DOCUMENT RESUME

ED 352 157 PS 020 943

TITLE	National Research Center on Student Learning Publications List: 1985-1991.
INSTITUTION	National Research Center on Student Learning, Pittsburgh, PA.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE	[91]
NOTE	34p.
AVAILABLE FROM	Learning Research and Development Center, 3939 O'Hara Street, University of Pittsburgh, Pittsburgh, PA 15260 ($4).
PUB TYPE	Reference Materials - Bibliographies (131)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Academic Education; Annotated Bibliographies; Concept Formation; Cultural Influences; Developmental Psychology; Educational Change; *Educational Research; Educational Technology; Group Dynamics; *Instruction; Language Acquisition; *Learning; Memory; *Research and Development; Skill Development; Student Evaluation; Thinking Skills
IDENTIFIERS	*National Research Center on Student Learning

ABSTRACT

This list of publications contains approximately 230 items published by the National Research Center on Student Learning (NRCSL) over the last seven years and reflects the range of theoretical and applied work that is undertaken in the NRCSL research program. The publications listed in this volume report on NRCSL research, collaborations, and contributions to the body of knowledge about learning and instruction. An abstract is provided for most items. Each publication addresses one or more of 16 research topics: (1) learning and instruction; (2) structures of knowledge, including concept development and the role of prior knowledge in learning; (3) assessment; (4) education reform; (5) school subjects, including mathematics, science, literacy-related subjects, such as reading, and social sciences; (6) reasoning; (7) technology; (8) group processes; (9) memory; (10) concept acquisition; (11) developmental psychology; (12) language and communications processes; (13) skill and expertise; (14) social and cultural influences on learning; (15) texts; and (16) classroom teaching. (BC)

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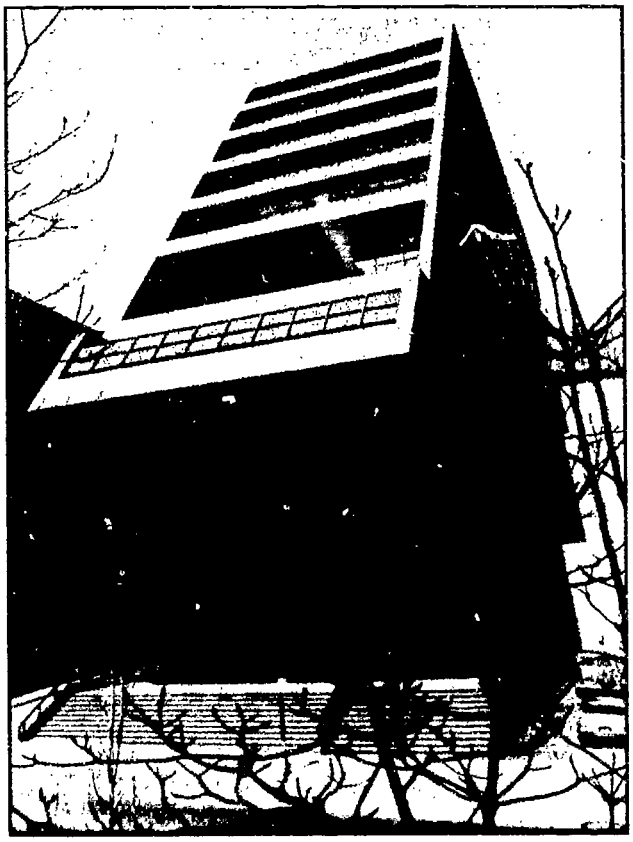
Publications List
1985-1991



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Mission of the National Research Center on Student Learning

The National Research Center on Student Learning (NRCSL) conducts research on effective learning and instruction in elementary and secondary school subjects. Core NRCSL projects examine reasoning, explanation, and problem solving in mathematics, sciences, and social sciences, looking especially at forms of thinking that characterize high levels of competence in these subject matters. Central to this work are studies that describe the ways in which learning can be facilitated by effective teaching, textbooks, assessments of achievement, and social processes of schooling. NRCSL projects examine instructional practice in schools and collaborate on education reform efforts with professional education associations, classroom teachers, and other educators. The publications listed in this volume report on seven years of NRCSL research, collaborations, and contributions to an expanding body of knowledge about learning and instruction. Their diversity reflects the range of theoretical and applied work that comes together in the NRCSL research program.

NRCSL Scientists (1985-1991)

Isabel Beck
William E. Bickel
Micheiene T.H. Chi
William W. Cooley
Robert Glaser
Leopold E. Klopfer
Gaea Leinhardt
Alan Lesgold
John M. Levine
Margaret G. McKeown
Sharon Nelson-Le Gall
Stellan Ohlsson
Charles A. Perfetti
Lauren B. Resnick
Leslie Salmon-Cox
Leona Schauble
Janet W. Schofield
Edward A. Silver
James F. Voss

How to Use This Publications List

Entries in this list are organized alphabetically by author and chronologically within each author's entries. Single-author publications appear before those with multiple authors. Most references include a short abstract. The bracketed number(s) near the end of each abstract correspond(s) to the numbers on the Research Topic List below. The final number after each reference is the publication's serial number, which must appear on all orders for copies of the work.

To obtain copies of publications or publication lists, please use one of the two forms in the back of this list. Please refer to these forms for prices of documents, and enclose a check or money order made payable to **The University of Pittsburgh**. You should receive your order within two weeks of receipt of payment.

Research Topics

1. Learning and Instruction
2. Knowledge Structures for Learning (includes conceptual change, role of prior knowledge in learning, knowledge analysis, explanation, etc.)
3. Assessment and Evaluation
4. Education Reform (includes curriculum revision & development, staff development, classroom redesign, school restructuring, etc.)
5. Learