measurement, psychometrics, and cognition, emphasized that assessment “should focus on making students’ thinking visible to both their teachers and themselves so that instructional strategies can be selected to support an appropriate course for future learning” (p. 4). NRC’s *KSWK* (2001) also stated that “good formative assessment requires radical changes in the way students are encouraged to express their ideas” (p. 227). Teachers must purposefully structure opportunities to generate evidence of learning during the lesson.

Feedback

Feedback is a central component of formative assessment practices. Feedback is both the information imparted from monitoring learners’ progress toward attaining a desired goal and the responses that foster student learning (Allal, 2010; Brookhart, 2011; Hattie & Timperley, 2007; Ruiz-Primo & Li, 2013; Sadler, 1989). Ample evidence has shown feedback to be one of the most powerful methods that influence student learning; in particular, many meta-analyses produced effect sizes above 0.4 (cf. Hattie, 2009; Kluger & DeNisi, 1996). A key finding in Hattie’s (2009) synthesis of over 800 meta-analysis studies, which accounted for over 50,000 studies, was that the most powerful single influence enhancing achievement is quality feedback. It is important to note that not all feedback is equally effective. Giving feedback that is descriptive and evaluative and engages students in mindful activity—in contrast to feedback that gives current achievement—had the greatest benefits in student achievement (Kluger & DeNisi, 1996; Tunstall & Gipps, 1996; Shute, 2008).

In summary, formative assessment, a set of assessment practices that are integrated into instruction, has been shown as a powerful tool in increasing student achievement. Drawing from learning theories and research from classroom practices, assessment that is integrated into instruction is a critical aspect in teaching and student learning.

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Appendix A

Summary of Reviewed Studies

| Author(s) | Type | Summary |
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| Allal, L. (2010) | Theoretical | The author discusses how models of individual self-regulation have limited usefulness in informing the design of classroom assessments, which are socially contextualized. Instead, theoretical models that emphasize the interplay between individual and social or contextual aspects of regulation are more appropriate to frame the design of classroom assessments. In particular, the author emphasizes the importance of integrating assessments into the teaching-learning process, communicating feedback to students in a meaningful way, and involving and empowering students throughout the assessment cycle. The negative effects of disconnected summative and formative assessments are discussed, as well as strategies to minimize this disconnect. |
| Alvermann, D. E., & Hague, S. A. (1989) | Empirical | This study examined the effects of activating prior knowledge and refutation text structure on students' comprehension of counterintuitive science material. Developmental studies students, who also were incompetent readers, either read a passage that referred directly to their known misconceptions about a science topic and then refuted those misconceptions, or they read a passage that only described the topic. Text structure was crossed with three levels of poor knowledge activation (augmented activation, activation only, and no activation). Statistically significant differences were found that favored augmented activation over activation only. Additionally, the students favored refutation text over nonrefutation text. Implications are drawn for future research and development studies instruction. |
| Alvermann, D.E., & Hynd, C.R. (1989) | Empirical | The purpose of this study was to investigate a pragmatic, low-cost way to enhance student learning of complex science concepts without totally revamping texts or methods of instruction. Undergraduate nonscience majors (N=62) with known naïve conceptions about projectile motion were randomly assigned to one of six groups formed from three |

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| | | <p>levels of a prior knowledge activation activity and two levels of text. The results of a multivariate analysis of variance showed that activating competent readers' naïve conceptions about a complex science concept is not as effective a means for dispelling inaccurate information as is the practice of activating their naïve conceptions and then explicitly directing them to read and attend to ideas that might differ from their own. This result and the no difference found for refutation text are discussed within the context of earlier work and Kintsch's observation that incongruity leads to new learning.</p> |
| Ames, C. (1984) | Theoretical | <p>This article begins by noting that traditional research on competitive and noncompetitive goal structures has focused on the relative efficacy of each. Substantially more work has been done to predict outcomes under these differing structures than has been done to understand the motivational processes that mediate such outcomes. The author addresses two broad questions: (1) What is the psychological meaning of success and failure to the student within different goal-reward structures? (2) How does the goal structure influence students' self-evaluations and cognitive-motivational thought processes? The different motivational systems that are activated by each goal structure are discussed, and consideration is given to the different effects that goal structures have on high- and low-achieving students.</p> |
| Ames, C. (1992) | Theoretical | <p>This article examines the classroom learning environment in relation to achievement goal theory of motivation. Classroom structures are described in terms of how they make different types of achievement goals salient and as a consequence elicit qualitatively different patterns of motivation. Task, evaluation and recognition, and authority dimensions of classrooms are presented as examples of structures that can influence children's orientation toward different achievement goals. Central to the thesis of this article is a perspective that argues for an identification of classroom structures that can contribute to a mastery orientation, a systematic analysis of these structures, and a determination of how these structures relate to each other. The ways in which interventions must address the independency among these structures are discussed in terms of how they influence student motivation.</p> |

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| Ames, C., & Archer, J. (1988) | Empirical | The authors studied how specific motivational processes are related to the salience of mastery and performance goals in actual classroom settings. Students (N=176) attending a junior high/high school for academically advanced students were randomly selected from one of their classes and responded to a questionnaire on their perceptions of the classroom goal orientation, use of effective learning strategies, task choices, attitudes, and causal attributions. Students who perceived an emphasis on mastery goals in the classroom reported using more effective strategies, preferred challenging tasks, had a more positive attitude toward the class, and had a stronger belief that success follows from one's effort. Students who perceived performance goals as salient tended to focus on their ability, evaluating their ability negatively and attributing failure to lack of ability. The pattern and strength of the findings suggest that the classroom goal orientation may facilitate the maintenance of adaptive motivation patterns when mastery goals are salient and are adopted by students. |
| Ames, C., Ames, R., & Felker, D. W. (1977) | Empirical | The authors studied how success and failure outcomes occurring under competitive and noncompetitive reward structures influenced children's attributional and affective responses. Forty 5th grade boys solved sets of achievement-related puzzles, working in pairs in which one succeeded and one failed at the task. Results show that the reward structure of the performance setting was an important determinant of self- and interpersonal evaluations. Competitive conditions caused self-punitive behavior for failure outcomes and some ego-enhancing strategies for success outcomes. Failing students expressed strong negative affect and perceived themselves as less capable than their successful partners, while successful students perceived themselves as more deserving of reward than their failing partners. No differences in self-other attributions or affect were found in noncompetitive conditions. |
| Anderson, R. C. (1977) | Theoretical | The author discusses the implications of schema theory for education researchers and theorists who seek to improve teaching and learning practices. The concept of schemata is introduced, and the important distinction is made between schema use and schema change. The author notes that schema use is a dynamic and constructive process, as students cannot possibly have stored schema to accommodate every conceivable situation. Schema change, instead of the traditional notion of aggregation of knowledge, is posited |

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| | | to be the most important educational enterprise. A teacher's task, the author argues, is to distinguish between schema use and schema change and encourage the latter when it is a necessary next step in a student's intellectual development. |
| Anderson, R. C., & Pearson, P. D. (1984) | Theoretical | The authors focus on a particular aspect of reading comprehension: how the reader's schemata (knowledge already stored in memory) function in the process of interpreting new information and allowing it to enter and become a part of the knowledge store. They review traditional schema theory and discuss problems with current realizations of that theory, as well as possible solutions. By example, they discuss the interplay between the abstracted knowledge embodied in schemata and memory. They further decompose comprehension to examine components of encoding (attention, instantiation, and inference) and retrieval (retrieval plans, editing and summarizing, and reconstructive processes). The authors conclude with recommendations for quality reading instruction: a curriculum rich with concepts from the everyday world and learned fields of study, books that explain how and why things function as they do, and teachers who insist that students think about the interconnections among ideas as they read. |
| Ausubel, D. P. (1963) | Theoretical | The aim of this book is to present a comprehensive theory of how human beings learn and retain large bodies of subject matter in classroom and similar learning environments. Its scope is limited to the "reception" learning and retention of meaningful material. "Reception" learning refers to the situation where the content of the learning task (what is learned) is presented rather than independently discovered by the learner. The book is primarily intended as a textbook for advanced courses in educational psychology and the psychology of school learning, and as a reference work for specialists and research workers in educational psychology. |
| Baker, L., & Brown, A. L. (1984) | Theoretical | The importance of metacognition to the process of critical reading is discussed in this report. Specifically, the report covers two areas of research: (1) reading for meaning, which involves the metacognitive activity of comprehension monitoring, and (2) reading for remembering, which includes identifying important ideas, testing one's mastery of material, developing effective study strategies, and allocating study time appropriately. The report discusses the potential application of the research for developing instructional |

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| | | <p>routines to help alleviate some of the more disabling consequences of inadequate knowledge and control of effective reading strategies. The final section addresses recent relevant research and implications.</p> |
| Bandura, A. (1986) | Theoretical | <p>A comprehensive theory of human motivation and action from a social cognitive perspective is presented in this book. It deals with the prominent roles played by cognitive, vicarious, self-reflective, and self-regulatory processes in psychosocial functioning. The book is organized to emphasize the reciprocal causation through the interplay of cognitive, behavioral, and environmental factors. The author systematically applies this social cognitive theory to personal and social change. Among its highlights, the book: covers a wide range of issues relating to human thought, motivation, and behavior; provides a theory of social diffusion and innovation that integrates modeling and social-network influences; shows how converging technological changes are transforming the nature and scope of human influence; and analyzes the determinants and processes governing personal and social change.</p> |
| Bandura, A., & Schunk, D. H. (1981) | Empirical | <p>The authors tested the hypothesis that self-motivation through proximal goal setting serves as an effective mechanism for cultivating competencies, self-percepts of efficacy, and intrinsic interest. Forty children (7.3–10.1 years of age) who exhibited gross deficits and disinterest in mathematical tasks pursued a program of self-directed learning under conditions involving proximal subgoals, distal goals, or no goals. Results of the multifaceted assessment provide support for the superiority of proximal self-influence. Under proximal subgoals, students progressed rapidly in self-directed learning, achieved substantial mastery of mathematical operations, and developed a sense of personal efficacy and intrinsic interest in arithmetic activities that initially held little attraction for them. Distal goals had no demonstrable effects. In addition to its other benefits, goal proximity fostered veridical self-knowledge of capabilities as reflected in high congruence between judgments of mathematical self-efficacy and subsequent mathematical performance. Perceived self-efficacy was positively related to accuracy of mathematical performance and to intrinsic interest in arithmetic activities.</p> |

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| Barca, I. (1997) | Empirical | Adolescents' ideas about provisional historical explanation were analyzed in a sample of Portuguese students (twelve to twenty years of age) attending the 7th, 9th, and 11th grade. From a theoretical framework considering criteria for the assessment of explanatory validity, students' ideas were categorized in a model of five levels of logical progression, generated through a systematic, qualitative analysis. Criteria for explanatory assessment are tentatively conceptualized in terms of evidential confirmation and refutation. The frequency distribution of responses by level raises the hypothesis that a majority of Portuguese adolescents might have an idea of provisionality of explanations tied to aggregation of information (level 3). A few 11th graders seem to apply more elaborate notions as confirmation/non refutation and perspectival neutrality (level 5) as criteria for assessing explanations. The process of data analysis brought up some other observations leading to the formulation of particular hypotheses concerning social cognition. These findings suggest that many students tend to reason in history based on everyday assumptions about the social world, and they convert substantive information in an operational scheme that is often misunderstood by the teacher. |
| Barca, I., Magalhães, O., & Castro, J. (2004) | Theoretical and empirical | The recent research on historical consciousness has drawn attention to the need to investigate how historical understanding might influence young people's decisions in the present. A similar concern is the focus of the Portuguese Historical Consciousness Theory and Practices Project (funded by the Foundation for Science and Technology-FCT) which aims to investigate students' and teachers' ideas of significance, narrative, explanation and evidence in history, social identity and citizenship as related to history, and how those ideas fit the claim that "history is useful to understand the present and predict the future." The project seeks to understand the ways in which beginning history teachers relate their ideas on change and significance of the past to their orientation in time. This paper analyzes the essays and group interviews of eighteen beginning teachers involved in the teacher-training program of three universities. Each interview was conducted with three teacher trainees and the guidelines were based upon personal narratives about contemporary Portuguese history given by beginning teachers in a former exploratory study. |

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| Battistich, V., Solomon, D., Watson, M., & Schaps, E. (1997) | Theoretical | There has recently been a renewed appreciation of the importance of social context to effective schools. This article describes an ongoing program of research on schools as caring communities. The research spans about a decade and a half and involves a diverse set of elementary schools from across the United States. The findings indicate that sense of school community can be enhanced for both students and teachers, that it is associated with a wide range of positive outcomes for both, and that the potential benefits of enhancing school community may be greatest in schools with large numbers of economically disadvantaged students. At the same time, it is noted that enhancing community has the potential for producing negative as well as positive outcomes, and that the content of the community values is of critical importance. Overall, the concept of school as community appears to provide a powerful framework for looking at educational practice and guiding educational reform efforts. |
| Biemans, H. J. A., & Simons P. R. J. (1994) | Empirical | The effects of the contact strategy (a computer-assisted instructional strategy aimed at conceptual change in text processing) were investigated by dismantling the strategy. An experiment with eighty-six students (5th and 6th graders) was conducted in which the number of instructional steps was cumulatively varied from zero steps (no activation) over one step (search for old idea) and three steps (1. search for old idea; 2. compare and contrast with new information; 3. formulate new idea) to all five contact steps (1. search for old idea; 2. compare and contrast with new information; 3. formulate new idea; 4. apply new idea; 5. evaluate new idea). A design with two between-subjects factors (instructional strategy and students' familiarity with the central concepts from the seven instructional texts used) and two within-subjects factors (type of learning performance test item and time of testing) was used. Dependent variables concerned quality of final conceptions and learning performance. Results indicated that the complete contact strategy was the most effective variant. It seemed to be the case, however, that students mainly focused their attention on the central concepts from the texts. The authors argue that instructional strategies to foster conceptual change should both support knowledge restructuring processes and offer a solution for this problem of selective attention. |
| Black, P. J., & Wiliam, D. | Review | In this landmark paper in the area of formative assessment research, the authors reviewed and synthesized 250 studies that engaged students and teachers with feedback information |

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| (1998) | | <p>that modified their teaching and learning activities. The authors argue that formative assessment is an integral part of classroom instruction and that its implementation can significantly improve student learning outcomes. The authors begin by examining whether or not there is research showing that improvements to formative assessment practices in the classroom raise standards, and they find that students who experience formative assessment strategies, particularly low achievers, demonstrate significant learning gains. Numerous suggestions are provided on how to improve formative assessment practices in the classroom (e.g., train students in self-assessment, provide specific and reflective feedback, give students the guidance to improve their performance). The authors conclude with recommendations for changing policy and practice, including four steps to implementation (learning from development, dissemination, reducing obstacles, and research). Overall, the authors maintain that formative assessment is essential to effective teaching.</p> |
| Black, P., Harrison, C., Lee, C., Marshall, B., & Wiliam, D. (2003) | Empirical | <p>The project described in this book was motivated by international research studies which suggest that development of formative assessment raises students' test scores. The significant improvement in the achievements of the students in this project confirms this research, while providing teachers, teacher trainers, school heads, and others leaders with ideas and advice for improving formative assessment in the classroom. The book is based on a two-year project involving thirty-six teachers in schools in Medway and Oxfordshire. After a brief review of the research background and of the project itself, successive chapters describe the specific practices which teachers found fruitful and the underlying ideas about learning that these developments illustrate. Later chapters discuss the problems that teachers encountered when implementing the new practices in their classroom and give guidance for school management and LEAs about promoting and supporting the changes.</p> |
| Blumenfeld, P. C., Kempler, T. M., & Krajcik, J. S. (2006) | Theoretical | <p>In this article the authors briefly review the literature on motivation and cognitive engagement and discuss how the key features of learning-sciences-based environments are likely to influence them. They indicate some challenges posed by each of these features, for students and for teachers, which may have negative effects on motivation. They describe strategies for meeting these challenges and argue that the challenges should be</p> |

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| | | taken into account when designing learning environments and when enacting them in the classroom. |
| Bransford, J. D., & Johnson, M. K. (1972) | Empirical | This paper presents a series of studies showing that relevant contextual knowledge is a prerequisite for comprehending prose passages. Four studies are reported, each demonstrating increased comprehension ratings and recall scores when students were supplied with appropriate information before they heard test passages. Supplying students with the same information subsequent to the passages produced much lower comprehension ratings and recall scores. Various explanations of the results are considered, and the role of topics in activating cognitive contexts is discussed. |
| Bransford, J. D., Stein, B. S., Vye, N. J., Franks, J. J., Auble, P. M., Mezynski, K. J., & Perfetto, G. A. (1982) | Theoretical and empirical | This article presents an overview for three sets of experiments that examine differences in the way that academically successful and less successful 5th graders approach the problem of learning new information. The overview includes discussions of (a) theoretical approaches to the problem of learning new information, (b) pilot studies that suggest differences in successful and less successful students' approaches to learning, and (c) specific hypotheses about reasons for the differences in learning suggested by the pilot studies. Also described is how these hypotheses will be tested in the three proposed sets of experiments. |
| Brookhart, S. (2011) | Review and theoretical | The 1990 Standards for Teacher Competence in Educational Assessment of Students made a documentable contribution to the field of teacher education. However, the standards have become a bit dated, most notably in two ways. First, the standards do not consider current conceptions of formative assessment knowledge and skills. Second, the standards do not consider teacher knowledge and skills required to successfully work in the current accountability and "standards-based reform" context. This article briefly reviews the 1990 standards and their influence, describes some other lists of assessment knowledge and skills that might be considered in updating them, and then proposes educational assessment knowledge and skills for teachers that reflect current teacher assessment needs. This set of competencies should help focus the work of teachers, teacher supervisors, professional developers, teacher educators, and others responsible for |

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| | | teachers' assessment knowledge and skills. |
| Brophy, J. (1987) | Review and theoretical | This article synthesizes the conclusions drawn from a literature review on principles for motivating students to learn. The author outlines numerous suggestions for creating essential learning preconditions and for motivating, including maintaining high expectations, supplying extrinsic incentives, and capitalizing on students' intrinsic motivation. Strategies are provided for stimulating students to learn course content. |
| Brophy, J. E., & VanSledright, B. (1997) | Review and empirical | This book addresses the teaching and learning of history in the elementary grades. The literature review in the first two chapters presents an overview of scholarship in the field and provides a context within which to interpret the research in subsequent chapters. The remainder of the book presents and discusses research on the teaching and learning of U.S. history in 5th grade. Included are detailed case studies of U.S. history units taught by three contrasting 5th grade teachers. The contrasts of the teachers are found in their goal priorities and approaches to curriculum and instruction. The research concluded with a yearlong study of developments in one group of students' historical knowledge and thinking as they experienced their first chronological survey of U.S. history. |
| Brophy, J., Rohrkemper, M., Rashid, H., & Goldberger, M. (1983) | Empirical | This study correlated the presence/absence of various teacher task-presentation statements with measures of subsequent student task engagement to investigate the possibility that expectations about classroom tasks that teachers communicate to students in the process of presenting those tasks might affect student engagement in the tasks. Reading and math lessons were observed (eight to twenty-five times each) in two 4th grade, two 5th grade, and two 6th grade classes. Typically, each reading or math period was subdivided into two to four tasks. For example, a math period might begin with a review of the previous day's seatwork/homework assignment, followed by presentation of a new concept or skill, followed by presentation of a new assignment. Teacher-presentation data and student-engagement data were collected for each task observed. Contrary to expectation, student engagement was generally higher when teachers moved directly into tasks than when they began with some presentation statement. Within the subset of tasks that were begun with teacher-presentation statements, those presentation statements classified as likely to have negative effects on student engagement were associated with |

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| | | lower student engagement, but there was no corresponding tendency for teacher-presentation statements classified as likely to have positive effects on student engagement to be associated with high rates of student engagement. |
| Brown, A. L., & Reeve, R. A. (1987) | Theoretical | This paper examines the relationship between learning and development from a Vygotskian perspective. While many contemporary developmental theorists have avoided taking a stand on this controversial relationship, the authors believe that the notion of "bandwidth of competence," and Vygotsky's "zone of proximal development," provide a useful framework for considering the relationship between learning and development. A basic theme of this paper concerns the concept of bandwidth of competence created by contexts that vary in degree of support for cognitive activity. The authors suggest that these contexts can be overtly social, as in the case of adult or peer assistance, or covertly social, as in the case of responding to an imagined or internalized audience. They also contend that children create their own zones of competence by working recursively on their own theories of cognition. Finally, they stress the importance of studying processes of change in children's thinking by observing cognition over time. |
| Brown, A. L., Palincsar, A. S., & Purcell, L. (1986) | Theoretical | This chapter discusses some of the reasons that many poor children experience problems learning to read and examines methods that are successful at overcoming some of the problems. The authors begin by presenting compelling evidence that passive resistance is not an unrealistic reaction to academic learning situations by children who have experienced early school failure. Furthermore, they claim that these children have been taught to behave according to particularly damaging stereotypes: extrinsically motivated, failure oriented, and unable to orchestrate or direct their own learning. The argument is made that, with adequate diagnosis replacing labeling, what could become a cumulative academic deficit can be overcome. The authors hold that the basic skills of self-directed reading can be taught, and that adequate teaching leads not only to improvement in academic skills, but also to important attitude change on the part of both the child and the teacher. |
| Brown, D. E., & Clement, J. | Theoretical and | In most work investigating factors influencing the success of analogies in instruction, an underlying assumption is that students have little or no knowledge of the target situation |

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| (1989) | empirical | (the situation to be explained by analogy). It is interesting to ask what influences the success of analogies when students believe they understand the target situation. If this understanding is not normative, instruction must aim at conceptual change rather than simply conceptual growth. Through the analysis of four case studies of tutoring interviews (two of which achieved some noticeable conceptual change and two of which did not) we propose a preliminary list of factors important for success in overcoming misconceptions via analogical reasoning. First, there must be a usable anchoring conception. Second, the analogical connection between an anchoring example and the target situation may need to be developed explicitly through processes such as the use of intermediate, bridging analogies. Third, it may be necessary to engage the student in a process of analogical reasoning in an interactive teaching environment, rather than simply presenting the analogy in text or lecture. Finally, the result of this process may need to be more than analogical transfer of abstract relational structure. The analogies may need to be used to enrich the target situation, leading to the student's construction of a new explanatory model. |
| Bruner, J. (1966) | Theoretical | This book examines how mental growth proceeds and the ways in which teaching can profitably adapt itself to that progression and help it along. The author references his theory of "evolutionary instrumentalism," the idea that instruction is the means of transmitting the tools and skills of a culture, especially the symbolic tools of language, number, and logic. Comprehensive theories of instruction should specify four components: (1) the experiences that facilitate a predisposition toward learning, (2) the ways that subject matter should be structured to be most readily grasped by learners, (3) the best sequencing of materials, and (4) the nature and pacing of rewards and punishments in the process of learning and teaching. The author repeatedly offers insights into the manner in which language functions as an instrument of thought. |
| Bunch, G. C., Kibler, A., & Pimentel, S. (2012) | Theoretical | This paper opens a larger conversation about what must be done to realize opportunities presented by the Common Core State Standards in English Language Arts and the literacy standards in other subject areas. It emphasizes the simultaneous challenges and opportunities for ELLs. The paper emphasizes that texts are approached differently for different purposes. Students need opportunities to approach texts with these varied |

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| | | purposes in mind. It also highlights how ELLs may be well served by opportunities to explore and justify their own “textual hypotheses,” even if their initial interpretations diverge from those of the teacher. |
| Candela, A. (1999) | Empirical | This qualitative study on discursive classroom interaction from the student perspective is designed to demonstrate the active and reflective participation of children in the processes of knowledge negotiation and construction. The study examines the experiences of lower-class children from a marginal urban area of Mexico city. Their interactions in science class at a public elementary school are considered. The research is intended to be descriptive, not prescriptive, and as such it does not advocate a particular approach to teaching or learning, nor does it attempt to evaluate the quality of the observed science instruction. |
| Carpenter, T. P., Fennema, E., & Franke, M. L. (1996) | Theoretical | In this article, the authors propose that an understanding of students’ thinking can provide coherence to teachers’ pedagogical content knowledge and their knowledge of subject matter, curriculum, and pedagogy. The authors describe a research-based model of children’s thinking that teachers can use to interpret, transform, and reframe their informal or spontaneous knowledge about students’ mathematical thinking. Their major thesis is that children enter school with a great deal of informal or intuitive knowledge of mathematics that can serve as the basis for developing much of the formal mathematics of the primary school curriculum. The development of abstract symbolic procedures is characterized as progressive abstractions of students’ attempts to model action and relations depicted in problems. Although they focus on one facet of teachers’ pedagogical content knowledge, the authors argue that understanding students’ thinking provides a basis for teachers to reconceptualize their own knowledge more broadly. |
| Carpenter, T. P., Fennema, E., Peterson, P. L., & Carey, D. A. (1988) | Empirical | This study investigated forty 1st grade teachers’ pedagogical content knowledge of children’s solutions of addition and subtraction word problems. Most teachers could identify many of the critical distinctions between problems and the primary strategies that children used to solve different kinds of problems. But this knowledge generally was not organized into a coherent network that related distinctions between problems, children’s solutions, and problem difficulty. The teachers’ knowledge of whether their own students |

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| | | could solve different problems was significantly correlated with student achievement. |
| Carpenter, T. P., Fennema, E., Peterson, P. L., Chiang, C. P., & Loef, M. (1989) | Empirical | This study investigated teachers' use of knowledge from research on children's mathematical thinking and how their students' achievement is influenced as a result. Twenty 1st grade teachers, assigned randomly to an experimental treatment, participated in a month-long workshop in which they studied a research-based analysis of children's development of problem-solving skills in addition and subtraction. Other 1st grade teachers (N=20) were assigned randomly to a control group. Although instructional practices were not prescribed, experimental teachers taught problem solving significantly more and number facts significantly less than did control teachers. Experimental teachers encouraged students to use a variety of problem-solving strategies, and they listened to processes their students used significantly more than did control teachers. Experimental teachers knew more about individual students' problem-solving processes, and they believed that instruction should build on students' existing knowledge more than did control teachers. Students in experimental classes exceeded students in control classes in number fact knowledge, problem solving, reported understanding, and reported confidence in their problem-solving abilities. |
| Cazden, C. B. (2001) | Theoretical | Noting that classroom communication is a central issue in school systems, this book investigates classroom discourse within the framework of applied linguistics and discusses research drawn from elementary, secondary and postsecondary classrooms. The first section deals with teacher-student talk and includes chapters on sharing time, the structure of lessons, variations in lesson structure, differential treatment, and classroom discourse and student learning. Student-student talk is the focus of the second section, which contains chapters on cognitive processes and contextual influences of peer interactions. The third section reviews ways of talking in the classroom, and includes chapters on the teacher-talk register and the student-talk register. |
| Chase, W. G., & Simon, H. A. (1973) | Empirical | This paper develops a technique for isolating and studying the perceptual structures that chess players perceive. Three chess players of varying strength (from master to novice) were confronted with two tasks: (1) a perception task, where the player reproduces a chess position in plain view, and (2) de Groot's short-term recall task, where the player |

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| | | reproduces a chess position after viewing it for five seconds. The successive glances at the position in the perceptual task and long pauses in the memory task were used to segment the structures in the reconstruction protocol. The size and nature of these structures were then analyzed as a function of chess skill. |
| Cheuk, T. (2011) | Theoretical | Specific student practices (from the Common Core State Standards in Mathematics and Framework for K-12 Science Education) and portraits (from the Common Core State Standards for English Language Arts and Literacy) are grouped in a Venn diagram to compare and contrast student competencies across disciplines. |
| Chi, M. T. H. & Roscoe, R. (2002) | Theoretical | Students engaged in learning a large body of related knowledge often possess some incorrect, naïve knowledge about the domain. These “misconceptions” must be removed and the correct conception must be built in order for students to achieve a deep understanding. This repair process is generally referred to as conceptual change. Although conceptual change has been discussed for several decades within different research contexts, the literature nevertheless presents a somewhat blurry picture of what exactly misconceptions are, what constitutes conceptual change, and why conceptual change is difficult. In this chapter, the authors suggest that one should think of misconceptions as ontological miscategorizations of concepts. From this perspective, conceptual change can be viewed as a simple shift of a concept across lateral (as opposed to hierarchical) categories. The authors argue that this process is difficult if students lack awareness of when a shift is necessary or lack an alternative category into which to shift the target concept. These ideas are explored using a detailed example (diffusion) from a broad class of science concepts (emergent processes) that are often robustly misunderstood by students. |
| Chi, M. T. H., & VanLehn, K. (1991) | Empirical | Several earlier studies have found the amount learned while studying worked-out examples is proportional to the number of self-explanations generated while studying examples. A self-explanation is a comment about an example statement that contains domain-relevant information over and above what was stated in the example line itself. This article analyzes the specific content of self-explanations generated by students while studying physics examples. In particular, the content is analyzed into pieces of constituent |

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| | | <p>knowledge that were used in the comments. These were further analyzed in order to trace the source of knowledge from which self-explanations could be generated. The results suggest that there are two general sources for self-explanations. The first is deduction from knowledge acquired earlier while reading the text part of the chapter, usually by simply instantiating a general principle, concept, or procedure with information in the current example statement. The second explanation is generalization and extension of the example statements. Such construction of the content of the example statements yields new general knowledge that helps complete the students' otherwise incomplete understanding of the domain principles and concepts. The relevance of this research for instruction and models of explanation-based learning is discussed.</p> |
| <p>Chi, M. T. H., Bassok, M., Lewis, M. W., Reimann, P., & Glaser, R. (1989)</p> | <p>Empirical</p> | <p>This paper analyzes the self-generated explanations (from talk-aloud protocols) that “good” and “poor” students produce while studying worked-out examples of mechanics problems, and their subsequent reliance on examples during problem solving. The authors find that “good” students learn with understanding: They generate many explanations that refine and expand the conditions for the action parts of the example solutions, and relate these actions to principles in the text. These self-explanations are guided by accurate monitoring of their own understanding and misunderstanding. Such learning results in example-independent knowledge and in a better understanding of the principles presented in the text. “Poor” students do not generate sufficient self-explanations, monitor their learning inaccurately, and subsequently rely heavily on examples. The authors then discuss the role of self-explanations in facilitating problem solving, as well as the adequacy of current AI models of explanation-based learning to account for these psychological findings.</p> |
| <p>Chi, M. T. H., Feltovich, P. J., & Glaser, R. (1981)</p> | <p>Empirical</p> | <p>The representation of physics problems in relation to the organization of physics knowledge is investigated in experts and novices. Four experiments examine (a) the existence of problem categories as a basis for representation; (b) differences in the categories used by experts and novices; (c) differences in the knowledge associated with the categories; and (d) features in the problems that contribute to problem categorization and representation. Results from sorting tasks and protocols reveal that experts and novices begin their problem representations with specifiably different problem categories,</p> |

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| | | and completion of the representations depends on the knowledge associated with the categories. The experts initially abstract physics principles to approach and solve a problem representation, whereas novices base their representation and approaches on the problem's literal features. |
| Chi, M. T. H., Glaser, R., & Rees, E. (1982) | Theoretical and empirical | The central thesis of this paper is that a major component of intelligence is the possession of a large body of accessible and usable knowledge. Accordingly, the authors have grounded their research in a conceptual framework based on expertise (defined as the possession of a large body of knowledge and procedural skill). Two fields that have similarly explored an expertise-informed conceptualization of intelligence, cognitive psychology and artificial intelligence, are discussed. The authors present several studies investigating high and low competence in problem solving in physics and conclude that the problem-solving difficulties of novices can be attributed mainly to inadequacies of their knowledge bases and not to limitations in either the architecture of their cognitive systems or their processing capabilities. The authors conclude with implications and recommendations for teaching and learning, including instruction in recognizing and manipulating existing knowledge. |
| Chi, M.T.H., Slotta, J.D., & de Leeuw, N. (1994) | Theoretical | Conceptual change occurs when a concept is reassigned from one category to another. The theory of conceptual change in this article explains why some kinds of conceptual change, or category shifts, are more difficult than others. The theory assumes that entities in the world belong to different ontological categories, such as <i>matter</i> (things) and <i>processes</i> . Many scientific concepts (light, for example) belong in a subcategory of <i>processes</i> , which we call <i>constraint-based interactions</i> . However, students initially categorize these concepts as <i>matter</i> . The ontological status of the initial and scientific conceptions determines the difficulty of learning. If the two conceptions are ontologically compatible (e.g., both are <i>matter</i>), conceptual change is easy. If the two conceptions are ontologically distinct, learning is difficult. Evidence for these two cases is presented from studies of learning about the human circulatory system and about key physics concepts, such as heat and light. |

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| Chiang, C. S., & Dunkel, P. (1992) | Empirical | <p>This study investigates the listening comprehension of 388 high-intermediate listening proficiency (HILP) and low-intermediate listening proficiency (LILP) Chinese students of English as a foreign language. These students listened to a lecture, the discourse of which was (a) familiar-unmodified, (b) familiar-modified, (c) unfamiliar-unmodified, or (d) unfamiliar-modified. The modified discourse contained information redundancies and elaborations. After the lecture, the subjects took a multiple-choice exam testing recognition of information presented in the lecture and general knowledge of the familiar ("Confucius and Confucianism") and unfamiliar ("The Amish People") topics. A significant interaction between speech modification (redundant vs. nonredundant speech) and listening proficiency (HILP vs. LILP) indicated that the HILP students benefited from speech modification, which entailed elaboration and redundancy of information, but the LILP students did not. A significant interaction between prior knowledge (familiar vs. unfamiliar topic) and test type (passage-independent vs. passage-dependent items) was also found. For both the HILP and LILP subjects, prior knowledge had a significant impact on subjects' memory for information contained in the passage-independent test items on the post lecture comprehension test. Those EFL subjects who listened to the familiar-topic lecture on Confucius had higher passage-independent than passage-dependent scores. There was no difference in the performance on the passage-independent and passage-dependent items of those who listened to the lecture on an unfamiliar topic (the Amish). However, the passage-independent performance of subjects who listened to the familiar topic lecture was superior to that of those who listened to the lecture on the unfamiliar topic. Subjects' performance on passage-dependent items did not differ significantly whether the familiar or unfamiliar topic was presented. Implications of the findings for assessing and teaching EFL listening comprehension are suggested.</p> |
| Chiesi, H. L, Spilich, G. J., & Voss, J. F. (1979) | Empirical | <p>This research was concerned with how knowledge of a given topic influences the acquisition of topic-related information. The knowledge domain studied was baseball, and a knowledge structure was postulated which included the goal structure as well as the states and actions of the game. In each of five experiments, passages of domain-related information were presented and performance was compared for individuals with high</p> |

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| | | (HK) or low (LK) baseball knowledge. Experiment 1 indicated that HK recognition performance was superior to LK, and that this difference was greater for changes in new material that were more important in terms of the game. Experiment 2 showed that HK individuals need less information to make recognition judgments than LK individuals. Experiment 4 showed that HK individuals anticipated a greater percentage of high-level goal state outcomes than LK individuals. Experiments 3 and 5 indicated that HK individuals are superior at recalling event sequences, a finding attributed to the greater ability of HK individuals to relate successive segments of input information. The results are considered in relation to a conceptual framework and to related literature. |
| Chin, C. (2006) | Empirical | The purpose of this study was (a) to develop an analytical framework that represents classroom talk and questioning in science, (b) to find out how teachers use questioning to engage their students in thinking about conceptual content that enables the construction of knowledge, and (c) to identify the various forms of feedback provided by teachers in the follow-up move of the initiation response follow-up format of teaching exchange. Several lessons from year 7 classes were observed across a variety of lesson structures such as expository teaching, whole-class discussions, laboratory demonstration, and hands-on practical work. The lessons were audiotaped and videotaped. Transcripts of the lessons were made and analyzed, with particular attention paid to interactions that involved questions. Using the “Questioning-Based Discourse” analytical framework developed in this study, four different types of feedback were identified. Interactional issues related to ways of speaking and questioning that encourage student responses and thinking are addressed. This information provides a description of what constitutes effective discourse in science teaching and learning, and will also be useful for both teachers and teacher educators in identifying an appropriate repertoire of skills for subsequent teacher education and professional development. |
| Chin, C. (2007) | Empirical | The purpose of this study was to find out how teachers use questions in classroom discourse to scaffold student thinking and help students construct scientific knowledge. The study was conducted in large-class settings where the medium of instruction was English although the students were non-native speakers of the language. Six teachers teaching grade 7 science classes from four schools participated in the study. Thirty-six |

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| | | <p>lessons covering a range of topics were observed across a variety of lesson structures such as expository teaching, whole-class discussions, and laboratory work. The lessons were audiotaped and videotaped. Verbal transcripts of classroom discourse were analyzed interpretively. Particular attention was paid to questioning exchanges that stimulated productive thinking in students, as manifested by their verbal responses. A framework was developed that included four questioning approaches adopted by the teachers. This included Socratic questioning, verbal jigsaw, semantic tapestry, and framing. This paper describes these various questioning approaches, their features, and the conditions under which they were used. It also discusses the implications of these approaches for instructional practice. The findings from this study have potential application in translating research insights into practical advice for teachers regarding tactical moves in classroom discourse. The findings also provide guidelines for teachers to increase their repertoire of questioning skills.</p> |
| Chinn, C. A., & Brewer, W. F. (1993) | Theoretical | <p>Understanding how science students respond to anomalous data is essential to understanding knowledge acquisition in science classrooms. This article presents a detailed analysis of the ways in which scientists and science students respond to such data. The authors postulate that there are seven distinct forms of response to anomalous data, only one of which is to accept the data and change theories. The other six responses involve discounting the data in various ways in order to protect the pre-instructional theory. The authors analyze the factors that influence which of these seven forms of response a scientist or student will choose, giving special attention to the factors that make theory change more likely. The implications of the framework for science instruction are discussed.</p> |
| Clement, J. (1988) | Empirical | <p>Evidence from videotapes of experts thinking aloud is presented which documents the spontaneous use of analogies in scientific problem solving. Four processes appear to be important in using an analogy: (1) generating the analogy; (2) establishing confidence in the validity of the analogy relation; (3) understanding the analogous case; and (4) applying findings to the original problem. This study concentrates on the first of these processes. Evidence was found for three different methods of analogy generation: generation via a principle (one case), generation via an association (eight cases), and generation via a</p> |

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| | | transformation (eighteen cases). Although the mechanism underlying analogy generation is usually described as an association process, transformation processes, where the subject modifies or transforms some aspect of the original problem, may be just as important if not more important. In contrast to the usual view of an analogous case as already residing in memory, several of the analogous cases were quite novel, indicating that they were newly invented Gedanken experiments. The usefulness of some analogies appears to lie in a “provocative” function of activating additional knowledge schemata that is different from the commonly cited “direct transfer” function in which established knowledge is transferred fairly directly from the analogous to the original case. |
| Clement, J. (1989) | Empirical | In this study thirty-four spontaneous analogies produced by sixteen college freshmen while solving qualitative physics problems are analyzed. A number of the analogies were invalid in the sense that they led to an incorrect answer from the physicist’s point of view. However, many were valid, and a few were powerful in the sense that they seemed not only to help the student solve the problem, but led to generalizations indicating that some conceptual change was taking place. Some of the effective analogies have also been observed in the solutions used by expert scientists and mathematicians. These findings support the position that many creative reasoning processes are ordinary thinking processes used with special purposes in mind, not unanalyzable acts of genius. This suggests that analogies are an intuitive form of reasoning that could be taken advantage of in instruction to a greater extent than is currently the case. |
| Clifton, C., Jr., & Slowiaczek, M. L. (1981) | Empirical | Three experiments investigated the integration of new information with old concepts about famous people and the extent to which learning conditions influence this integration. In experiments 1 and 2, subjects learned a set of facts about famous people in a list or in the context of a short biography. The facts were normatively related to prior knowledge of the person. Subjects were tested on sentences that required them to make an inference combining the newly learned fact with a well-known old fact. For example, subjects learned “Walt Disney grew up on a farm,” and were tested with “The creator of Mickey Mouse grew up on a farm.” They were faster when the newly learned facts were clearly related to old knowledge about the person, but only in the biography condition. In experiment 3, inferences were verified faster when the description and fact were |

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| | | consistent with the same perspective, but only in the story condition, not in the list condition. These experiments suggest that activating old knowledge facilitates integration and that new information is not necessarily integrated with all old knowledge about a given concept but, rather, is organized within a subconcept. |
| Cohen, C.E. (1981) | Empirical | Current assumptions about the processing role of prior social knowledge in social perception may need modification when applied to situations that are richer and more complex than typical research paradigms. Two experiments investigated whether stereotypic knowledge would influence social perception in a more realistic setting. In experiment 1, subjects watched a videotape of a target woman identified either as a waitress or a librarian. Subjects more accurately remembered features of the woman that were consistent with their prototype of a waitress (librarian) than features that were inconsistent. The prototype-consistency effect did not interact with the delay time before recognition memory was assessed. In experiment 2, subjects learned the occupational information either before or after watching the tape. The prototype-consistency effect from experiment 1 was replicated. In addition, knowing the target's occupation while watching her led to increased accuracy for both consistent and inconsistent information. The probable role of both encoding and retrieval processes in contributing to this effect is noted. Perceivers' stereotypic prior knowledge influenced their memory of a target person's behavior even in a realistic person-perception situation. Conditions that favor the memorability of consistent versus inconsistent information are discussed. |
| Cohen, E. G. (1994) | Theoretical | Moving beyond the general question of effectiveness of small group learning, this conceptual review proposes conditions under which the use of small groups in classrooms can be productive. Included in the review is recent research that manipulates various features of cooperative learning as well as studies of the relationship of interaction in small groups to outcomes. The analysis develops propositions concerning the kinds of discourse that are productive of different types of learning, as well as propositions concerning how desirable kinds of interaction may be fostered. Whereas limited exchange of information and explanation are adequate for routine learning in collaborative seatwork, more open exchange and elaborated discussion are necessary for conceptual learning with group tasks and ill-structured problems. Moreover, task instructions, student |

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| | | preparation, and the nature of the teacher role that are eminently suitable for supporting interaction in more routine learning tasks may result in unduly constraining the discussion in less structured tasks where the objective is conceptual learning. The research reviewed also suggests that it is necessary to treat problems of status within small groups engaged in group tasks with ill-structured problems. With a focus on task and interaction, the analysis attempts to move away from the debates about intrinsic vs. extrinsic rewards and goal-resource interdependence that have characterized research in cooperative learning. |
| Corno, L., & Mandinach, E. B. (1983) | Theoretical | This article analyzes the concept of student cognitive engagement and the manner in which classroom instruction may develop self-regulated learners. Since theory and research on academic motivation to date only vaguely define the role of learning processes, and since studies of learning strategies rarely assess motivational outcomes, the authors' analysis integrates these two streams of literature. The authors also identify specific features of instruction and discuss how they might influence the complex of student interpretive processes focal to classroom learning and motivation. Measurement issues and research strategies peculiar to the investigation of cognitive engagement are addressed. |
| Corno, L., & Rohrkemper, M. (1985) | Theoretical | This article addresses how children may derive intrinsic motivation to learn through the development of particular cognitive skills. It then investigates which social-instructional classroom tasks support and enhance the development of these skills. The authors make salient the important distinction between independent learning and classroom learning, the second of which is an appreciably more complex construct due to classroom interactions, peer relationships, power structures, etc. Traditional discussions of intrinsic motivation frequently reference research on independent learning, which the authors argue is a misguided approach when considering students in classrooms. Accordingly, the authors frame their arguments within the body of research on classroom learning. Several suggestions to foster the development of students' intrinsic motivation are given, including incorporating student choice into classroom tasks, giving frequent and precise formative feedback to students, and helping students to set short- and long-term learning |

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| Covington, M. V. (1984) | Theoretical | This article describes the self-worth theory of achievement motivation, summarizes the research generated under this model, and considers the implications of this research for classroom teaching and learning. The author focuses on ability perceptions and the developmental changes in these perceptions, strategies that students employ to maintain a sense of worthiness in the face of failure, and potential conflict of values between teachers and students. |
| Covington, M. V., & Omelich, C. L. (1984) | Empirical | This study investigated the qualitative (motivational) and quantitative (performance) consequences of two fundamental features of task-mastery learning structures: retesting opportunities and criterion-referenced grading. As part of an introductory psychology course, 435 undergraduates were assigned to a norm-referenced (competitive) or a criterion-referenced grading system and to either a single-test or retest condition for a two week period ending with a midterm examination. Results show that performance superiority of mastery instruction occurred primarily because of the retest option, with enhanced motivation due to both retesting opportunities and criterion-referenced standards. Path analysis confirmed a complex interrelationship among these factors such that increased performance (caused by the retesting option) enhanced motivational involvement, which in turn fostered further learning gains. |
| Crooks, T. J. (1988) | Review | In most educational programs, a substantial proportion of teacher and student time is devoted to activities which involve (or lead directly to) evaluation by the teacher of student products or behavior. This review summarizes results from fourteen specific fields of research that cast light on the relationships between classroom evaluation practices and student outcomes. Particular attention is given to outcomes involving learning strategies, motivation, and achievement. Where possible, mechanisms are suggested that could account for the reported effects. The conclusions derived from the individual fields are then merged to produce an integrated summary with clear implications for effective educational practice. The primary conclusion is that classroom evaluation has powerful direct and indirect impacts, which may be positive or negative, and thus deserves very |

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| | | thoughtful planning and implementation. |
| Cross, D. R., & Paris, S. G. (1988) | Empirical | Children’s understanding of their own cognitive skills, or metacognition, has been hypothesized to play a major role in learning and development. In this study, the authors examine the developing relation between children’s metacognition and reading comprehension. Children in 3rd and 5th grade classes were given an experimental curriculum, Informed Strategies for Learning, designed to increase their awareness and use of effective reading strategies. In both grades, children in experimental classes made significant gains in metacognition and the use of reading strategies compared with children in control classes. The multivariate profiles of reading skills derived from the developmental analyses helped to identify subgroups of children who responded differently to the metacognitive instruction. Although there were specific aptitude-by-treatment interactions, there was a general trend for metacognition and strategic reading to become more congruent from eight to ten years of age. |
| Davis, H. A. (2003) | Theoretical | The purpose of this article is to augment current understanding of the social contexts of education by synthesizing research on the nature and influence of relationships between students and their teachers. The author considers three questions. First, how have we conceptualized students’ relationships with teachers? Second, how have our approaches to studying relationships shaped our understanding of the phenomenon? Third, looking across these different approaches to studying student-teacher relationships, what do we know about the nature and influence of student-teacher relationships developmentally? The author reviews in three broad themes the multiple conceptions to the study of student-teacher relationships. These include student-teacher relationships from attachment perspectives, from motivation perspectives, and from sociocultural perspectives. Each approach is understood to pose a critical question that needs to be addressed conceptually, methodologically, and developmentally. Looking across approaches, findings reveal one limitation of our current understanding of student-teacher relationships: most of our knowledge about relationships for a particular population of students (e.g., preschool, elementary school, middle school, or high school) is embedded within knowledge about a particular approach (e.g., attachment, motivation, or sociocultural) as well as within specific methods of studying relationships. Implications |

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| | | for future research and theory development are discussed. |
| Davis, R. B. (1983) | Theoretical | In this chapter, the author begins by describing an unfortunately prevalent conception of mathematics education: focused on external observable behavior, devoid of discussions of thought processes, and reliant on statistical tests of significance. Often a researcher's unit of analysis, the "learning event," involves thirty or more students over a period of several weeks. The author argues that this is far too wide a lens to allow meaningful observations. Instead, researchers of mathematical learning must consider the thought processes of individual students and gather data primarily through task-based interviews. Using such a research paradigm will foster a shift in emphasis from rote drill, routine practice, and algorithmic performance to creativity, vision, understanding, and problem solving. |
| Delclos, V. R., & Harrington, C. (1991) | Empirical | Thirty 5th and 6th grade students were given extensive proactive instruction on the content of a computer-based problem-solving game called Rocky's Boots. Participants were then divided into three treatment groups that received either problem-solving training, problem-solving and self-monitoring training, or no further training. The monitored problem-solving group solved more complex problems than either of the other two groups, and they took less time to solve those complex problems. The specific impact of the monitoring training is discussed as evidence for the importance of strategy monitoring in learning to solve problems. Results are discussed as evidence of the potential impact of proactive instruction on problem-solving performance. |
| Dickinson, A. K. (1978) | Theoretical | This book is a collection of essays dealing with the politics and pedagogy of teaching history. A common theme uniting the essays is the notion that history curriculum should promote participatory inquiry by students and not treat history simply as a body of passively received information. History teachers are urged to foster within their students an appreciation of the discipline (the process of generating historical explanations by inferential thinking from available evidence), rather than just a familiarity with a volume of detailed knowledge. |
| Dochy, F. (1996) | Theoretical and | Prior knowledge is widely understood to be a key factor in student learning. This article puts forth a new theoretical construct to understand prior knowledge. Previous |

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| | empirical | conceptualizations have been too unitary in their approach, argue the authors, and a more nuanced understanding of prior knowledge is needed. The authors propose that four dimensions comprise prior knowledge: cognitive-psychological, educational-psychological, psychometric, and content-based. By disaggregating prior knowledge according to this model, a knowledge profile can be created for a student, yielding a more detailed and actionable description of the student's academic readiness. The authors report on the results of a study that attempts to test the validity of their multi-dimensional model through item analysis of a state test of economics prior knowledge. Implications for differentiating diagnostic tools and instruction are discussed. |
| Dochy, F., Segers, M., & Buehl, M. M. (1999) | Review | The purpose of this article was (a) to review prior knowledge research and its role in student performance, and (b) to examine the effects of prior knowledge in relation to the method of assessment. The authors selected 183 articles, books, papers, and research reports related to prior knowledge. While prior knowledge generally had positive effects on students' performance, the effects varied by assessment method. More specifically, prior knowledge was more likely to have negative or no effects on performance when flawed assessment measures were used. However, in some studies, flawed methods yielded informative results. Thus, in educational research the implications of assessment measures must be considered when examining the effects of prior knowledge. |
| Duit, R. (1991) | Review and theoretical | In the past fifteen years much research (empirical as well as analytical) on analogy use has been carried out. This paper presents an overview of the research and includes metaphors in an analysis of the educational power of analogies. Analogies and metaphors are viewed as close relatives. Analogies are shown to be valuable tools in conceptual-change learning if their metaphorical aspects are regarded. The paper deliberately takes a constructivist position. The role of analogies in the learning process is mainly analyzed from this perspective. |
| Dweck, C. S. (1986) | Theoretical | This article describes how motivational processes influence a child's acquisition, transfer, and use of knowledge and skills. Recent research within the social-cognitive framework illustrates adaptive and maladaptive motivational patterns. A research-based model of motivational processes is presented that shows how the particular performance and |

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| | | learning goals children pursue through cognitive tasks shape their reactions to success and failure and influence the quality of their cognitive performance. Implications for practice and the design of interventions to change maladaptive motivational processes are outlined. It is suggested that motivational patterns may contribute to gender differences in mathematics achievement and that empirically based interventions may prevent current achievement discrepancies and provide a basis for more effective socialization. |
| Dweck, C. S., & Elliott, E. S. (1983) | Theoretical | This chapter deals with motivational factors that affect learning and performance. More specifically, it deals with the many factors other than ability that affect the acquisition and display of ability, particularly intellectual ability. Among these are factors that determine whether children seek or avoid tasks they can profit from most, whether children successfully display the skills we know they have, and whether they succeed in acquiring new skills we know they can. |
| Dweck, C. S., & Leggett, E. L. (1988) | Theoretical | Past work has documented and described major patterns of adaptive and maladaptive behavior: the mastery-oriented and the helpless patterns. In this article, the authors present a research-based model that accounts for these patterns in terms of underlying psychological processes. The model specifies how individuals' implicit theories orient them toward particular goals and how these goals set up the different patterns. The authors show how each feature (cognitive, affective, and behavioral) of the adaptive and maladaptive patterns can be seen to follow directly from different goals. They then examine the generality of the model and use it to illuminate phenomena in various domains. Finally, they place the model in its broadest context and examine its implications for our understanding of motivational and personality processes. |
| Eisenberg, N., Valiente, C., & Eggum, N. D. (2010) | Theoretical and review | In this article, the authors review research on the relations of self-regulation and its dispositional substrate, effortful control, to variables involved in school success. They present a conceptual model in which the relation between self-regulation/effortful control and academic performance is mediated by low maladjustment and high-quality relationships with peers and teachers, as well as school engagement. They then review research indicating that effortful control and related skills are indeed related to maladjustment, social skills, relationships with teachers and peers, school engagement, |

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| | | and academic performance. |
| Elliott, E. S., & Dweck, C. S. (1988) | Empirical | This study tested a framework in which goals are proposed to be central determinants of achievement patterns. Learning goals, in which individuals seek to increase their competence, were predicted to promote challenge seeking and a mastery-oriented response to failure regardless of perceived ability. Performance goals, in which individuals seek to gain favorable judgments of their competence or avoid negative judgments, were predicted to produce challenge avoidance and learned helplessness when perceived ability was low and to promote certain forms of risk avoidance even when perceived ability was high. Manipulations of relative goal value (learning vs. performance) and perceived ability (high vs. low) resulted in the predicted differences on measures of task choice, performance during difficulty, and spontaneous verbalizations during difficulty. Particularly striking was the way in which the performance goal-low perceived ability condition produced the same pattern of strategy deterioration, failure attribution, and negative affect found in naturally occurring learned helplessness. Implications for theories of motivation and achievement are discussed. |
| Ennis, R. H. (1985) | Theoretical | This article discusses the logical basis for measuring critical thinking skills. The author defines critical thinking, compares critical thinking and higher-order thinking in light of Bloom's taxonomy, and considers how dispositions and abilities relate to critical thinking. |
| Erickson, F. (2007) | Theoretical | In this chapter, the author discusses an approach to formative assessment of student learning in which the time loops between data collection and data use are especially short, and the focus of attention in assessment is also especially pertinent to informing the real-time conduct of instruction by teachers. He begins by defining a particular kind of formative assessment, "proximal formative assessment," and then discusses its general characteristics. In the middle section of the chapter, examples of proximal formative assessment in early-grade classrooms are presented. A first set of examples comes from an accomplished teacher in a suburban public school system whose institutional circumstances, curriculum, and teaching practice is typical of that found in many early-grade classrooms in the United States. A second set of examples comes from the classrooms of accomplished teachers whose practice is atypical. They teach in a university- |

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| | | sponsored laboratory school and, in the absence of external accountability pressures currently experienced in public schools, they are teaching science topics very thoroughly, with the aim of fostering deep conceptual understanding on the part of their students. The chapter concludes with a section discussing the implications of the examples and of the kind of within-classroom assessment by teachers that the author calls both proximal and formative. |
| Facione, P. A. (1990) | Theoretical | Using a qualitative research methodology, known as the Delphi Method, an interactive panel of experts was convened to work toward a consensus on the role of critical thinking (CT) in educational assessment and instruction. In Delphi research, experts participate in several rounds of questions that require thoughtful and detailed responses. Panelists work toward consensus by sharing reasoned opinions and reconsidering the opinions with regard to comments, objections, and arguments offered by other experts. A total of forty-six scholars, educators, and leading figures in CT theory and CT assessment research were gathered for the panel meetings. About half of the panelists were primarily affiliated with philosophy departments; the others were affiliated with education, social sciences, or physical sciences. Recommendations resulting from the discussion rounds address the cognitive skill dimension of CT, the dispositional dimension of CT, and specific recommendations on CT instruction and assessment, including development of a CT curriculum. A discussion of commercially available CT assessment tools, a bibliography with an emphasis on assessment, and a set of letters which chronicles the progress of the Delphi research group are appended. |
| Fang, Z., Schleppegrell, M. J. (2008) | Theoretical | This book presents a linguistic approach to teaching reading in different subjects, an approach that focuses specifically on language. Central to this approach is a view that knowledge is constructed in and through language and that language changes with changes in knowledge. As students move from elementary to secondary schools, they encounter specialized knowledge and engage in new contexts of learning in all subjects. This means that the language of secondary school learning is quite different from the language of the elementary years. While in the elementary years the subject matter of reading materials is often close to students' everyday life experiences, the curriculum of secondary school deals with knowledge that is removed from students' personal lives and |

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| | | <p>everyday contexts. The language that constructs this more specialized knowledge thus tends to be more abstract, technical, information-laden, and hierarchically organized than the more familiar language that students typically encounter during the elementary years. Students need to develop specialized literacies (literacy relevant to each content area) as well as a critical literacy they can use across subject areas to engage with, reflect on, and assess specialized and advanced knowledge.</p> |
| <p>Ferrari, M., & Chi, M. T. H. (1998).</p> | <p>Theoretical and empirical</p> | <p>Unlike some pivotal ideas in the history of science, the basic notion of natural selection is remarkably simple and so one might expect most students to easily grasp the basic principles of the Darwinian theory; yet many students nevertheless have difficulty understanding Darwinian evolution. The authors suggest that misconceptions about natural selection arise from mistaken categorization. Their thesis for explaining students' failure to understand this concept or evolution in general is not that they necessarily fail to understand individual Darwinian principles; rather, they often fail to understand the ontological features of equilibration processes, of which evolution is one instance. They thus attribute the evolutionary process in general, and natural selection in particular, with event-like properties. For example, naïve students appear to focus on the idea of survival of the fittest, but embed this idea within an event ontology that involves actors struggling to overcome obstacles and achieve goals. Results showed that most naïve subjects' evolutionary explanations reflected an event ontology. Furthermore, event ontology attributes were positively correlated with non-Darwinian explanations; by contrast, equilibration attributes, when present, were positively correlated with key Darwinian principles. These findings suggest that students would greatly benefit from science instruction that emphasized the underlying ontology of modern evolutionary theory.</p> |
| <p>Flavell, J. H. (1979)</p> | <p>Theoretical</p> | <p>Studies suggest that young children are quite limited in their knowledge of cognitive phenomena and do relatively little monitoring of their own memory, comprehension, and other cognitive enterprises. Metacognitive knowledge is one's stored knowledge or beliefs about oneself and others as cognitive agents, about tasks, about actions or strategies, and about how all these interact to affect the outcomes of any sort of intellectual enterprise. Metacognitive experiences are conscious cognitive or affective experiences that occur during the enterprise and concern any aspect of it – often, how well it is going. Research is</p> |

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| | | needed to describe and explain spontaneous developmental acquisitions in this area and find effective ways of teaching metacognitive knowledge and cognitive monitoring skills. |
| Fuchs, L. S., & Fuchs, D. (1986) | Empirical | This study investigated the effects of formative evaluation procedures on student achievement, using a meta-analysis of twenty-one controlled studies involving preschool, elementary, and secondary students (predominantly mildly handicapped). Ninety-six relevant effect sizes, with an average weighted effect size of .70, were generated. The magnitude of the effect of formative evaluation was associated with publication type, data-evaluation method, data display, and use of behavior modification. Within a group of studies that employed predominantly mildly handicapped students, results indicate that the use of systematic formative evaluation procedures significantly increased students' school achievement, both statistically and practically. |
| Gandara, P. C., & Contreras, F. (2009) | Theoretical and empirical | The main thesis of this book is that the education of Latino youth constitutes a critical policy imperative bearing economic and social implications. The book outlines educational gaps between Latinos and other students, refutes myths about the Latino population, provides specific examples of effective program models, and makes policy recommendations. |
| Garcia, E., & Gonzalez, R. (1995) | Theoretical | The ethnic and linguistic diversity of U.S. schools has grown significantly in the last two decades. Such diversity provides distinct new challenges for school reform efforts. New policy and federal programs, particularly exemplified in Title VII of the 1994 reauthorization of the Elementary and Secondary Education Act, attempt to address this challenge. This act calls for integrated and comprehensive programming based on a new empirical and conceptual knowledge base that has emerged in the last decade. This article addresses the demographic circumstances of student diversity, the emerging knowledge base, and the related changes in federal education policy. |
| Garner, R. (1990) | Theoretical | It is widely accepted that intentional use of strategies can enhance learning. However, children and adults often fail to invoke strategic behaviors. In this article, five reasons for failure to use strategies are discussed: (1) poor cognitive monitoring, (2) primitive routines that yield a product, (3) a meager knowledge base, (4) attributions and classroom goals that |

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| | | do not support strategy use, and (5) minimal transfer. The author argues that use and failure to use strategies are not fruitfully studied without consideration of setting. A theory of settings reminds us that, when context varies, the nature of strategic activity often varies as well. |
| Gee, J. P. (1989) | Theoretical | This article defines literacy as the control of secondary uses of language. The author differentiates between the natural process of language acquisition and the formal process of language learning. Particular attention is given to the social conflict experienced by minority group students in formal classroom settings. |
| Gentner, D., & Kurtz, K. J. (2006) | Empirical | This research addresses the kinds of matching elements that determine analogical relatedness and literal similarity. Despite theoretical agreement on the importance of relational match, the empirical evidence is neither systematic nor definitive. In three studies, participants performed online evaluations of relatedness of sentence pairs that varied in either the object or relational match. Results show a consistent focus on relational matches as the main determinant of analogical acceptance. In addition, analogy does not require strict overall identity of relational concepts. Semantically overlapping but nonsynonymous relations were commonly accepted, but required more processing time. Finally, performance in a similarity-rating task partly paralleled analogical acceptance; however, relatively more weight was given to object matches. Implications for psychological theories of analogy and similarity are addressed. |
| Gibbons, P. (2009) | Theoretical | Deep understanding, critical thinking, subject knowledge, and control of academic literacy are goals held for all students. Educators face challenges in finding a way to help everyone, including English Language Learners (ELLs), reach these high expectations. This book presents an action-oriented approach that gives ELLs high-level support to match high expectations. The author details five broad areas that enable ELLs in the middle grades to participate in high-quality learning across the curriculum. She then presents guidelines on designing long-term, high-quality instruction that simultaneously provides explicit scaffolding for ELLs. |

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| Glaser, R. (1984) | Theoretical | This article investigates how psychological science’s increased understanding of the nature of human thinking and problem solving has contributed to instructional practices that might foster these higher-order abilities. A brief discussion of the implications of past theories for the teaching of thinking introduces a description of a sample of current programs for improving reasoning and problem-solving skills and related learning abilities. These current programs include process-oriented programs, programs that use generally familiar knowledge, problem-solving heuristics in well-structured domains, and logical thinking in the context of the acquisition of basic skills. These efforts are considered in light of current theory and findings in cognitive science, developmental psychology, and the study of human intelligence. The interaction between the development of problem-solving and learning skills and the acquisition of structures of domain-specific knowledge is discussed. Suggestions are made for developing thinking abilities in the context of the acquisition of knowledge and skill. |
| Glaser, R., & Chi, M. T. H. (1998) | Theoretical | Due largely to developments made in artificial intelligence and cognitive psychology during the past two decades, expertise has become an important subject for scholarly investigations. This book presents the variety of domains and human activities to which the study of expertise has been applied. Applying approaches influenced by such disciplines as cognitive psychology, artificial intelligence, and cognitive science, the contributors discuss those conditions that enhance and those that limit the development of high levels of cognitive skill. |
| Glasnapp, D. R., Poggio, J. P., & Ory, J. C. (1978) | Empirical | Using end-of-course achievement outcomes and long-term cognitive retention as criteria, this study provides comparative data on the effectiveness of a mastery and non-mastery approach to instruction. Differential effects across taxonomic levels were assessed for both criteria. The results indicated that mastery students performed significantly higher than non-mastery students for end-of-course outcomes at the highest taxonomic level and equally well for knowledge, comprehension, and application level outcomes. Retention differences were found for knowledge level outcomes only, with mastery students demonstrating significantly greater retention performance. The feasibility and desirability of implementing a learning-for-mastery paradigm in a single course at the college level are |

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| | | discussed relative to the magnitude of the study's results. |
| Gonzalez, N., Moll, L., & Amanti, C. (2005) | Theoretical | Working within the framework of funds of knowledge, this book examines the proposition that first-hand research experiences with families allow one to document unique, experientially-gained competence and knowledge, and that such engagement provides many possibilities for positive pedagogical actions. The funds of knowledge approach draws from both Vygotskian and neo-sociocultural perspectives to design a methodology that views the everyday practices of language and action as constructing knowledge. The approach facilitates a systematic and powerful way to represent communities in terms of the resources they possess and how to harness these resources for classroom teaching. This book accomplishes three objectives. First, it gives readers the basic methodology and techniques followed in the contributors' funds of knowledge research. Second, it extends the boundaries of what these researchers have done. Third, it explores the applications to classroom practice that can result from teachers knowing the communities in which they work. |
| Good, T. L., & Brophy, J. E. (1990) | Theoretical | The purpose of this book is to improve instruction by helping future teachers understand the realities of teaching, understand and organize relevant psychological theory, and become competent instructors. The book addresses student development (physical, cognitive, social, and personal), theories and techniques of instruction, learning environments (including classroom management, behavior management strategies, and student motivation), and student diversity (socioeconomic status, IQ, gender, emotional disturbances, creativity, special needs). Additionally, topics in educational measurement are discussed, including statistical concepts, test construction, and grade assignment. |
| Good, T. L., & Brophy, J. E. (1994) | Theoretical | This book presents an overview of contemporary research on a variety of topics, including classroom instruction, student learning and motivation, teacher expectations, and adapting instruction to the needs of individual learners. The book also includes sections on how to use quantitative and qualitative observational techniques for describing and improving instruction. |

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| Gottfried, A. E. (1990) | Empirical | Two studies, one longitudinal and one cross-sectional, demonstrate that for young elementary school children, academic intrinsic motivation is a reliable, valid, and significant construct. It was positively related to achievement, IQ, and perception of competence, and inversely related to anxiety. Academic intrinsic motivation at age 9 was significantly predicted by motivation measured one and two years earlier, above and beyond the contribution of IQ and achievement. Children with higher academic intrinsic motivation at ages 7 and 8 were more likely to show higher motivation at age 9. Whereas young children could reliably distinguish between subject areas of academic intrinsic motivation, only math motivation showed consistently specific relations to other math criteria. Findings are discussed with regard to developmental theories of intrinsic motivation and the significance of academic intrinsic motivation for children’s education. |
| Greenfield, P. M. (2009) | Theoretical | The author’s new theory of social change and human development aims to show how changing socio-demographic ecologies alter cultural values and learning environments and thereby shift developmental pathways. Worldwide socio-demographic trends include movement from rural residence, informal education at home, subsistence economy, and low-technology environments to urban residence, formal schooling, commerce, and high-technology environments. The former ecology is summarized by the German term <i>gemeinschaft</i> (“community”) and the latter by the German term <i>gesellschaft</i> (“society”). A review of empirical research demonstrates that, through adaptive processes, movement of any ecological variable in a <i>gesellschaft</i> direction shifts cultural values in an individualistic direction and developmental pathways toward more independent social behavior and more abstract cognition. In contrast, the (much less frequent) movement of any ecological variable in a <i>gemeinschaft</i> direction is predicted to move cultural values and developmental pathways in the opposite direction. In conclusion, sociocultural environments are not static either in the developed or the developing world and therefore must be treated dynamically in developmental research. |
| Greenfield, P. M., & Suzuki, L. K. (1998) | Theoretical | This paper discusses the integral and complex relationship between culture and child development. From a psychological perspective, an important aspect of development is children’s acquisition of cultural knowledge. From a sociological perspective, children from birth are exposed to the culture surrounding them. This cultural environment spans |

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| | | everything from sleeping arrangements and feeding practices to the child’s eventual value systems, school experiences, and interpersonal interactions. The relationship between the child’s active acquisition of cultural knowledge and the child’s development constitutes the focus of this paper. Behavioral and value differences that exist in different cultures are discussed from a dual-culture (home and society) perspective. |
| Greeno, J. G., & Hall, R. P. (1997) | Theoretical | From a social practice perspective, this article discusses the process of learning to construct and interpret representations. The authors illustrate their main argument with an example from a math or science classroom: if students need to construct tables and graphs to complete a project report, they can learn to consider whether these forms are effective at communicating important information. If, however, students merely complete assignments with prefabricated representations, they have lost a vital learning opportunity. |
| Guzzetti, B. J., Snyder, T. E., Glass, G. V., & Gamas, W. S. (1993) | Review | Numerous investigations have been conducted in reading education and science education to test the effects of various instructional interventions on misconceptions. These studies have produced disparate and inconclusive results. The purpose of this project was, therefore, to synthesize quantitatively the experimental and quasi-experimental research designed to produce conceptual change. A meta-analytical perspective was used to conduct a cross-disciplinary analysis. Results from the accumulated evidence identified specific strategies in reading education and particular approaches in science education that were effective in producing conceptual change. These effective procedures had a common element of producing conceptual conflict. Results of the analysis and scrutiny of the research from these two disciplines raise questions regarding construct definition and measurement of conceptual change. |
| Halliday, M. A. K., & Martin, J. R. (1993) | Theoretical | This book explores the use of language and literacy issues in scientific research and in science classrooms. Working within the theoretical framework of systemic functional analysis, the authors explore the evolution of scientific discourse in the English-speaking world, and the apprenticeship of students into the discourse in secondary schools. |
| Halliday, M. A. K., & | Theoretical | This text presents an outline of the grammar of modern English in the framework of systemic-functional linguistic theory and serves as an introduction to functional theory in |

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| Matthiessen, C. M. (2004) | | general, which can be used for describing any language in its own terms. The description of English presented here has been widely used in a number of applied linguistics contexts, particularly artificial intelligence and language education (both second language and mother tongue) and also in literary stylistics and other fields requiring a rich interpretation of the text. |
| Halpern, D. F. (1998) | Theoretical | Advances in technology and changes in necessary workplace skills have made the ability to think critically more important than ever before, yet there is ample evidence that many adults consistently engage in flawed thinking. Numerous studies have shown that critical thinking, defined as the deliberate use of skills and strategies that increase the probability of a desirable outcome, can be learned in ways that promote transfer to novel contexts. A four-part, empirically-based model is proposed to guide teaching and learning for critical thinking: (1) a dispositional component to prepare learners for effortful cognitive work, (2) instruction in the skills of critical thinking, (3) training in the structural aspects of problems and arguments to promote transcontextual transfer of critical-thinking skills, and (4) a metacognitive component that includes checking for accuracy and monitoring progress toward the goal. |
| Halpern, D. F., Hansen, C., & Riefer, D. (1990) | Empirical | This study explored the impact of analogy use on comprehension and memory. Analogies from near and far knowledge domains were presented with three different scientific passages. A no-analogy condition served as a control. Students who read passages with a distant domain analogy listed more facts in free recall and cued recall tests, and answered correctly more questions that required inferences or comprehension of a novel analogy. Before or after placement of the analogy was a nonsignificant variable. There were no differences between near-domain analogies and the no-analogy control conditions. These results are interpreted as support for the concept of structure mapping as the underlying process in the use of analogies. Results suggest that analogies from far domains promote comprehension of and memory for scientific text. |
| Hasselhorn, M., & Körkel, J. (1986) | Empirical | This study analyzed the effects of metacognitive and traditional reading instructions on comprehension and retention performance of forty-eight 6th graders using a pre posttest design. Prior knowledge about the topic under study and the knowledge, monitoring, and |

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| | | regulation components of metacognition were assessed independently. Results show that both instructional programs were effective with respect to increasing comprehension performance. Benefits from the traditional approach, however, were largely restricted to experts. In contrast, metacognitive instructions led to considerable improvement in comprehension for novices. |
| Hattie, J. (1999, August) | Empirical | In this paper, the author attempts to delineate an ideal model of teaching and learning based on an ambitious meta-analysis of a multitude of factors that influence student achievement. The “effect size” of each factor is calculated in an effort to rank these factors according to their impact on student achievement. The factors he considers include programmatic features (bilingual programs, teacher training), instructional practices (ability grouping, team teaching), student characteristics (prior cognitive ability, physical attributes of students, home factors), and others. In synthesizing his results, he concludes that important factors influencing student success include critical innovations in practice or program design; teacher feedback to students; and the setting of appropriate, specific and challenging goals. |
| Hattie (2009) | Theoretical and empirical | This book synthesizes fifteen years of research by reviewing over eight hundred meta-analyses related to influences of student achievement. The author uses an average effect size of $d = 0.40$ as a cut-off point to judge the effectiveness of six achievement-related influences on students (student, home, school, curricula, teacher, and teaching approaches). The book details the major themes that emerged from the six areas of influence above. From the data, the author builds a model called “visible learning” to increase student achievement. “Visible learning” refers to a particular type of teaching-learning situation in which there are learning goals are made explicit, the learning is appropriately challenging, both students and teachers check the degree to which the learning goal is attained, feedback is sought and given, and there is active participation from both teachers and students. |
| Hattie & Timperley (2007) | Review | In this meta-analytical study, the authors review research examining the impact of feedback on student learning and performance. The authors find considerable variability in the effect of feedback, depending on implementation and context. In addition to |

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| | | summarizing the results, the report discusses practical implications and what these findings mean for classroom implementation. The authors also provide a graphic to help support teachers at multiple stages of the feedback process. |
| Heath, S. B. (1983) | Theoretical | This book examines how children learn to use language at home and at school in two communities only a few miles apart in the southeastern United States. 'Roadville' is a white working-class community of families steeped for generations in the life of textile mills; 'Trackton' is an African-American working-class community whose older generations grew up farming the land, but whose existent members work in the mills. In tracing the children's language development the author shows the deep cultural differences between the two communities, whose ways with words differ as strikingly from each other as either does from the pattern of the townspeople, the 'mainstream' blacks and whites who hold power in the schools and workplaces of the region. The author raises fundamental questions about the nature of language development, the effects of literacy on oral language habits, and the sources of communication problems in schools and workplaces. |
| Hennessey, M. G. (1999, March) | Empirical | The purpose of this study was threefold: first, to better understand the nature of metacognition and to characterize facets of higher-level metacognitive thought; second, to explore the process by which individuals change their metacognitive capacities with experience; and third, to investigate the role of pedagogical practices in facilitating changes in metacognition. Six cohorts of elementary students (grades 1-6) participated in this naturalistic study across three academic years. Analysis of the data supports the following claims. First, metacognition is within the capabilities of young (school age) children. Second, children's metacognitive ability is multifaceted in nature; it can be probed and teased apart. Third, changes in metacognitive sophistication can be gained by actively engaging in the process. Fourth, changes in metacognitive ability and conceptual understanding may be more closely linked to the individual student's epistemological stance. |
| Heritage, M., Silva, M., Pierce, | Theoretical | In this chapter, the authors examine the linguistic competencies that students need to have for academic success. They then present a model of teacher knowledge for students' |

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| M., & Bailey, A. R. (2007) | | academic success and use examples to explore the application of the model in the classroom setting. A critical component of the model is teachers' knowledge of students derived from formative and summative assessments. The authors discuss the challenges that current assessment practices, both formative and summative, present for teachers in implementing the suggested model. |
| Hickey, D. T. (1997) | Theoretical | The perspective generally referred to as socio-constructivism is prominent in contemporary educational reform efforts. This article argues for expanded study of the motivational issues presented by new curricular approaches that follow from this perspective. The conflict between the models of motivation that are most influential in education and socio-constructivist perspectives is explored, and newer models of motivation, including explicitly socio-constructivist ones, are described. A review of motivation's treatment in new curricular approaches further illustrates how socio-constructivist perspectives can expand and revise our understanding of classroom motivation. This review also illustrates how the expanded study of motivation might help demonstrate the value of new approaches and yield important insights that can help advance them. Finally, this review shows how ubiquitous intrinsically motivating instructional principles may undermine the goals of new curricular approaches, suggesting expanded consideration of motivational issues within curricular and professional development efforts associated with those approaches. |
| Hiebert, J., & Carpenter, T. P. (1992) | Theoretical | The goal of many research and implementation efforts in mathematics education has been to promote learning with understanding. Drawing broadly from the field learning psychology, the authors present a framework for examining issues of understanding. The questions of interest are those related to learning with understanding and teaching with understanding: what can be learned from students' efforts to understand that might inform researchers' efforts to understand understanding? The framework proposed for reconsidering understanding is based on the assumption that knowledge is represented internally, and that these internal representations are structured. The authors point to some alternative ways of characterizing understanding but argue that the structure of represented knowledge provides an especially coherent framework for analyzing a range of |

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| | | issues related to understanding mathematics. |
| Hiebert, J., & Wearne, D. (1996) | Empirical | This study traces the emerging relations between children’s understanding of multidigit numbers and their computational skill, and investigates how instruction influences these relations. The authors followed about seventy children over the first three years of school while they were learning about place value and multidigit addition and subtraction in two different instructional environments. By interviewing the students several times each year, the authors found that understanding and skill were closely related on tasks for which students had not yet received instruction as well as on more difficult tasks even after instruction. Students appeared to apply specific understandings to invent new procedures and modify old ones. The alternative instruction, which encouraged students to develop their own procedures and to make sense of procedures presented by others, appeared to facilitate higher levels of understanding and closer connections between understanding and skill. |
| Hood, S. (2008) | Theoretical | The practice of summary writing from source texts has long been a core activity in academic writing programs. When described as précis writing, textbooks focusing on teaching this skill date back to the second half of the nineteenth century. In current guidelines, students are typically asked to demonstrate an understanding of the key meanings encoded in source texts by recording those meanings in note form and then reconstructing them in a significantly shorter summary, relying minimally on the original wording. However, what is presented as a relatively straightforward process is made considerably more complex when we consider that any change in wording necessarily impacts meaning in some way. In this paper, the author explores how meaning is implicated in the process of re-instantiation from original text to notes to summary text, and considers at a theoretical level what is involved in these changes. The findings suggest ways to scaffold the task more effectively for students and novice writers in academic English. |
| Hynd, C.R., & Alvermann, D. E. (1989) | Empirical | This study examines the combined effects of prior knowledge activation and the use of refutation/nonrefutation texts to alter misconceptions about the principles of motion held by forty-three undergraduates at two state colleges in Georgia. Each student was assigned |

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| | | to one of four groups so that activation, nonactivation, refutation, and nonrefutation could be tested in all combinations. Analysis of pre- and post-intervention test results using a 2×2 analysis of covariance design indicated that (1) students who had their misconceptions activated prior to reading a text did not remember as many important ideas from the text as did those who did not have their misconceptions activated, and (2) reading of refutation vs. nonrefutation texts made little difference. |
| Jameson, J., & Gentner, D. (2003) | Empirical | This paper addresses the role of comparison in highlighting relational structure. The authors investigated whether literal similarity comparisons (where both objects and relations match) can lead to a focus on common relations over equally suitable object matches. Whereas previous studies have demonstrated the highlighting of relations during analogical comparisons (where only relations match), the study presented in this paper suggests that even literal similarity comparisons can promote relational focus. In addition, the authors explore the role of types of comparison tasks (listing commonalities or listing differences). This extension follows naturally from structure-mapping theory, which predicts that in certain cases, listing differences between two things can actually lead to a heightened focus on the structure common to both. |
| Jewitt, C., Kress, G., Ogborn, J., & Tsatsarelis, C. (2000) | Theoretical | As conceptions of communication shift from a single focus on language to the full repertoire of communicational resources (e.g. image, action, sound), this paper challenges the assumption that learning and teaching are primarily linguistic accomplishments. Through an example of school-based teaching, the authors show that classroom texts are realized through the interaction of different “modes” of communication (organized, regular, socially specific means of representation). That is, they are multimodal. Action and image are not mere illustrations to language; rather each realizes specific representational work. Further, the authors suggest that learning is a multimodal process, and goes beyond language. They conclude that multimodality presents a new challenge to current teacher education and the evaluation of learning. |
| Johnston, P., & Pearson, P. D. (1982) | Empirical | This study examines effects of prior knowledge and explicitness of text connectivity on various measures of reading ability. The purpose of the study was to suggest some possible relationships, some alternative measures, and some new directions for research, |

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| | | <p>particularly research that is designed to refine how we measure comprehension and make consequent judgments about students' abilities. The study addresses reading comprehension and its assessment from a schema-theoretic perspective. The authors contend that current assessment of reading comprehension is strongly biased by the extent of an individual's prior knowledge about the topic presented in the text to be read. Since this is a statement about the relationship between text and reader, it can be examined by manipulating such factors as text familiarity or by measuring the reader's prior knowledge. The study indicates that, indeed, sizable effects of prior knowledge on reading comprehension can be found by manipulating the text or by measuring the individual reader's prior knowledge. The value of direct measurement of prior knowledge is discussed. This study suggests that ability may be a more important factor to consider than prior knowledge when determining what audience characteristics interact with the connectivity of the text.</p> |
| <p>Kaufman, D. R., Patel, V. L., & Magder, S. A. (1996)</p> | <p>Empirical</p> | <p>Analogical reasoning is increasingly recognized as an important instrument for promoting conceptual change in science learning. This study characterized students' and physicians' spontaneous use of analogies in reasoning about concepts related to the mechanical properties of cardiovascular physiology. The analogies were made in response to questions at different levels of abstraction from basic physiology to clinical problems. The results indicate that analogies generated by subjects facilitated explanations in a number of ways. These include creating coherent representations in novel situations, bridging gaps in understanding, and triggering associations that result in modified explanations. Subjects at different levels of expertise used analogies differently. The more expert subjects used analogies to facilitate articulation and communication; that is, to illustrate and expand on their explanations. Novices and advanced medical students used more between-domain analogies to explain all categories of questions. This is less evident in physicians' responses to pathophysiological and clinical problems. The paper discusses ways in which analogies can be used productively, and identifies factors that can lead to a counter-productive use of analogies resulting in misconceptions and erroneous explanations.</p> |
| <p>Kelly, G. J., & Brown, C.</p> | <p>Empirical</p> | <p>This study examines the communicative demands placed on 3rd grade students through their participation in a solar technology design and construction project. Drawing from</p> |

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| (2003) | | <p>sociocultural studies of science in schools and other settings, the authors used a discourse analytic approach to identify what students in this class needed to understand and express in order to complete this technical design and construction project. Their analysis identified six broad categories of discourse practices constructed by the members of the classroom across the academic activities. Students were required to engage in a variety of discourses as they defined roles with other student members of their small groups, negotiated ways of accomplishing the academic task, presented their ideas and products to multiple audiences, and distributed credit among student group members. Participation in this instructional approach afforded students opportunities to learn science as they participated in cycles of design, presentation, and production of their solar devices. The authors consider the technological design and construction activities in the context of educational reform through a discussion of the state and national science education standards. Educational implications are drawn focusing on the value of communication in inquiry, the use of ideas-in-progress, the assessment of student knowledge through discourse, and the ways educational discourse processes are situated in cultural practices.</p> |
| King, A. (1997) | Theoretical | <p>This article presents an inquiry-based model of mutual peer tutoring called ASK to THINK-TEL WHY®. The model is described along with its purpose, its theoretical and research bases, and how tutoring partners use it to mediate each other's learning. Unlike tutoring systems used to promote learning at the comprehension level, this model is designed to promote higher-level, complex learning, namely the construction of new knowledge. The model emphasizes reciprocal tutor-tutee roles, supportive communication, elaborated explanations, and questioning skills. When in the tutoring role, students learn to use different kinds of questions to prompt their partners to make corresponding responses. Tutors also learn to sequence their questioning in a particular way. Thus, during this transactive process, partners scaffold each other's thinking and learning to progressively higher levels. Mechanisms involved in this form of peer-mediated learning are discussed along with results of research on the model's effectiveness.</p> |
| Kingston, N., & Nash, B. (2011) | Review | <p>An effect size of about .70 is often claimed for the efficacy of formative assessment, but this is not supported by the existing research base. More than three hundred studies that appeared to address the efficacy of formative assessment in grades K-12 were reviewed.</p> |

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| | | <p>Many of the studies had severely flawed research designs yielding uninterpretable results. Only thirteen of the studies provided sufficient information to calculate relevant effect sizes. A total of forty-two independent effect sizes were available. The median observed effect size was .25. Using a random effects model, a weighted mean effect size of .20 was calculated. Moderator analyses suggested that formative assessment might be more effective in English language arts than in mathematics or science, with estimated effect sizes of .32, .17, and .09, respectively. Two types of implementation of formative assessment, one based on professional development and the other on the use of computer-based formative systems, appeared to be more effective than other approaches, yielding mean effect size of .30 and .28, respectively. Given the wide use and potential efficacy of good formative assessment practices, the paucity of the current research base is problematic. A call for more high-quality studies is issued.</p> |
| Kluger, A. N. & DeNisi, A. (1996) | Review and theoretical | <p>Since the beginning of the century, feedback interventions (FIs) produced negative but largely ignored effects on performance. A meta-analysis (607 effect sizes; 23,663 observations) suggests that FIs improved performance on average ($d = .41$) but that over one-third of the FIs decreased performance. This finding cannot be explained by sampling error, feedback sign, or existing theories. The authors propose a preliminary FI theory (FIT) and test it with moderator analyses. The central assumption of the FIT is that FIs change the locus of attention among three general and hierarchically organized levels of control: task learning, task motivation, and meta-tasks (including self-related processes). The results suggest that FI effectiveness decreases as attention moves up the hierarchy closer to the self and away from the task. These findings are further moderated by task characteristics that are still poorly understood.</p> |
| Kozulin, A., Gindis, B., Ageyev, V. S., & Miller, S. M. (2003) | Theoretical | <p>This text comprehensively covers all major topics of Vygotskian educational theory and its classroom applications. Particular attention is paid to the Vygotskian idea of child development as a consequence, rather than premise, of learning experiences. Such a reversal allows for new interpretations of the relationship between cognitive development and education during different phases of the human life span. The book introduces new perspectives on atypical development, learning disabilities, and assessment of children's learning potential. Classroom applications of Vygotskian theory are discussed in the book,</p> |

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| | | as well as teacher training and the changing role of a teacher in a sociocultural classroom. Relevant research findings from the United States, Western Europe, and Russia are brought together to clarify the possible new applications of Vygotskian ideas in different disciplinary areas. |
| Kress, G., Charalampos, T., Jewitt, C., & Ogborn, J. (2001) | Theoretical | This work suggests that communication proceeds by many modes, of which language is one and not necessarily the dominant one. Drawing on research conducted in science classrooms, the authors explore image, gesture, speech, writing, models, and spatial and bodily codes as other vital forms of communication. This book takes a nontraditional view of communication in education, insisting that meaning and knowledge are shaped by the ways in which they are communicated. |
| Kuhn, D. (2000) | Theoretical | Traditional developmental research in memory and reasoning and current research in theories of mind, epistemological understanding, knowledge acquisition, and problem solving share the need to invoke meta-level cognition in explaining their respective phenomena. The increasingly influential construct of metacognition can be conceptualized in a developmental framework. Young children's dawning awareness of mental functions lies at one end of a developmental progression that eventuates in complex metaknowing capabilities that many adults do not master. During its extended developmental course, metacognition becomes more explicit, powerful, and effective as it comes to operate increasingly under the individual's conscious control. Two important developmental and educational goals are (1) enhancing metacognitive awareness of what one believes and how one knows and (2) enhancing metastrategic control in application of strategies to process new information. |
| Kuhn, D., & Dean Jr, D. (2004) | Theoretical | Educational practitioners and academic researchers largely agree on a broad goal: to develop in students the kinds of thinking skills that will prepare them to contribute to a democratic society. But the two groups largely speak different languages. While educators frequently talk about critical thinking as an objective, researchers have largely avoided the term, preferring constructs that can be more precisely defined and measured. How do we connect critical thinking to modern research on cognition and learning? The authors propose the construct of metacognition as having the potential to bridge the concerns of |

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| | | educators and researchers whose work is addressed to the development of skilled thinking. Given its growing importance in studies of cognition and learning, teachers would benefit from an understanding of the mechanisms involved in metacognition and how best to foster it. |
| Kurtz, K. J., Miao, C. H., & Gentner, D. (2001) | Empirical | Analogies are typically drawn from a well-understood situation and applied to a situation that is poorly understood. This research investigates a different route to analogical insight. The authors suggest that mutual alignment (that is, comparison between two partially understood situations) can act to promote comprehension and abstraction. Participants were presented with two analogous scenarios depicting heat flow. They were given processing tasks that varied in the degree to which comparison was required. The authors then measured insight into the common structure in three ways. Participants were asked to (a) specify differences between the two pictured scenarios, (b) write scenario descriptions, and (c) rate the similarity of the two scenarios. The results show that carrying out comparison promotes greater insight into the common causal structure, but only when the comparison is intensive. The best results were obtained when participants were asked to jointly interpret the scenarios and to list specific correspondences. In a second experiment designed to further pinpoint the source of the comparison advantage, participants were asked to make correspondences between the elements of the two scenarios. These results suggest that mutual alignment is an effective means of promoting insight. |
| Lai, E. R. (2011) | Theoretical | This paper explores the taxonomy of intrinsic and extrinsic motivation and describes how motivation varies with age and across subject areas. Student motivation and the desirability of external versus internal motivation in an educational setting are studied. Noting that motivation tends to decrease as children progress through school, the author examines instructional practices that can influence motivation. Recommendations are made regarding learning structures, the classroom environment, and goal schemes. Finally, the author comments on the difficulty of assessing motivation in children and offers strategies for further research. |

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| Lambiotte, J. G., & Dansereau, D. F. (1992) | Empirical | This study examined the use of various types of lecture aids on memory. The effects of three different lecture aids on students' recall of two college-level biology lectures were compared. Students heard audiotaped lectures while viewing knowledge maps, outlines, or lists of key terms. Free-recall tests revealed that listeners with low prior knowledge of biology learned the most when knowledge maps accompanied the lecture and the least when key terms were listed. For listeners with high prior knowledge, however, the opposite was true. An analysis of recall coherence revealed that learners recalled significantly fewer fragmented facts after viewing maps or outlines than after viewing lists. Prior knowledge was a significant factor in all analyses. Results are interpreted in terms of Mayer's cognitive model of assimilation encoding. |
| Larkin, J., McDermott, J., Simon, D. P., & Simon, H. A. (1980) | Theoretical | Although a sizable body of knowledge is prerequisite to expert skill, that knowledge must be indexed by large numbers of patterns that, on recognition, guide the expert in a fraction of a second to relevant parts of the knowledge store. This background knowledge forms complex schemata that can guide a problem's interpretation and solution and that constitute a large part of what we call physical intuition. |
| Lave, J. (1988) | Theoretical | This research is an investigation into quantitative problem solving by adults in their everyday lives. The author proposes an alternative socio-cultural model of learning, where cognition is a dialectic between individuals and their setting, which includes such features as relationships with other people, feelings, motivation, values, and tools. Cognition is proposed to be active and dynamic, changing over time and between situations. The author holds that problems and their solutions are generated from disjunctions, conflicts and contradictions that occur in the course of socio-cultural activities. It is argued that solutions to problems may be partial and shifting: often, generation of problem and solution occur simultaneously. |
| Lee, P., Ashby, R., & Dickinson, A. (1996) | Theoretical | This paper is an initial discussion of phase one of the CHATA (Concepts of History and Teaching Approaches at Key Stages 2 and 3) project, and it is intended to be followed by a more comprehensive review of that project's results. The project is a meta-analysis of small-scale, qualitative research projects, and the first stage of the project attempts to investigate children's ideas about historical inquiry and explanation. The authors discuss |

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| | | the inherent difficulties in measuring children’s understanding of history, different methodological approaches, and emerging models of historical understanding. The next stage of their analysis will involve developing a workable concept of progression in history which can serve as a basis for assessment, a diagnostic tool for teachers, and a means of addressing pupils’ ideas as directly and effectively as possible. |
| Lemke, J. L. (1990) | Theoretical | This book addresses the role of language in teaching and in communication of scientific and technical subjects. It identifies and analyzes the many strategies teachers and students use to communicate about science and to influence one another’s beliefs and behavior. Special emphasis is placed on analyzing patterns of social interaction, the role of language and semantics in communicating scientific concepts, and the social values and interests that lie behind these patterns of communication. Working from transcripts of recordings made in real science classrooms, the author illustrates how the conceptual content of a specialized subject is actually communicated through the semantic patterns that teachers and students make with language. |
| Lesh, R., Hoover, M., Hole, B., Kelly, A., & Post, T. (2000) | Theoretical | The central goal of this chapter is to describe six principles that have proven to be especially useful in helping researchers and practitioners create thought-revealing activities (which the authors refer to as model-eliciting activities). General characteristics, purposes, and examples of model-eliciting activities are described, as well as caveats and common misconceptions about their use. The authors discuss how research can be enriched through productive model-eliciting activities and describe principles for designing them effectively. |
| Levelt, W. J. M. (1983) | Empirical | By studying 959 instances of spontaneous self-repairs in speech, this study analyzes the processes of monitoring and self-repair. Making a self-repair typically proceeds in three phases. The first phase involves the monitoring of one’s own speech and the interruption of the flow of speech when trouble is detected. It appears that interrupting follows detection promptly, with the exception that correct words tend to be completed. The second phase is characterized by hesitation, pausing, and the use of so-called editing terms. The selection of editing term depends on the nature of the speech trouble. The third phase consists of making the repair. The linguistic well-formedness of a repair is |

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| | | dependent on the structural relation between original utterance and repair. It is argued that speakers have little or no access to their speech production process; self-monitoring is probably based on parsing one's own inner or overt speech. |
| Limon, M. (2002) | Theoretical | This chapter addresses the question, "To what extent can results from research on conceptual change in science education be applied to other domains, particularly history?" To answer this question, the author examines the peculiarities of history and history teaching and their possible implications for conceptual change. First, she discusses the characteristics of history concepts and how they may influence students' prior knowledge; particular attention is paid to second-order concepts (evidence, cause, explanation, empathy, etc.) that seem to play a crucial role in history understanding. Second, she reviews the peculiarities of history as a discipline and their implications for history teaching and learning. Last, the author compares conceptual change in history and science; the characteristics of students' prior knowledge and the goals of conceptual change in history and science are considered. |
| Lin, P. J. (2005) | Empirical | This study was designed to examine how teachers encourage their students to maintain high-level cognition throughout various classroom tasks. Within the empirical framework of the case method, eight teachers viewed, evaluated, and discussed videos depicting classroom lessons and student work time. The video cases were explored through within-case and cross-case analysis. The study concluded that an important factor in maintaining high-level student cognition is differentiation of the level of cognitive demand in a task. Teachers achieved this differentiation by designing tasks that built on students' prior knowledge, asking thought-provoking questions, and sustaining pressure for sense-making explanations. |
| Lobato, J. (2008) | Theoretical | In this paper, the author compares two theoretical approaches for understanding transfer of learning, the traditional approach and the actor-oriented approach. Examples from a university calculus class and a high school physics class are considered under both approaches. An actor-oriented theory of learning transfer, which considers the psychological context of the individual engaged in the attempted learning transfer, is most effectively realized using qualitative research methods, as opposed to the quantitative |

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| | | methods of traditional theories. The actor-oriented theory offers more insight into the psychological processes of students and is thus better suited to formative research. Such formative research can both provide alternative ways for teachers to interpret student work and suggest new instructional activities. |
| Lodico, M. G., Ghatala, E. S., Levin, J. R., Pressley, M., & Bell, J. A. (1983) | Empirical | This research investigated how children select and use metacognitive strategies. Second grade students were given training in general principles of strategy monitoring prior to being exposed to differentially effective acquisition strategies in a memory task. The results showed that even though both experimental and placebo control groups could assess when they remembered better, more experimental than control children attributed performance differences to their strategic behavior and then selected the more effective strategy on a forced-choice trial. These findings indicate that instruction in general memory-monitoring principles is sufficient to effect a change in strategy usage. The study therefore provides direct experimental support for the presumed relationship between metacognitive knowledge and subsequent strategy use. |
| Loewenstein, J., & Gentner, D. (2001) | Empirical | To test the hypothesis that comparison processes facilitate schema extraction, the authors studied the effect of making comparisons on young (three years old) children's ability to perform mapping tasks. In three studies, children were tested on their ability to find a hidden toy in a model room after being shown its location in a perceptually different room. In Experiment 1, the authors found that seeing two similar hiding events (permitting a sequential comparison) improved performance on the mapping task. Experiment 2 showed a more striking effect: simply comparing the initial hiding model with another nearly identical model helped children to succeed on the subsequent mapping task. Experiment 3 showed that the comparison effect was not simply due to an opportunity to interact with two examples, but was specific to comparing them. The authors conclude that comparing examples can help children notice common relational schemas (in this case, a spatial relational schema) and increase their ability to use this system of relations in subsequent tasks. The authors' central hypothesis is that the process of comparison is a major force in children's learning and development. This work tests the specific claim that drawing comparisons among similar spatial arrays fosters insight into |

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| | | the common spatial relations, as assessed in a subsequent spatial mapping task. |
| Loewenstein, J., & Gentner, D. (2005) | Empirical | This study tests the claim that learning and using language for spatial relations can influence spatial representation and reasoning. Preschool children were given a mapping task in which they were asked to find a “winner” placed in a three-tiered box after seeing one placed in a virtually identical box. The correct choice was determined by finding the corresponding relative location in the test box, making it a difficult task for preschool children. The authors found that hearing language for spatial relations facilitated children’s mapping performance. They found effects at younger ages on easier tasks (Experiments 1 and 2) and at older ages on harder tasks (Experiment 3). The effects of spatial relational language differed predictably according to the semantics of the terms children heard (Experiment 4). Finally, the effects of spatial language were maintained over time (Experiment 5): children given one initial exposure to the spatial terms maintained their advantage over baseline children when they again carried out the mapping task two days later, with no further exposure to the spatial terms. The evidence is consistent with the explanation that language bolsters children’s spatial encodings, which in turn supports their mapping performance. |
| Markman, E. M., & Gorin, L. (1981) | Empirical | This study investigated the extent to which children are able to adjust their standards for evaluating comprehension. Children between eight and ten years of age (N = 144) listened to essays that contained either false statements or inconsistencies. They were asked to indicate which essays had problems in them. The first group of students was simply informed that some of the essays contained problems. A second group was additionally told that some of the statements would be false and was given examples of falsehoods. A third group was told instead that some of the essays would be inconsistent and was given examples of inconsistencies. Under neutral instructions, the rate of problem detection was quite low for both age groups. Specific instructions helped students find problems. Moreover, the relative order of difficulty in finding falsehoods and inconsistencies shifted depending on the instructional set, suggesting that the instruction enabled students to adjust their standard of evaluation. |

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| Marshall, H. H., & Weinstein, R. S. (1984) | Theoretical | This paper presents a complex interactional model of classroom factors that contribute to the development of students' self-evaluations. The model integrates previously investigated factors, suggests the operation of additional factors, and extends the notion of the operation of classroom factors to account for the possibility that certain factors may compensate for or negate the effect of otherwise crucial factors in influencing students' interpretations of and reactions to classroom events. Described are (a) task structure, (b) grouping practices, (c) feedback and evaluation procedures and information about ability, (d) motivational strategies, (e) locus of responsibility for learning, and (f) the quality of teacher-student relationships. This notion of compensating and negating features within the classroom environment can be applied to understanding other student outcomes as they are influenced by teaching processes. |
| Martin, J. R., & Rose, D. (2005) | Theoretical | The authors consider the popular Genre-Based Literacy model, the primary focus of which is student writing within specific genres. The authors' purpose is to augment this model to include an equal emphasis on reading across the curriculum. They observe that teachers can capitalize on the synergistic relationship between writing and reading and that deconstruction of the discourse of both student-generated and existing text can reveal semantic patterns, without requiring that students first acquire facility in technical grammar. This approach, they argue, is more democratic and inclusive because it acknowledges that students from economically or culturally marginalized backgrounds do not typically read outside of school, and are thus disadvantaged in comparison with their more extensively read peers. |
| Mathews, S. R. (1982) | Empirical | The effects of prior knowledge on accessibility and availability are examined in this work. The impact of prior knowledge on accessibility was primarily qualitative while the effect on availability was quantitative. Evidence for the effect was observed at both the encoding level and the retrieval level. Further, the hierarchical structure of text was shown to be particularly vulnerable to prior knowledge, while the logical relations among concepts in the text were not. |
| Mayer, R.E. (1992) | Theoretical | This book provides a survey of the higher cognitive processes of human thinking, problem solving, and learning by incorporating recent research developments and classic theories |

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| | | of problem solving. The information is relevant to discussions in cognitive psychology, learning and memory, problem solving, critical-thinking, and educational psychology. |
| McCombs, B. L. (1984) | Theoretical | This article advances a generative process model of continuing motivation in which the central role of perceived self-efficacy and personal control are explicated. Support for this model from current theories of learning and motivation is presented, along with implications for specific skills training interventions. It is argued that the functional purpose of motivational skills training is to promote perceptions of self-efficacy and personal control that underlie the ability to take positive self-control and change negative attitudes and orientations toward learning. For students with motivational deficiencies, this training is a necessary precursor to their active engagement in the learning process and execution of appropriate learning strategies and skills. |
| McKeown, M. G., Beck, I. L., Sinatra, G. M., & Loxterman, J. A. (1992) | Empirical | The authors investigate the effects of background knowledge and coherent text on student comprehension. Students were provided with relevant background knowledge and their comprehension of two versions of a text was examined. The two versions were a sequence of four segments of text from a 5th grade social studies textbook about the period leading to the American Revolution and revised versions of these segments designed to improve text coherence. Forty-eight 5th graders were presented with an instructional module designed to upgrade their background knowledge prior to reading one of the text versions. The results showed that students who read the revised text recalled significantly more material and answered significantly more questions correctly than students who read the original text. Further, qualitative analyses suggest specific influences of knowledge and coherent text. Finally, the discussion focuses on the importance of the teacher's role in mediating learning from social studies text. |
| McLeod, L. (1997) | Review and theoretical | This article offers an overview of the philosophies and influences that have underpinned research into the metacognitive abilities of young children during the last two decades. The author discusses the implications of this research for current teaching practice and offers concerns and suggestions for future research. |

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| McMillan, J. H. (2013) | Theoretical | In this article, the author argues that an accumulation of rigorous, relevant research on classroom assessment is critical. Six features of the current political and educational context are highlighted: advances in technology; high-stakes testing; developments in measurement techniques; the need for quality formative assessment; a movement towards standards-based education; and development of learning and motivation theory. The impact of each of these features on classroom assessment is discussed. The author highlights the important relationship between classroom assessment, student feedback, and student motivation. |
| McNamara, D. S., Kintsch, E., Butler-Songer, N., & Kintsch, W. (1996) | Empirical | Through two experiments, his study examined the interaction between text coherence and background knowledge and considered how these factors influenced student comprehension. In Experiment 1, junior high school students' comprehension of one of three versions of a biology text was examined via free recall, written questions, and a key-word sorting task. This study demonstrated advantages for globally coherent text and for more explanatory text. In Experiment 2, interactions among local and global text coherence, readers' background knowledge, and levels of understanding were examined. Using the same methods as in Experiment 1, the authors examined students' comprehension of one of four versions of a text, orthogonally varying local and global coherence. They found that readers who knew little about the domain of the text benefited from a coherent text, whereas high-knowledge readers benefited from a minimally coherent text. The authors argue that the poorly written text forces the knowledgeable readers to engage in compensatory processing to infer unstated relations in the text. These findings, however, depended on the level of understanding, text base or situational, being measured by the three comprehension tasks. Whereas the free-recall measure and text-based questions primarily tapped readers' superficial understanding of the text, the inference questions, problem-solving questions, and sorting task relied on a situational understanding of the text. This study provides evidence that the rewards to be gained from active processing are primarily at the level of the situation model rather than at the superficial level of text-base understanding. |
| McVee, M. B., Dunsmore, K., | Review and | During the 1970s, schema theory gained prominence as reading researchers took up early work by cognitive scientists to explore the role of schemata in reading. In the 1980s and |

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| <p>& Gavelek, J. R. (2005)</p> | <p>theoretical</p> | <p>1990s, the field shifted as researchers increasingly used sociocultural theories, particularly those of Vygotsky, to frame investigations of literacy. This article provides a brief review of schema theory, as it is situated in literacy studies. The authors review various conceptions of schema theory to consider how recent social and cultural perspectives might prompt reconsideration of schemata as transactional and embodied constructs. Concomitantly, they explore how earlier conceptions of schema theory may assist researchers in their articulation of concepts, such as ideal and material tools. The article concludes with considerations of implications for future work.</p> |
| <p>Mestre, J. P. (1994)</p> | <p>Theoretical</p> | <p>This paper discusses the nature of cognitive research and its implications for learning and teaching science. In addition to needing adequate financial support, active involvement of scientists and educators, and education of teachers, two other factors should loom large in the development of new instructional materials in science and in the design of new instructional strategies. The first factor is cognitive research findings on teaching, learning, and problem solving. The second factor is the nature of science as it is practiced by scientists. The author discusses research on learning and problem solving in science, lack of alignment between instructional practices and current views of learning, and factors necessary to bring about alignment between instructional practices and current views of learning.</p> |
| <p>Meyer, W. U., Folkes, V., & Weiner, B. (1976)</p> | <p>Empirical</p> | <p>This paper presents four experiments that were conducted to examine the affective and informational determinants of risk-preference behavior. In the initial two experiments, subjects classified according to their level of achievement needs expressed a preference among tasks varying in difficulty. It was found that the majority of all subjects preferred to undertake tasks of intermediate difficulty and that both positive affect and information gain were perceived to be optimal at or near the level of intermediate difficulty. Experiments 3 and 4 investigated the levels of task difficulty at which individuals most desired information about their performance. The data revealed that the tasks selected for feedback became objectively less difficult as the self-perception of ability decreased. In addition, the tasks chosen for feedback were near the intermediate subjective certainty of success level for all subjects. The authors contend that the data contradict Atkinson's model of choice but support an attributional conception. The general issue of affective</p> |

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| | | versus informational models of motivation is discussed. |
| Moll, L. C. (1990) | Theoretical | This book analyzes Vygotsky's ideas as a means of bringing to light the relevance of his concepts to education. Scholars from various countries (and representing several disciplines) discuss the essence and significance of Vygotsky's work, analyze the educational implications of his theories, and present applications in practice. They address educational issues such as school organization, teacher training, educational achievement, literacy learning and development, uses of technology, community-based education, and special education. |
| Moll, L. C. (1992) | Theoretical | From a conceptual framework grounded in critical race theory and critical pedagogy, this article aims to move beyond the shortcomings of traditional approaches to literacy education. Two large studies are considered in order to holistically understand the social contexts in which children live and learn. The first study aims to understand the complex social relationships of Hispanic households in Tucson, Arizona, in order to help redefine Hispanic families for educators and others involved in education. The second study considers how teachers can forge relationships with community members in order to take advantage of the abundant social capital of the community. The authors argue that the most effective approaches to literacy research, and educational research in general, are those that consider a student's diverse funds of knowledge, such as those actualized in social, familial, and community contexts. |
| Mortimer, E. F. (1998) | Empirical | The analyses of talk amongst students in three episodes, video recorded from a teaching sequence on a particle model for Brazilian students (age 14-15) is presented. The analysis has two dimensions. The discursive dimension is an attempt to understand how meanings are constructed in the classroom as a result of discursive interactions. The conceptual dimension comprises the description of the evolution of ideas of matter based on the notion of a conceptual profile of matter, in which conceptual and historical features of the atom concept are profiled with pupils' and adolescents' ideas on atomism. The student talk showcases interactions among different 'voices', representing different zones of a conceptual profile of matter. In these interactions, students resort to both 'authoritative' and 'internally persuasive' discourses. The analysis emphasizes the role of |

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| | | these two types of discourse and points to epistemological and ontological obstacles in the construction of scientific meanings in the classroom. |
| Mortimer, E., & Scott, P. (2003) | Theoretical | This book focuses on the talk of science classrooms and, in particular, on the ways in which the different kinds of interactions between teachers and students contribute to meaning making and learning. Central to the text is a new analytical framework for characterizing the key features of the talk of science classrooms. This framework is based on sociocultural principles and links the work of theorists such as Vygotsky and Bakhtin to the day-to-day interactions of contemporary science classrooms. |
| Moschkovich, J. (2012) | Theoretical | Within the framework of the Common Core Standards for Mathematics, the author addresses three main questions. (1) How can instruction provide opportunities for mathematical reasoning and sense making for ELLs? (2) What instructional strategies support ELLs' mathematical reasoning and sense-making skills? (3) How can instruction help ELLs communicate their reasoning effectively in multiple ways? The central recommendation is that teachers prioritize communication about mathematical concepts over low-level language skills by encouraging all students, regardless of their English proficiency level, to participate in conceptual discussions in which sophistication of mathematical reasoning, rather than pronunciation or vocabulary, is emphasized. The author notes the difficulty in assessing ELLs' content knowledge, apart from their fluency in English-based expression or comprehension. |
| Nasir, N. S., Rosebery, A. S., Warren, B., & Lee, C. D. (2006) | Theoretical | In this article, the authors challenge the traditional notion of "diversity as a problem to be solved," and argue that diversity is, in fact, a pedagogical asset. From a conceptual framework that posits learning as a cultural process, the authors consider three main questions. (1) What characterizes learning in the varied repertoires of practice in which people routinely participate as they go about their everyday lives? (2) In what specific ways do these varied repertoires of practice connect with academic practices? (3) In what ways can these varied repertoires of practice be recruited to create meaningful opportunities for academic learning for all students? A radical restructuring of classroom learning is called for, one that rejects a deficit-oriented view of diversity and recognizes the myriad of |

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| | | cultural contexts in which people learn. |
| National Council of Teachers of Mathematics. (2000) | Theoretical | This document provides a collection of K-12 learning goals for mathematics. It is intended as a resource for teachers, education leaders, and policymakers as they examine and improve the quality of mathematics instruction. The document contains references to research on what it is possible for students to learn about certain content areas, at certain levels, and under certain pedagogical conditions. |
| National Governors Association Center for Best Practices, Council of Chief State School Officers. (2010) | Theoretical | This document provides a collection of K-12 standards for English language arts and mathematics. It is intended as a resource to help teachers, education leaders, and policymakers orient their educational programs. |
| National Research Council (2000) | Theoretical | This book offers research about the mind and brain on such topics as the relationship between classroom learning and everyday settings of community and workplace, the role of technology in education, and how existing knowledge affects what people notice and how they learn. The book addresses what teachers and schools can do with curricula, classroom settings, and teaching methods to help children learn most effectively. |
| National Research Council (2001) | Theoretical | This book explains how expanding knowledge in the scientific fields of human learning and educational measurement can form the foundations of an improved approach to assessment. These advances suggest ways that the goal of assessment (to determine what students know and how well they know it) and the methods used to make inferences about student learning can be made more rigorous and instructionally useful. Principles for designing and using these new kinds of assessments are presented, and examples are used to illustrate the principles. Implications for policy, practice, and research are discussed. |
| National Research Council (2005) | Theoretical | The book explores the importance of balancing students' knowledge of historical fact, their understanding of concepts such as change and cause, and their skills in assessing historical accounts. It discusses how straightforward science experiments can be used to foster true understanding of scientific principles. It also addresses how to overcome the difficulties in teaching math to generate real insight and reasoning in math students. |

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| National Research Council (2011) | Theoretical | This book outlines a broad set of expectations for students in science and engineering in grades K-12. These expectations are intended to inform the development of new standards for K-12 science education and, subsequently, revisions in curriculum, instruction, assessment, and professional development for educators. The book identifies three dimensions that convey the core ideas and practices around which science and engineering education in these grades should be built: (1) crosscutting concepts that unify the study of science and engineering, (2) scientific and engineering practices and (3) disciplinary core ideas in the physical sciences, life sciences, and earth and space sciences. |
| Natriello, G. (1987) | Review and theoretical | This review provides a synthesis of recent research on the classroom evaluation. A conceptual framework is developed to highlight key elements of the evaluation process. Within this framework, alterable features of evaluation are considered. These features include evaluation purposes, task resolution, clarity of criteria, demand level and referents of standards, soundness of appraisals, and differentiation and affective value of feedback. A range of effects on students and classrooms is examined. Studies of evaluation processes are found to be limited by a lack of descriptive information on actual evaluation practices in schools and classrooms, a concentration on one or two aspects of a multifaceted evaluation process, and failure to consider the multiple purposes that evaluation systems must serve in schools and classrooms. Recommendations are made for future studies to overcome these limitations. |
| Nee-Benham, M. K. P. (2002) | Theoretical | This book offers an answer to the question, "What is the philosophy that should drive native education policy and practice?" In July of 1997, a group of native educational leaders from the United States, Canada, Australia, and New Zealand gathered to define a potential solution to this question. This book presents the individual educational philosophies of the participants and frames these philosophies in a holistic model, "Go to the Source." This model offers a collective vision of native language- and culture-based educational philosophy that should inform the work of educational leaders, teachers, policymakers, and curriculum developers. |
| Newell, A. (1990) | Theoretical | Writing within a conceptual framework informed by computer science and cognitive psychology, the author argues that unified theories of cognition are within reach and that |

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| | | <p>theorists from fields such as cognitive science, artificial intelligence, psychology, and computer science must pursue them. The book traces the foundational concepts of cognitive science (including knowledge, representation, computation, symbols, architecture, intelligence) and discusses at length a case of artificial intelligence.</p> |
| <p>Next Generation Science Standards. (n.d.)</p> | <p>Theoretical</p> | <p>This document-in-progress will provide a set of K-12 standards for science, based on the Framework for K-12 Science Education developed by the National Research Council. The standards, scheduled for release in late 2012, are intended as a resource to help teachers, education leaders, and policymakers orient their educational programs.</p> |
| <p>Nicholls, J. G. (1984)</p> | <p>Theoretical</p> | <p>This paper discusses different conceptions of ability, their corresponding subjective qualities, and their effect on task choice and performance. Achievement behavior is defined as behavior directed at developing or demonstrating high rather than low ability. Ability can be conceived either with reference to the individual's own past performance (a context in which gains in mastery indicate high ability) or with reference to others' performance (a context in which a gain in mastery alone does not necessarily indicate high ability). To demonstrate high ability using the latter context, one must achieve more with equal effort or use less effort than do others for an equal performance. The conditions under which these different conceptions of ability function as individuals' goals and the nature of subjective experience in each case are specified. Different predictions of task choice and performance are derived and tested for each case using data from previously published studies. The effects of task and ego involvement, task choice, and self-perceptions are discussed.</p> |
| <p>Nicholls, J. G., Cheung, P. C., Lauer, J., & Patashnick, M. (1989)</p> | <p>Theoretical</p> | <p>The authors argue that research on academic motivation should recognize and attempt to address the problems that result from preoccupation with one's ability relative to that of others. However, research on perceived ability often obscures these problems. Research on the individual difference dimensions of ego orientation (desire for superiority) and task orientation (desire for understanding) provides one framework for addressing these problems. Task orientation and ego orientation are uncorrelated or only slightly correlated with each other and with perceived ability. A case is made for broadening the scope of research on academic motivation to include students' ethical and political values and their</p> |

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| | | understanding of the purpose of education. |
| Niemi, D. (1996) | Empirical | The purpose of this study was to investigate how a deep understanding of mathematical concepts might be assessed in the classroom or in larger scale assessment contexts. The study focused on several types of assessment based on cognitive analysis of fractions: problem solving, justification, and explanation tasks. Additional assessments, including propositional and procedural knowledge measures, provided validation data. Data were collected from 540 5th grade students. To score at the highest levels, students had to show (or take significant steps towards showing) that they understood that fractions are numbers that can express relations between quantities. Overall, student performance was consistent with that obtained in many other research and assessment studies. Fewer than 10% of the students performed adequately on the explanation task. More than 60% of the students failed to express any fraction principle or concept in their explanations, and 54% expressed serious misconceptions. A small number of students, however, displayed exceptional understanding. The effectiveness of a short instructional intervention provided an additional reason for optimism: students who received seven days of instruction on fractions in measurement contexts performed better on the explanation task than students who received traditional part-whole instruction. This result, in addition to the finding that high levels of performance on all tasks were strongly associated with the expression of conceptual or principled knowledge in explanations, supported the use of the explanation task to assess understanding of concepts and principles. |
| OECD (2005) | Empirical and review | This study examines the practice of formative assessment in classrooms and schools in eight education systems: Australia, Canada, Denmark, England, Finland, Italy, New Zealand, and Scotland. There are three parts to this study: (1) analysis of case study findings and international research on formative assessment, (2) case studies of highly effective practices in formative assessment, and (3) literature reviews describing the context and traditions of formative assessment research in three countries. Case study classrooms and schools were selected by national experts using a broad set of criteria to locate exemplary schools. They identified teachers who were using coordinated teaching and assessment strategies to respond to student learning styles, predispositions, skills, |

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| | | <p>interests, and/or motivations.</p> <p>Major findings include:</p> <ul style="list-style-type: none"> • Although case study countries did not share a common definition of formative assessment, six key elements emerged from the case studies, which were: <ol style="list-style-type: none"> 1. Establishment of a classroom culture that encourages interaction and the use of assessment tools 2. Establishment of learning goals and tracking of individual student progress toward these goals 3. Use of varied instruction methods to meet diverse student needs 4. Use of varied approaches to assessing student understanding 5. Feedback and adaptation of instruction to meet identified needs 6. Active involvement of students in the learning process • In all cases, teachers had incorporated each of the six elements into regular practice, although teachers may have placed different emphases on the various elements. • Across case study schools, teachers referred to research as they built their facility with formative assessment, paying particular attention to using formative approaches and the impact of new methods on student learning. • Change in classroom culture (e.g., planning for student learning rather than merely planning activities) was central to creating and sustaining a regular practice of formative assessment. • Teachers in case study schools developed creative ways to address logistical barriers (e.g., large class size, extensive curriculum requirements) to formative assessment. • A number of case study schools reported having moved from failing to exemplary status based on implementing formative assessment practices. |
| Ogborn, J., Kress, G., Martins, I., & McGillicuddy, K. (1996) | Theoretical | <p>This book explores whether instructional scientific explanation is an art or a process that can be described, taught and learned. Drawing evidence from classroom observations, the authors give detailed descriptions of how teachers explain science to students, and ground their account in a sound theoretical basis. Attention is given to the ways in which needs for explanation are generated, how unfamiliar scientific concepts are created through talk and action, how knowledge is transformed to become explainable, and how</p> |

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| | | demonstrations link explanation and reality. |
| Palincsar, A. M. S., Magnusson, S. J., Marano, N., Ford, D., & Brown, N. (1998) | Empirical | This article describes an elementary-level professional development project designed to build a community of practice focused on inquiry-based science teaching. The theoretical framework of the project is the Guided Inquiry supporting Multiple Literacies model. The article presents the basic tenets that guided the development of learning experiences for teachers, and illustrates how the principles influenced the design of specific activities during the first year of the project. |
| Paris, S. G., & Winograd, P. (1990) | Theoretical | The authors discuss metacognitive strategies as tools to promote academic learning. The article begins with a synthesis of existing research and the difficulties researchers and practitioners have when conceptualizing metacognition. A traditional description of metacognition refers to strategies for planning, monitoring, and revising one's own thinking. The authors augment this description by arguing that metacognition also includes self-appraisal, motivation, and a sense of self-efficacy. Various approaches to instruction are suggested to combine an emphasis on cognitive skills and motivational encouragement. These suggestions include direct explanation, scaffolded instruction, cognitive coaching, and cooperative learning. These techniques are designed to move students from direct instruction to personal ownership of metacognitive habits. |
| Paul, R. (1992) | Theoretical | The author defines critical thinking and its relationship to knowledge, intellectual discipline, and intellectual values. He identifies elements and domains of thought and traits of mind that should be cultivated in students and offers guidelines on teaching for critical thinking and on incorporating critical thinking into existing curriculum. |
| Pearson, P. D. (1992) | Theoretical | This overview of research on reading focuses on trends and results from the 1980s. The author notes that this decade marked a shift from "reading research" to "literacy research," observing the latter approach situates reading alongside the other three domains of literacy: writing, listening, and speaking. The author describes the decline of traditional schema-selection theory and the growing popularity general mental models, schema-assembly theory, multiple analogies, and situated cognition. Advances in research on reading instruction are outlined, including instructional strategies for comprehension, |

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| | | vocabulary, and word identification. The author discusses research on classroom ecologies and reading opportunities, as well as negative effects of high-stakes testing on reading curricula. |
| Peirce, C. S. (1955) | Theoretical | This collection of writings from Charles S. Peirce includes many of his essential theories and philosophical arguments from logic, mathematics, scientific methodology, and semiotics. As the founder of pragmatism, Peirce wrote extensively about this philosophy, and several chapters delineate this perspective. |
| Peirce, C. S. (1991) | Theoretical | This collection of writings from Charles S. Peirce provides a basic introduction his philosophy. His general theory of signs, or semiotic, holds that thoughts are not “ideas” but “signs,” external to the self and without meaning unless interpreted by a subsequent thought. His semiotic theory has implications for many disciplines, including sociology, literature, linguistics, and education. |
| Pellegrino, J. W. (2006) | Theoretical | This paper explains how current research and theory about the nature of learning are key to improving teaching and learning practices. The author notes that curriculum, instruction, and assessment are three elements that must be aligned to effectively meet educational goals. He highlights important principles about learning and understanding, such as the effect of student preconceptions, the relationship between competence and knowledge, and the importance of meta-cognitive strategies. Concerns about the shortcomings of current assessment are outlined, including the insufficient measurement instruments and the limited usability of results. An expanded use of technology is suggested as a way to address these shortcomings. |
| Perkins, D. N., & Simmons, R. (1988) | Theoretical | This article examines unifying factors among diverse problems of understanding in several fields. Certain misunderstandings in science, mathematics, and computer programming display strong structural analogies with one another. Even within one of these domains, however, not all misunderstandings are structurally similar. To explain the commonality and variety, four levels of knowledge are posited: (1) content, (2) problem-solving, (3) epistemic, and (4) inquiry. Through analysis of several examples, it is argued that misunderstandings have causes at multiple levels, with highly domain-specific causes |

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| | | predominant at the “content level” and somewhat more general causes at the other levels. The authors note that education characteristically neglects all but the content level, describe successful interventions at all levels, and urge more attention in education to integration across the levels. |
| Peterson, P. L., Swing, S. R., Stark, K. D., & Waas G. A. (1984) | Empirical | This study investigated students’ reports of attention, understanding, cognitive processes and affect during mathematics instruction. Over the course of nine days, two classes of 5th grade students (N = 38) were taught a mathematics unit on measurement by one of their teachers. Students were videotaped during instruction and interviewed subsequently using a stimulated-recall procedure. Students completed an achievement test and questionnaires about their attention, cognitive processes, motivational self-thoughts, and attitudes toward mathematics. Results suggest that students’ reports of attention, understanding, and cognitive processes were more valid indicators of classroom learning than observers’ judgments of students’ time on task. Findings also indicate that students’ reported affect as well as cognitions mediated the relationship between instructional stimuli and student achievement and attitudes. |
| Piaget, J. (1970) | Theoretical | This chapter presents the author’s classic theory of the nature and development of human cognitive functions. The theory, which integrates elements from biology, sociology, linguistics, logic, and epistemology, deals with the nature of knowledge and how humans come gradually to acquire, construct, and use it. The author posits that cognitive development is a progressive reorganization of mental processes as a result of biological maturation, environmental experience, and self-regulation. In particular, children construct understandings of the world around them and then experience discrepancies between what they already know and what they discover in their environment. |
| Piaget, J., & Inhelder, B. (1972) | Theoretical | This book offers a definitive presentation of the developmental psychology Piaget has elaborated over four decades. The authors trace each stage of a child’s cognitive development over the entire period of childhood from infancy to adolescence. Specific sections are devoted to (1) the sensorimotor level, (2) the development of perception, (3) semiotic or symbolic function, (4) the concrete operations of thought and interpersonal |

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| | | relations, and (5) the preadolescent and the propositional operations. |
| Pintrich, P. R., Marx, R. W., & Boyle, R. A. (1993) | Theoretical | Conceptual change models of student learning are useful for explicating the role of prior knowledge in students' learning and are very popular in the research on learning in the subject areas. This article presents an analysis of a conceptual change model for describing student learning by applying research on student motivation to the process of conceptual change. Four general motivational constructs (goals, values, self-efficacy, and control beliefs) are suggested as potential mediators of the process of conceptual change. In addition, there is a discussion of the role of classroom contextual factors as moderators of the relations between student motivation and conceptual change. The article highlights the theoretical difficulties of a clinical or overly rational model of conceptual change that focuses only on student cognition without considering the ways in which students' motivational beliefs about themselves as learners and the roles of individuals in a classroom learning community can facilitate or hinder conceptual change. |
| Podolefsky, N. S., Perkins, K. K., & Adams, W. K. (2010) | Empirical | This paper extends prior research on student use of computer simulations (sims) to engage with and explore science topics, in this case the topic of wave interference. The authors describe engaged exploration, a process that involves students actively interacting with educational materials, sense making, and exploring primarily via their own questioning. They analyze interviews with college students who use physics education technology (PhET) sims in order to demonstrate engaged exploration and identify factors that can promote this type of inquiry. With minimal explicit guidance, students explore the topic of wave interference in ways that bear similarity to how scientists explore phenomena. PhET sims are flexible tools that allow students to choose their own learning path, but they also provide constraints such that students' choices are generally productive. This type of inquiry is supported by sim features such as concrete connections to the real world, representations that are not available in the real world, analogies to help students make meaning of and connect across multiple representations and phenomena, and a high level of interactivity with real-time, dynamic feedback from the sim. These features of PhET sims enable students to pose questions and answer them in ways that may not be supported by more traditional educational materials. |

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| Pressley, M. (1986) | Theoretical | This article briefly reviews the strategic, metacognitive, and knowledge components of good strategy use. Five principles of teaching that follow from this good strategy user model are illustrated by examples from arithmetic instruction. Practitioners are advised: (1) to teach strategies; (2) to teach knowledge about when, where, and how to use strategies; (3) to teach general knowledge about factors that promote strategy functioning; (4) to teach relevant nonstrategic knowledge; and (5) to have students practice components of good strategy use and the coordination of components. The good strategy user model for math instruction is compared to Polya's conception of how to teach problem solving. |
| Pressley, M., Borkowski, J. G., & Schneider, W. (1987) | Theoretical | In this article, the authors put forth their Good Strategy User (GSU) model, which describes the interactions between strategies, metacognition, and knowledge. They characterize a GSU according to five proficiencies: (1) a GSU possesses a large bank of useful strategies; (2) a GSU knows how, when, and where to apply each of these strategies; (3) a GSU understands that effort and minimal distractions are necessary to successfully execute strategies; (4) a GSU has sufficient content knowledge; and (5) a GSU has automatized the first four components and their coordination. The authors propose that there are regular patterns in the development of these five proficiencies and note that further research into these patterns will lead to effective ways to teach good strategy use in a classroom setting. |
| Puntambekar, S. (1995) | Theoretical | Intelligent tutoring systems have most frequently concentrated on imparting domain knowledge. However, there is another important aspect to learning: the meta level knowledge about how to learn a domain. Metacognition is a very important feature of learning. It consists of being aware of and regulating one's own cognitions. Good students have full control over their learning and see it as a purposive activity. They reflect on their learning activities, they are aware of a variety of strategies, and they oversee and monitor the application of these strategies. This paper describes a computer-based system that helps students learn these important self-regulation skills. Students work with the system in pairs, and they can use it with any instructional text. Apart from being used as a study aid, the system is being used as a tool to gather data about students learning processes. |

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| Putnam, R. T., Lampert, M., & Peterson, P. L. (1990) | Theoretical | This paper considers various research perspectives that can inform thinking about the nature of mathematics education in U.S. public elementary schools. To this end, the paper examines recent National Council of Teachers of Mathematics recommendations for changes in the mathematics curriculum and three major research perspectives that may inform thinking about mathematics pedagogy. The first of these perspectives is that of researchers, primarily cognitive psychologists, who focus on the individual knower of mathematics. The second perspective is that of the discipline of mathematics, i.e. what it means to understand mathematics from within the discipline. The third perspective is that of “classroom practice,” in particular the ways in which researchers studying the teaching and learning of mathematics in classrooms have conceptualized mathematical knowledge and learning. |
| Quinn, H., Lee, O., & Valdés, G. (2012) | Theoretical | The authors address learning opportunities for ELLs in English-speaking classrooms in which the Next Generation Science Standards have been adopted according to the framework for K-12 science education set forth by the National Research Council in 2011. This framework calls for “inquiry-based science,” which refers to a set of science and engineering practices that mirror what scientists do as they engage in scientific inquiry. The authors see a clear parallel between inquiry-based learning and ELLs’ need to use language meaningfully in context. Instructional situations in which students are required to speak, listen, read, and write about science promote language development and content learning. The authors do not ask that science teachers function as language teachers, but rather that they support the language learning that occurs in a content-rich and discourse-rich classroom environment. |
| Ray, K., & Smith, M. C. (2010) | Theoretical | This article describes kindergarten using a “whole child” philosophy. It reviews current research on memory skills and math, language, and science pedagogy. It also describes the social experiences children have in kindergarten with respect to their academic success. The authors discuss the impact of emotional competence on school success, as well as three major factors in children’s kindergarten success (transition, parental involvement, and retention). The article concludes with a discussion of full-day kindergarten programs and their potential for improving the chances of all kindergarten children, especially low- |

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| | | income and ethnic minority children, for success in school. |
| Rittle-Johnson, B., Siegler, R. S., & Alibali, M. W. (2001) | Empirical | The authors propose that conceptual and procedural knowledge develop in an iterative fashion, and that improved problem representation is one mechanism underlying the relations between them. Two experiments were conducted with 5th and 6th grade students learning about decimal fractions. In Experiment 1, children’s initial conceptual knowledge predicted gains in procedural knowledge, and gains in procedural knowledge predicted improvements in conceptual knowledge. Correct problem representations mediated the relation between initial conceptual knowledge and improved procedural knowledge. In Experiment 2, amount of support for correct problem representation was experimentally manipulated, and the manipulations led to gains in procedural knowledge. Thus, conceptual and procedural knowledge develop iteratively, and improved problem representation is one mechanism in this process. |
| Rogoff, B. (1998) | Theoretical | This text asks how cognitive development occurs in and is promoted by individuals’ collaboration with others. The author traces the evolution of theory and research on processes of collaboration and their implications for cognitive development. To ground her work, the author outlines various conceptual frameworks that have influenced theories of cognition as a collaborative process and discusses differing methodological approaches to observing and evaluating social cognition. Contemporary conceptualizations of and research about social cognition as a collaborative process are discussed. |
| Rogoff, B., Paradise, R., Arauz, R. M., Correa-Chavez, M., & Angelillo, C. (2003) | Theoretical | This article examines how people can learn by actively observing and “listening-in” on ongoing activities. Keen observation and listening-in are especially valued and used in some cultural communities in which children are part of mature community activities. This intent participation also occurs in some settings (such as early language learning in the family) in communities that routinely segregate children from the full range of adult activities. However, in the past century some industrial societies have relied on a specialized form of instruction that seems to accompany segregation of children from adult settings, in which adults “transmit” information to children. The authors contrast these two traditions of organizing learning in terms of their participation structure, the roles of more- and less-experienced people, distinctions in motivation and purpose, |

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| | | sources of learning (observation in ongoing activity versus lessons), forms of communication, and the role of assessment. |
| Rose, D. (2006) | Theoretical | In this paper, the author argues that every part of the educational process is so fundamentally and closely connected to reading that reading instruction is at the heart of sound pedagogy in all content areas. The author challenges those who focus on teaching the language of spoken and written texts, without affording reading the central role it deserves, and argues that it is only by learning to read (and practicing this skill) that students can effectively learn to write. From a conceptual framework that views schooling as a social institution and the learning process as highly interactional, the author proposes a learning model that has relevance for instruction in all subjects, at all grade levels. |
| Rosenholtz, S. J., & Simpson, C. (1984) | Theoretical | This paper examines a growing literature on the ways in which children develop conceptions of their own and their peers' intellectual abilities, a phenomenon the authors call "ability formation." They show that this literature may be integrated usefully under a recently developed theory regarding the ways in which schools construct academic ability as a reality experienced by students. They argue that this perspective offers an advance on developmental interpretations of findings in this area. |
| Roychoudhury, A., & Roth, W. M. (1996) | Empirical | In this naturalistic study of interactions in an open-inquiry physics laboratory, four aspects were considered: (1) the nature of student-student interactions, (2) the nature of peer group-teacher interactions, (3) the nature of interactions involved in task management, and (4) the views of students toward group work. The study found that students used three modes of negotiation: a collaborative mode, an adversarial mode, and by following a majority rule. During the planning and data interpretation phases of an experiment, interactions were primarily verbal and took shape according to the behavior of participating individuals. From the analysis of the degree of participation by different members of a group, three major patterns of interaction emerged: symmetric, asymmetric, and shifting asymmetric. During the planning and the data interpretation sessions, interactions between the teacher and students were either a Socratic interlocution or a discussion between a coach and novices. During the data collection stage, the teacher primarily helped students solve various local problems pertaining to the equipment or |

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| | | measurements. Students' views toward working in a group, as expressed in their essays, were generally very positive. |
| Ruiz-Primo, M. A., & Li, M. (2013) | Review and theoretical | After presenting results from a meta-analysis of current research on feedback, the authors argue that the knowledge base about feedback is mainly drawn from studies done in laboratories or in artificial classroom environments in which learning tasks tend to be minimally meaningful or irrelevant to learners and seldom take place over extended periods of time. They point to the inconvenient truth that much less is known about feedback practices in the classroom context than most education experts are comfortable admitting. In an effort to further meaningful research efforts, the authors provide a theoretical framework in which to situate research on feedback in a classroom setting. They also provide an expanded definition of feedback intended to broaden more familiar definitions described in a variety of books and papers. This expanded definition intentionally blurs the distinction between instruction and assessment to include such informal feedback strategies as peer-to-peer conversations during group problem solving, posted student work, lesson-integrated checks for understanding, and spontaneous follow-up questions. The chapter concludes with a proposed research agenda to guide future studies, frame new questions, and thoughtfully select methodological approaches for examining feedback practice in the classroom. |
| Rumelhart, D. E., & Norman, D. A. (1978) | Theoretical | This paper identifies three qualitatively different phases of the learning process. In one phase, the learner acquires facts and information, appending new structures onto the already existing knowledge structures. This phase of learning is adequate only when the material being learned is part of a previously understood topic because the appropriate memory schemata already exist. In a second phase, the learner must devise new memory structures to interpret the new material. This is the most difficult and the most significant form of learning, for it marks the acquisition of truly new conceptualizations about a topic. The third phase of learning involves a continual process of modification to both constrain and generalize the knowledge within the schemata of memory. This stage of learning does not increase the formal content of one's knowledge, but it makes the use of the knowledge more efficient. Thus, although a beginner and an expert might both perform a task with perfect accuracy, there is a marked qualitative difference between the performances of the |

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| | | two. The authors propose three mechanisms that may be responsible for the different phases of learning: accretion, restructuring, and tuning. |
| Rumelhart, D. E., & Norman, D. A. (1982) | Theoretical | This article considers the aptitude of skilled typing and proposes a model for the control of the hands and fingers during typing. The model is based upon an Activation-Trigger-Schema system in which a hierarchical structure of schemata directs the selection of the letters to be typed and then controls the hand and finger movements by a cooperative, relaxation algorithm. The interactions of the patterns of activation and inhibition among the schemata determine the temporal ordering for launching the keystrokes. The model exists as a working computer simulation and produces an output display of the hands and fingers moving over the keyboard. It reproduces some of the major phenomena of typing, including the interkeystroke interval times, the pattern of transposition errors exhibited by skilled typists, and doubling errors. Although the model is clearly inadequate in some of its features and assumptions, it serves as a useful first approximation for the understanding of skilled typing. |
| Sadler, 1989 | Theoretical | This article describes a theory of formative assessment and considers the role of formative assessment in the learning process. The author highlights teacher feedback and student self-monitoring as key aspects of formative assessment and describes both in detail. The author argues that traditional definitions of feedback (“correct” or “incorrect”) are too narrow to be helpful and should be expanded to include qualitative judgments about performance. This requires a knowledge of standards and multi-criteria comparisons and an understanding of how to narrow the gap between work produced and the desired goal. The author also discusses the need for students to become less dependent on teacher feedback and develop skills and knowledge (through exemplars and explicit instruction) to evaluate their own work and progress. |
| Sanbonmatsu, D. M., Sansone, C., & Kardes, F. R. | Empirical | This study considered the effects of time delay on memory and inference accuracy. Perceivers often infer the values of unknown attributes from evaluative expectancies. In two experiments, inferences about unknown attributes of a target made shortly after initial |

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| (1991) | | processing tended to be moderate, as perceivers presumably adjusted for the lack of directly relevant evidence. However, stronger inferences were drawn with the passage of time as memory of the absence of information faded. Expertise moderated this effect, as subjects highly knowledgeable of the target domain were much less likely than low or moderate knowledge subjects to draw extreme inferences over time. Memory-based inferences about unknown attributes were also found to be held with greater confidence than inferences made shortly after stimulus presentation. |
| Sandifer, C. (2004) | Empirical | The purposes of this qualitative study were (a) to investigate the factors that support the generation of spontaneous analogies (SAs) by students, and (b) to investigate the factors that interfere with comprehension of the analogy target of an SA. To promote the generation of SAs, eight algebra-based physics students were asked to participate in two group problem-solving sessions and one individual explaining session. Overall, eighteen SAs were generated. Two factors appeared to support the spontaneous generation of analogies: (1) sufficient prior understanding of the analogy target, and (2) the existence of previous analogical examples from other students. Two factors appeared to interfere with the comprehension of the SA analogy target: (1) an incorrect perception of the type of analogy between target and base (attributes, relationships), and (2) an incorrect understanding of the analogy base. |
| Savignon, S. J. (1991) | Theoretical | This paper looks briefly at the beginnings of what has come to be known as communicative language teaching (CLT) and discusses current issues and promising avenues of inquiry. From an international perspective, the author argues that CLT is not a British, European, or U.S. phenomenon, but rather an international effort to respond to the needs of present-day language learners in many different contexts of learning. |
| Sawyer, R. J., Graham, S., & Harris, K. R. (1992) | Empirical | This article extends previous research on components of effective strategy instruction operationalized in an approach referred to as self-regulated strategy development (SRSD). Comparisons were made among learning-disabled students in four conditions (SRSD, SRSD without goal setting and self-monitoring, direct teaching, and practice control) at posttest, generalization, and two maintenance probes. Normally achieving (NA) peers constituted a social validation condition. Full SRSD resulted in significantly greater |

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| | | schematic structure scores at generalization as compared with the other instructional conditions. At posttest, both SRSD conditions resulted in significantly greater schematic structure scores as compared with the practice control condition. Comparisons with NA peers indicated that all instructional conditions had a meaningful effect. No differences among conditions were found for self-efficacy. |
| Sawyer, R. K. (2006) | Theoretical | Contemporary notions of schooling have moved beyond instructionism, which conceptualizes education as the transfer of facts and procedures from teachers to students. In accordance with this theory, much traditional education research focused on teacher-centered techniques for imparting knowledge. Most scholars now believe that education is better understood as a complex process and is better studied from multiple perspectives, including those informed by constructivism, cognitive science, educational technology, and sociocultural studies. This new “learning science” seeks to identify processes of learning, including using prior knowledge, how students gain expertise, scaffolding, articulation of ideas, self-reflection, and self-monitoring. Additionally, this new perspective recognizes diverse methodological approaches for asking and answering questions about the relationship between teaching and learning. |
| Schleppegrell, M. J. (2004) | Theoretical | This book explores how language is used in the context of schooling and demonstrates that the type of English expected at school is different from the interactional language that students use for social purposes outside of school. Through the framework of functional linguistic analysis, the author discusses the challenges that school curriculum presents for non-native speakers of English, speakers of non-standard dialects, and students who have little exposure to academic language outside of school. This framework focuses on the structure of words and sentences, on how texts are constructed, and on how particular grammatical choices create meanings in the different kinds of texts students are asked to read and write at school. |
| Schneider, W., & Lockl, K. (2002) | Empirical | This text gives an overview of developmental trends in research on metacognition in children and adolescents. Whereas a first wave of studies focused on the assessment of declarative and procedural metacognitive knowledge in schoolchildren and adolescents, a second wave focused on very young children’s “theory of mind” (ToM). Findings from a |

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| | | recent longitudinal study are presented that demonstrate developmental links between early ToM and subsequent declarative metacognitive knowledge, mainly mediated by language competencies. The relevant literature further indicates that developmental trends in declarative and procedural metacognitive knowledge clearly differ. Whereas the findings for declarative metacognitive knowledge show steady improvement through childhood and adolescence, mainly due to increases in knowledge about strategies, the results are not similarly clear-cut for procedural metacognition. Age trends observed for this component of metacognition are significant for self-control activities but not pronounced for monitoring abilities. These findings have important implications for education, emphasizing the role of strategy training procedures in different instructional domains and illustrating teachers' potential impact on the improvement of monitoring and control processes. |
| Schraw, G. (1998) | Theoretical | The author describes two aspects of metacognition, knowledge of cognition and regulation of cognition, and how they are related to domain-specific knowledge and cognitive abilities. It is argued that metacognitive knowledge is multidimensional, domain-general in nature, and teachable. Four instructional strategies are described for promoting the construction and acquisition of metacognitive awareness. These include promoting general awareness, improving self-knowledge and regulatory skills, and promoting learning environments that are conducive to the construction and use of metacognition. |
| Schraw, G., & Moshman, D. (1995) | Theoretical | This paper proposes a framework for understanding people's theories about their own cognition. Metacognitive theories are defined broadly as systematic frameworks used to explain and direct cognition, metacognitive knowledge, and regulatory skills. The authors distinguish tacit, informal, and formal metacognitive theories and discuss critical differences among them using criteria borrowed from the developmental literature. They also consider the origin and development of these theories, as well as implications for educational research and practice. |
| Schraw, G., Crippen, K. J., & Hartley, K. (2006) | Theoretical | The purpose of this article is to review recent research on self-regulated learning and discuss the implications of this research for science education. The authors draw on examples of self-regulated learning from the science education literature to summarize |

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| | | and illustrate effective instructional methods and the development of metacognitive understanding. A focus is given to the crucial role that metacognition plays in self-regulation. The discussion is divided into two main parts. The first focuses on three components of self-regulated learning, including cognition, metacognition, and motivation. These aspects of self-regulation are related to current practices in science education. The second section focuses on six general instructional strategies for improving self-regulation in the science classroom. The focus is on the use of inquiry-based learning, the role of collaborative support, strategy and problem solving instruction, the construction of mental models, the use of technology to support learning, and the role of personal beliefs such as self-efficacy and epistemological world views. These instructional strategies are selected because they reflect extensive research agendas over the last decade within the science education literature and are essential to metacognition and self-regulation. |
| Schunk, D. H. (1989) | Theoretical | The central hypothesis presented in this article is that student self-efficacy has an appreciable impact on motivation and learning. A model of school learning that incorporates the self-efficacy construct is presented. The model proposes that students enter learning tasks with varying levels of self-efficacy that are a function of aptitudes and prior experiences. As students engage in learning activities, cues emanating from task engagement variables signal to students how well they are learning. This information affects their beliefs about their capabilities for further skill improvement. In turn, self-efficacy bears a positive relationship to task motivation and learning. A variety of task engagement variables are discussed, including content difficulty, strategy training, performance and attributional feedback, and modeling. |
| Schunk, D. H., & Zimmerman, B. J. (1998) | Theoretical | Academic self-regulation, the process through which individuals become proactive seekers, generators, and processors of information, is widely acknowledged as the means by which students transform their mental abilities into academic skills. This book presents strategies for effectively teaching self-regulatory skills, including distinct goal setting, accurate behavioral self-monitoring, and resourcefulness in strategic thinking. Multiple examples of integrating self-regulation instruction into the regular curriculum are discussed, and each project is described in depth and evaluated on how well it helped |

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| | | students acquire self-regulation principles, apply them to enhance learning, and maintain them over time. |
| Scott, P. (1998) | Theoretical | The author uses a theoretical framework derived from Vygotsky's writings to review studies of science classroom discourse interactions between teachers and students. The article suggests that shifting the research focus from isolated instructional activities to promote conceptual change toward viewing such activities in the critically influential context of an ongoing flow of discourse could greatly inform teaching practices. |
| Scott, P. H., Mortimer, E. F., & Aguiar, O. G. (2006) | Theoretical and empirical | In this paper, the authors draw upon a framework for analyzing the discursive interactions of science, to probe the movement between authoritative and dialogic discourse in a Brazilian high school science class. More specifically, they argue that such shifts between communicative approaches are an inevitable part of teaching. They suggest that a necessary tension therefore exists between authoritative and dialogic approaches, as dialogic exchanges are followed by authoritative interventions (to develop the canonical scientific view). Additionally, the authoritative introduction of new ideas is followed by the opportunity for dialogic application and exploration of those ideas. In these ways, one communicative approach follows from the other, authoritativeness acting as a seed for dialogicity and vice versa. The authors discuss how this analysis, in terms of shifts in communicative approach, offers a new and complementary perspective on supporting productive disciplinary engagement in the classroom. Methodological issues arising from this study are considered. |
| Semb, G. B., & Ellis, J. A. (1994) | Review | Popular belief holds that much of what is taught in classrooms is forgotten shortly thereafter. However, there is evidence from numerous studies that long-term retention for knowledge taught in school is substantial. These studies are reviewed, and several variables that affect the ability to remember are discussed. The article concludes that (a) students retain much of the knowledge taught in the classroom; (b) retention decreases over time as a function of the length of the retention interval but the forgetting curves for knowledge taught in school do not decline as rapidly or asymptote as low as the curves observed in traditional laboratory studies; (c) increasing the level of original learning differentially affects retention performance; (d) both instructional content and assessment |

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| | | tasks affect learning and retention, with one of the most consistent effects being that recognition tasks are retained at higher levels than recall tasks; (e) most instructional strategies that promote higher levels of original learning do not result in differentially better retention (however, several exceptions are discussed); and (f) while higher ability students learn and remember more than lower ability students, there is no evidence for differential forgetting. Implications for research and teaching are discussed. |
| Semb, G. B., Ellis, J. A., & Araujo, J. (1993) | Empirical | Three experiments examined students' long-term retention for information learned in college courses. In experiment 1, retention was measured four and eleven months after the term ended. Students retained a great deal of what they originally learned, and there were no differential forgetting effects as a function of level of original learning. Experiment 2 compared retention for recall test items and three types of multiple-choice test items: recognition, comprehension, and mental skills. Students performed poorer on recall items, but there were no differences among the multiple-choice items measuring the other types of tasks. Experiment 3 analyzed retention for student tutors. Tutors retained more after four months than the students they tutored. This suggests that tutoring, a type of overlearning, has positive effects that are maintained over time. |
| Shapiro, A. M. (2004) | Empirical | Prior knowledge has a marked effect on learning outcomes. Researchers typically rely on a number of methodologies to control for this factor in learning research, including the use of fictional stimuli and domain-novice subjects. The experiments reported here demonstrate that such methodological controls may be insufficient. In experiment 1, students read texts about fictional places and events. In experiment 2, novice students in a cognition course were asked to read several advanced texts. In both experiments, prior knowledge accounted for a large portion of the subjects' posttest performance. The data demonstrate that methodological approaches intended to control for prior knowledge may be insufficient to prevent that variable from influencing learning outcomes. Thus researchers are urged to include measures of prior knowledge in their analyses. |
| Shepard, L. A. (2000) | Theoretical | This article focuses on how classroom assessment can be used as part of instruction to support and enhance learning. The author discusses changes in curriculum, learning theory, and assessment by contrasting the central tenets of the 20th century dominant |

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| | | paradigm (including behaviorist learning theory and scientific measurement) with those of an emergent paradigm that draws on cognitive, constructivist and sociocultural theories of learning. This comparison highlights the discrepancy between new views of instruction and traditional views of testing. The author elaborates on the ways assessment practices should change in order to align with and support the social-constructive model of teaching and learning. These suggestions include ways to use assessment in the classroom both to monitor and promote individual students' learning and to examine and improve teaching practices. According to this article, teacher education programs must address the issues surrounding the use of assessment as teachers play a central role in shaping students attitudes about learning. |
| Shepard, L. A. (2006) | Theoretical | In this chapter, the author provides a comprehensive overview of classroom assessment. The evolution of theory and practice underlying assessment introduces the discussion, and the author highlights enduring ideas, as well as those that are currently contested. In subsequent sections, formative, summative, and external, large-scale assessments are considered. The author concludes with a call for further research (not only into assessment tools and practices, but also into the relationship between assessment and teacher development) as well as a suggestion for revised concepts of reliability and validity in the domain of classroom assessment. |
| Shepard, L. A. (2013) | Theoretical | In this article, the author gives a brief summary of current research and theory pertaining to classroom assessment. She notes that contemporary learning theory traces its roots to cognitive psychology, motivation theory, and socio-cultural learning theory, arguing that these are all critically important to understanding classroom assessment. Formative and summative assessments are discussed, including their potential utility and the dangers of misuse. In her call for further research, the author argues that research on classroom assessment must be the province of subject-matter experts and learning scientists as much as or even more than that of measurement experts. |

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| Shuell, T. J. (1986) | Theoretical | Although cognitive psychology currently represents the mainstream of psychological and educational thinking, it is only recently that much concern has been shown for learning as such that is, concern for the factors and variables that influence “changes” in human performance, knowledge structures, and conceptions. This article examines current thinking about learning within the framework of cognitive psychology and argues that a new cognitive conception of learning can guide future research on both learning and instruction. Similarities and differences between behavioral and cognitive conceptions of learning are discussed, along with issues such as the active (rather than passive) nature of learning, the concern for understanding, the role of prior knowledge, the cumulative nature of most forms of human learning, and the role played by cognitive analyses of performance. Several cognitive theories of learning are presented as examples of how cognitive psychology has influenced research on learning. |
| Shute, V. J. (2008) | Review | This article reviews the corpus of research on feedback, with a focus on formative feedback (defined as information communicated to the learner that is intended to modify his or her thinking or behavior to improve learning). According to researchers, formative feedback should be nonevaluative, supportive, timely, and specific. Formative feedback is usually presented as information to a learner in response to some action on the learner’s part. It comes in a variety of types (e.g., verification of response accuracy, explanation of the correct answer, hints, worked examples) and can be administered at various times during the learning process (e.g., immediately following an answer, after some time has elapsed). Finally, several variables have been shown to interact with formative feedback’s success at promoting learning (e.g., individual characteristics of the learner and aspects of the task). All of these issues are discussed. This review concludes with guidelines for generating formative feedback. |
| Siegler, R. S. (1983) | Theoretical | This article proposes five generalizations about existing knowledge, learning, and their interaction, and it discusses evidence for these generalizations from research on children’s learning, memory, conceptual understanding, and problem solving. Several of these generalizations address issues of longstanding concern in developmental psychology, such as why developmental sequences occur in the order that they do and why children sometimes fail to learn from seemingly reasonable instructional efforts. Other |

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| | | generalizations address issues that have received less extensive consideration, such as whether children’s reasoning shows more consistency when they know little about concepts than when they know more about them. General benefits that may come from studying learning and existing knowledge in conjunction also are discussed. |
| Siegler, R. S., & Klahr, D. (1982) | Theoretical | Cognitive psychologists have devoted far more attention to examining people’s existing knowledge than their ability to acquire new knowledge. However, methods that were originally developed to study problem solving, elementary information processes, and semantic memory are beginning to be extended to the study of learning. The research described in this article uses one recently developed method, the rule-assessment approach, to examine the relationship between existing knowledge and the ability to learn. The rule-assessment approach is shown to be useful in characterizing children’s initial knowledge, in classifying incoming information in relation to that knowledge, and in identifying the precise difficulties that prevent children from acquiring more advanced knowledge. The findings suggest that techniques from cognitive psychology can be applied profitably to the study of acquisition processes and that the topic of learning soon will assume its rightful role as a central concern of cognitive psychologists. |
| Sierpinska, A. (1994) | Theoretical | The concept of understanding with regard to mathematics education is considered in this book, which examines the difficult task of mathematics teachers in facilitating student understanding. The author frames her discussion with theoretical grounding in math, philosophy, logic, linguistics and the psychology of math education. The book synthesizes the author’s research and related European research to consider the contributions of social and cultural contexts to understanding. |
| Simons, P. R. (1984) | Empirical | This paper discusses three functions (a concretizing function, a structurizing function, and an active assimilation function) that might explain why analogies are effective in learning. Six experiments are reported that attempt to answer the following questions: (a) Does the addition of concrete analogies lead to improved performance in students of different ages? (b) Does this lead to longer reading times? (c) What are the effects under restrictive time conditions? (d) Are there aptitude-by-treatment interactions? (e) Why are analogies effective reading aids? These experiments used a total of 374 students (age ten to twenty- |

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| | | seven years) from elementary and secondary schools, and 179 college students studying science, biology, developmental psychology, and computer programming. Results show that analogies are effective reading aids; however, there are doubts as to their efficiency because they are effective only when there is enough time available. Yet some findings indicate that performance gains outweigh time costs. Some support was found for all three of the functions. On the basis of results, it is proposed that more analogies should be added to texts and oral lessons, but this should be done in such a way that students are free to decide whether or not they wish to use them. |
| Skemp, R. R. (2012) | Theoretical | This book presents problems of learning and teaching mathematics from both a psychological and mathematical perspective. The author discusses his most recent findings on the formation of mathematical concepts, different kinds of imagery, interpersonal and emotional factors, and a new model of intelligence. The author asserts that progress in the areas of learning and teaching mathematics can only be made when such factors as the abstract and hierarchical nature of mathematics, the relation to mathematical symbolism, and the distinction between intelligent learning and rote memorization are taken into account and reflected in instructional practice. |
| Slavin, R. E. (1996) | Theoretical | In this article, the author summarizes current research and perspectives on cooperative learning in the classroom setting and suggests specific directions for future research. Four major theoretical perspectives that have framed the study of cooperative learning are outlined: motivational perspectives, social cohesion perspectives, developmental perspectives, and cognitive elaboration perspectives. In attempting to reconcile these competing theoretical approaches, the author observes that all of them apply in some circumstances, but none are both necessary and sufficient in all circumstances. Factors that contribute to achievement effects of cooperative learning are discussed, including the balance between group goals and individual accountability and the structure of group interactions. The author discusses homogeneous and heterogeneous groupings, as well as which types of students benefit from cooperative learning. |
| Slife, B. D., Weiss, J., & Bell, | Empirical | This study investigated whether metacognition is a separate factor from cognition by measuring the effects of metacognitive factors in problem solving while attempting to hold |

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| T. (1985) | | relevant cognitive factors constant. Twenty four 2nd through 6th graders who were disabled in mathematics were matched to twenty four regular students on the basis of both students' performance on the same set of ten mathematics problems and their achievement test scores in mathematics. The two groups also did not significantly differ on IQ scores. Results show that the learning disabled students were less skilled in two forms of metacognition with respect to the set of problems: (a) knowledge about cognition, or in this case knowledge about their problem-solving skills; and (b) regulation of cognition, or in this case the ability to monitor their problem-solving performance. Implications of the results and the adequacy of the matching methodology are discussed. |
| Spires, H. A., Donley, J., & Penrose, A. M. (1990, April) | Empirical | This study investigated the effects of a prior knowledge activation strategy on students' ability to successfully engage in the ongoing comprehension of extended text. Data were elicited from seventy-nine 9th graders who were enrolled in a required social studies class in an urban high school in the Southeast. Equal numbers of high and low readers were assigned to each of three treatment groups: a prior knowledge activation (PKA) group; a main idea (MI) group; and a control group. All subjects participated in eight 45-minute instructional sessions followed by four 45-minute testing sessions (three immediate testing sessions and one delayed testing session four weeks later). Naturalistic reading passages were selected from the social studies textbook that the students were using, and instructors were mixed across treatments to control for an instructor effect. Results revealed that explicit instruction in how to spontaneously activate prior knowledge during reading had a positive affect on students' ability to answer application level questions. Results also revealed, however, that PKA strategy did not have a significant effect on literal comprehension, and that the MI group performed better on the literal measure, since the treatment focused on encouraging students to target main ideas and supporting details rather than to elaborate from the text. Further research into a strategy combining the tasks of the MI and PKA groups is called for. |
| Spiro, R. J., Feltovich, P. J., Coulson, R. L., & Anderson, D. K. (1989) | Theoretical | This chapter considers the risk of reliance on a single conceptual analogy. First, the authors illustrate the danger of misuse of single analogies in the learning of complex concepts. They demonstrate with several common misconceptions held by medical students that are traceable to a cognitive (and sometimes instructional) overreliance on |

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| | | <p>single analogies. They examine the circumstances of learning and instruction that promote the uncritical acceptance and entrenchment of learning based on inadequate analogies. Second, by way of an example from biology, the authors present their approach to the use of multiple analogies to capture correctly, yet manageably, the complexity of difficult concepts. In order to mitigate the additional cognitive load that multiple analogies introduce in learning, they describe a technique for context-dependent selective and contingent composite imaging of the productive features of the multiple analogies. Third, a more detailed picture is presented of the variety of ways that adding analogies can affect the earlier learning outcomes derived from previously encountered analogies. The authors develop a nine-part taxonomy of the functions of new analogies and modifications of old analogies in promoting understanding.</p> |
| Stavy, R. (1991) | Empirical | <p>A new approach to change student misconceptions is to build on ideas which match students' existing intuitive knowledge. This can be done by analogy. The use of an analogical relation between the known and the unknown can help students learn new information and discard or modify misconceptions. Previous studies have confirmed this result in such areas as mathematics. The present study examined the use of analogical instruction to overcome misconceptions about conservation of matter. Students who understood the concept of conservation of matter when iodine was evaporated were able to transfer their understanding to the evaporation of acetone. This indicates that teaching by analogy can be an effective tool in science. The author is now studying the relative effectiveness of conflict training and learning by analogy.</p> |
| Steele, C. M. (1997) | Theoretical | <p>A general theory of domain identification is used to describe achievement barriers still faced by women in advanced quantitative areas and by African Americans in school. The theory assumes that sustained school success requires identification with school and its subdomains; that societal pressures on these groups (e.g., economic disadvantage, gender roles) can frustrate this identification; and that in school domains where these groups are negatively stereotyped, those who have become domain identified face the further barrier of stereotype threat (the threat that others' judgments or their own actions will negatively stereotype them in the domain). Research shows that this threat dramatically depresses the standardized test performance of women and African Americans who are in the</p> |

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| | | academic vanguard of their groups (offering a new interpretation of group differences in standardized test performance), that it causes disidentification with school, and that practices that reduce this threat can reduce these negative effects. |
| Stein, M. K., Grover, B. W., & Henningsen, M. (1996) | Empirical | This article focuses on mathematical tasks as important vehicles for building student capacity for mathematical thinking and reasoning. A stratified random sample of 144 mathematical tasks used during reform-oriented instruction was analyzed in terms of (a) task features (number of solution strategies, number and kind of representations, and communication requirements) and (b) cognitive demands (e. g., memorization, the use of procedures with [and without] connections to concepts, the “doing of mathematics”). The findings suggest that teachers were selecting and setting up the kinds of tasks that reformers argue should lead to the development of students’ thinking capacities. During task implementation, the task features tended to remain consistent with how they were set up, but the cognitive demands of high-level tasks had a tendency to decline. The ways in which high-level tasks declined as well as factors associated with task changes from the set-up to implementation phase were explored. |
| Stiggins, R. J. (2008) | Theoretical | This document proposes numerous changes to the way assessment systems currently operate in schools to better support the learning of all students. The author discusses the importance of a balanced assessment system and how the assessment data must meet the information needs of all relevant users at the classroom, program, and institutional levels. He also argues that in addition to measures that are reliable and valid, the quality of assessments must be considered in light of the impact of the evaluation on the learning process. He maintains that rather than being isolated events at the end of the unit, assessments should be continuous, interrelated events that demonstrate student learning over time, and that assessments should not only inform teacher and school decision making, but they should also be used to support decisions made by students. He concludes that research over the past twenty years has led to a better understanding of balanced assessment, yet this information must now be used to educate teachers and help schools develop better and more effective assessment systems. |

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| Stigler, J. W., Gonzales, P., Kawanaka, T., Knoll, S., & Serrano, A. (1999) | Empirical | This paper describes the methods and preliminary findings of a large, comparative, video-based qualitative study of 8th grade mathematics lessons in Germany, Japan, and the United States. Part of the Third International Mathematics and Science study, this research project was the first study of videotaped records from national probability samples. Two aims of the study were to provide a rich source of information about what actually takes place in the lessons, and to develop objective measures of classroom instruction as indicators of teaching practices in the three countries. |
| Sutton, C. R. (1992) | Theoretical | Science and technology are often presented and taught as two separate disciplines. When this is done, students as well as teachers are forced to attempt to develop the appropriate linkages. This book is designed to help teachers develop their science and technological instruction in ways that are both satisfying to themselves and stimulating to their students. Emphases are placed on the centrality of language in scientific thinking, in particular the use, and abuse of metaphor. |
| Tharp, R., & Gallimore, R. (1988) | Theoretical | The authors develop a unified theory of education and propose the reconstitution of schools as “educating societies.” Drawing on studies from the family nursery through the university seminar and on their own extensive experience with students, they base their theory in developmental psychology and seek to integrate recent work in the Vygotskian tradition with basic concepts in cognitive science, anthropology, and sociolinguistics. One of the authors’ primary resources is the Kamehameha Elementary Education Program (KEEP), generally regarded as the world’s outstanding research and development program for elementary schooling. |
| Tunstall, P., & Gipps, C. (1996) | Theoretical | This article develops a grounded typology of teacher feedback based on observations of teacher-student interaction in the classroom. The result is a lexicon that can be used in discussing feedback with teachers. The authors argue that the importance of this work is its contribution to the translation of achievement goal theory into practical terms for classroom use. |
| Valencia, S. W., Stallman, A. C., Commeyras, M., Pearson, P. D., & Fuchs, D. (1998) | Empirical | This study was an effort to establish the construct validity of measures designed to assess topical knowledge. Assuming that the best way to find out how much people know about a |

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| P. D., & Hartman, D. K. (1991) | | <p>topic is to interview them, the authors first interviewed elementary students (N=44) and junior high students (N=31) about their knowledge of four topics. The interview results were used to validate the results from three paper-and-pencil recognition tests of topical knowledge administered two weeks later. Unexpectedly, students' knowledge as assessed in the interviews was not strongly correlated with their performance on any of the recognition tests of topical knowledge. A conditional probability analysis suggested differences in the information provided by the interview and the paper-and-pencil tests; the differences appeared related to the differences between recall and recognition tasks. If students volunteered information in the interviews, the probability was high that they would recognize similar information on a paper-and-pencil test. Conversely, the probability was low that any specific item of information recognized on the test would be mentioned in the interview. In a few case studies analyzed in depth, it was found that the interview approach captured individual differences more dramatically than did the recognition tests. The authors conclude that, if one's goal is to obtain a fairly complete picture of a person's topical knowledge, then both interview and recognition measures seem appropriate. If the goal is to assess only a specific body of information, then a recognition measure might suffice. And if the goal is to open a broader window on a student's knowledge, then an interview seems preferable.</p> |
| Van Lier, L. (2004) | Theoretical | <p>The ecological perspective on language and language education has in recent years become a major focus of interest in the fields of second language teaching and learning, and linguistics and education in general. This book provides a comprehensive overview of an ecology of language learning. It includes theoretical discussions on language, semiotics, emergence, and self. It also addresses the practical consequences of an ecological view for classroom work, including the role of project-based learning, modeling, scaffolding, and collaborative learning structures.</p> |
| Vygotsky, L. S. (1978) | Theoretical | <p>Through a series of essays, this book outlines a dialectical-materialist theory of cognitive development that anticipates much recent work in American social science. The author argues that the mind cannot be understood in isolation from the surrounding society, which provides an individual with technology (such as mnemonic devices or symbolic language) that can be used to shape private mental processes. This theoretical framework</p> |

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| | | is applied to perception, attention, memory, language, and play, and its implications for education are examined. |
| Vygotsky, L. S. (1986) | Theoretical | In this text, the author establishes the explicit and profound connection between speech (both silent inner speech and oral language) and the development of mental concepts and cognitive awareness. He argues that, while inner speech and external speech are fundamentally different, they are intimately related, so much so that thought itself develops socially. He traces the evolution of self-talk in children from its use as a social tool, to a self-regulating strategy, and finally to its mature form as the internal thought that adults experience. |
| Walqui, A., & Heritage, M. (2012) | Theoretical | In an effort to aid teachers in the complex challenge of providing ELLs with opportunities that allow them to attain the Common Core State Standards despite their various needs and abilities, the authors outline five principles of classroom instruction. These principles, which stress sensitivity and responsiveness to individual students, include the significance of prior knowledge in the learning process, the connection between language and cognition, and the importance of contextualizing learning. |
| Webb, N. M., & Palincsar, A. S. (1996) | Theoretical | This article discusses current research on group processes in the classroom. It considers the processes taking place in peer-led groups that shape learning and the impact of different group and classroom structures on the group processes that emerge. The authors provide a historical overview of group processes and group learning in education and detail several theories about how learning occurs in group contexts. Contemporary approaches to peer-based learning in the classroom are discussed, as well as findings from empirical literature about when and how group processes influence learning and other outcomes. The authors describe the outcomes typically investigated in research on group processes and the ways in which group processes have influenced learning outcomes. They examine the powerful effects that structuring groups and group work can have on emerging in-group processes. Finally, the authors summarize the state of the field and pose a number of questions for further research. |

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| Weiner, B. (1972) | Theoretical | This text presents an overview of four major theories of motivation: drive theory, field theory, achievement theory, and attribution theory. The author outlines the historical development of each theory and points to the similarities and differences between them. He compares and contrasts how each theory addresses particular issues, including conflict and frustration, success, social reinforcement of behavior, and incentives. The author concludes that a mechanistic conception of motivation is no longer viable and reviews several relevant studies concerned with cognitive approaches to motivation. |
| Wenger, E. (2005) | Theoretical | The term “community of practice” is of relatively recent coinage, even though the phenomenon it refers to is age-old. The concept has turned out to provide a useful perspective on knowing and learning. A growing number of people and organizations in various sectors are now focusing on communities of practice as a key to improving their performance. This brief and general introduction examines what communities of practice are and why researchers and practitioners in so many different contexts find them useful as an approach to knowing and learning. |
| Wentzel, K. R. (1997) | Empirical | This study examined adolescents’ perceptions of pedagogical caring in relation to their motivation to achieve positive social and academic outcomes in middle school. A longitudinal sample of 248 students was followed from 6th to 8th grade. Perceived caring from teachers predicted motivational outcomes, even when students’ current levels of psychological distress and beliefs about personal control, as well as previous (6th grade) motivation and performance, were taken into account. Eighth-grade students characterized supportive and caring teachers along various dimensions. Teachers who care were described as demonstrating democratic interaction styles, developing expectations for student behavior in light of individual differences, modeling a “caring” attitude toward their own work, and providing constructive feedback. The implications for understanding links between teacher behavior and student achievement are discussed. |
| Whitebread, D., Coltman, P., Pasternak, D. P., Sangster, C., Grau, V. Bingham. S., Almeqdad, Q., & Demetriou, | Empirical | This paper reports on observational approaches developed to identify and assess metacognition and self-regulation in young children between three and five years of age. It is argued that the development of observational tools, although containing methodological difficulties, allows researchers to make more valid assessments of children’s metacognitive |

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| D.(2009) | | and self-regulatory abilities in this age group. The analysis of 582 metacognitive or self-regulatory videotaped “events” is described, including the development of a coding framework identifying verbal and non-verbal indicators. The construction of an observational instrument, the Children’s Independent Learning Development (CHILD 3-5) checklist, is also reported together with evidence of the reliability with which it can be used by classroom teachers and early indications of its external validity as a measure of metacognition and self-regulation in young children. Given the educational significance of children’s development of metacognitive and self-regulatory skills, it is argued that the development of such an instrument is potentially highly beneficial. The establishment of the metacognitive and self-regulatory capabilities of young children by means of the kinds of observational tools developed within this study also has clear and significant implications for models and theories of metacognition and self-regulation. The paper concludes with a discussion of these implications. |
| Willoughby, T., Waller, T. G., Wood, E., & MacKinnon, G. E. (1993) | Empirical | Prior knowledge as a mediator of the effectiveness of the elaborative interrogation strategy was evaluated in this study. University students were given facts about animals and instructed either (1) to answer why each fact would be true of the particular animal being discussed (elaborative interrogation) or (2) to read each fact aloud at a rate so that they could understand it (repetition control). Half of the animals were familiar to the students and the other half were unfamiliar. The elaborative interrogation group outperformed the repetition control group on an associative memory test for the familiar animals only, both on an immediate post-test and on a delayed (one month) post-test. To facilitate memory of facts, the elaborative interrogation strategy requires general knowledge related to the target content. |
| Wineburg, S. S. (1991) | Empirical | In this article the author explores what it means to read a historical text. To do so, he draws on his research with historians and high school students, who thought aloud as they reviewed a set of texts about the American Revolution. He begins by providing an overview of what he learned from historians, sketching in broad strokes an image of the skilled reader of history. Next, he compares this image to what emerged from an analysis of high school students’ responses to these same documents. He then speculates about the source of differences between these two groups, arguing that each group brings to these |

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| | | texts a distinctive epistemological stance, one that shapes and guides the meanings that are derived from text. He ends by outlining the implications of this work for how we define reading comprehension and how we define the place of history in the school curriculum. |
| Wineburg, S. S. (1998) | Empirical | This study explored how historians with different background knowledge read a series of primary source documents. Two university-based historians thought aloud as they read documents about Abraham Lincoln and the question of slavery, with the broad goal of understanding Lincoln's views on race. The first historian brought detailed content knowledge to the documents; the second historian was familiar with some of the themes in the documents but quickly became confused in the details. After much cognitive flailing, the second historian was able to piece together an interpretative structure that brought him by the task's end to where his more knowledgeable colleague began. Data analysis focused on how, lacking detailed content knowledge, this historian was able to regain his intellectual footing, work through confusion, and resist the urge to simplify. Implications of this work for cognitive analyses in history and education are discussed. |
| Wong, E. D. (1993) | Empirical | This study examines how students can be taught to develop explanations for scientific phenomena on their own when their background knowledge is incomplete or poorly organized. Evidence from historical accounts of scientific discovery suggest that self-generated analogies are a tool by which individuals can generate, evaluate, and modify their own explanations. The central research questions for this study were: Can students use a series of self-generated analogies to bring about change in their understanding of a given scientific phenomenon, and what is the nature of the change in understanding? Participants were asked to create, apply, and modify their own analogies as opposed to applying a specific analogy provided by an outsider as a heuristic for constructing, evaluating, and modifying their own explanations for a given scientific phenomena. Nontrivial changes in explanation facilitated by the use of generative analogies were observed. Changes in understanding ranged from the emergence of new explanations to the raising of important questions about the nature of the phenomenon. |

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| Woolfolk, A. (1987) | Theoretical | This university textbook covers educational psychology, including research, current theory, and practice. The text treats student development from various perspectives, including linguistic, cognitive, emotional, and social. Behavior, cognitive, social-cognitive, and constructivist theories of learning are considered. Teaching and learning practice are discussed, specifically with regard to student motivation, the classroom environment and student assessment. |
| Yackel, E., Cobb, P., & Wood, T. (1991) | Empirical | This study investigated the nature and impact of group work in the context of elementary school mathematics instruction. Small-group problem solving was used as a primary instructional strategy for all aspects of 2nd grade mathematics, including computation, for the entire school year. This gave rise to learning opportunities that do not typically occur in traditional classrooms, including those that arise from collaborative dialogue as well as from the resolution of conflicting points of view. The nature of these learning opportunities is elaborated and illustrated. The manner in which the teacher used paradigm cases as she initiated and guided discussion of obligations and expectations to make possible the mutual construction of classroom norms for cooperative learning is also illustrated. This and the use of cognitively based activities designed to be problematic for children at a variety of conceptual levels are the crucial features of a cooperative learning environment in the absence of extrinsic rewards. |
| Zimmerman, B.J., & Martinez-Pons, M. (1992) | Theoretical | This paper considers the hypothesis that student perceptions of self-efficacy play an important role in their creation and use of a strategic metacognitive control system. The authors begin by noting that there is often a motivation-based disconnect between the possession of learning strategies and the subsequent use of those strategies. Several examples of student academic self-regulation are given, and the link between self-efficacy and feedback from strategic efforts is discussed. The authors summarize existing research which suggests that there are academic and self-efficacy benefits when students self-monitor and attribute outcomes to their use of strategies. The implications of this research for classroom practice are discussed. |
| Zimmerman, B. J., & Schunk, | Theoretical | Self-regulated learning is a new approach to studying student academic achievement that focuses on how students activate, alter, and sustain their learning practices using a variety |

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| D. H. (1989) | | of self-related processes. In this series of essays, different researchers write from varied theoretical traditions: operant, phenomenological, social cognitive, volitional, Vygotskian, and constructivist. The researchers outline their particular view of self-regulated learning, describe how it can be measured, explain how self-regulated learning can affect student motivation and achievement, and discuss how student self-regulated learning can be taught. |
| Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992) | Empirical | The causal role of students' self-efficacy beliefs and academic goals in self-motivated academic attainment was studied using path analysis procedures. Parental goal setting and students' self-efficacy and personal goals at the beginning of the semester served as predictors of students' final course grades in social studies. In addition, their grades in a prior course in social studies were included in the analyses. A path model of four self-motivation variables and prior grades predicted students' final grades in social studies ($R = .56$). Students' beliefs in their efficacy for self-regulated learning affected their perceived self-efficacy for academic achievement, which in turn influenced the academic goals they set for themselves and their final academic achievement. Students' prior grades were predictive of their parents' grade goals for them, which in turn were linked to the grade goals students set for themselves. These findings were interpreted in terms of the social cognitive theory of academic self-motivation. |
| Zohar, A., & Nemet, F. (2002) | Empirical | This study examined the outcomes of an instructional unit that integrated explicit teaching of general reasoning patterns into the teaching of specific science content. In particular, this article examined the teaching of argumentation skills in the context of dilemmas in human genetics. Before instruction only a minority (16.2%) of the students referred to correct, specific biological knowledge in constructing arguments in the context of dilemmas in genetics. Approximately 90% of the students were successful in formulating simple arguments. An assessment that took place following instruction supported the conclusion that integrating explicit teaching of argumentation into the teaching of dilemmas in human genetics enhances performance in both biological knowledge and argumentation. An increase was found in the frequency of students who referred to correct, specific biological knowledge in constructing arguments. Students in the experimental group scored significantly higher than students in the comparison group in a |

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| | | test of genetics knowledge. An increase was also found in the quality of students' argumentation. Students were able to transfer the reasoning abilities taught in the context of genetics to the context of dilemmas taken from everyday life. The effects of metacognitive thinking and of changing students' thinking dispositions by modifying what is considered valuable in the class culture are discussed. |
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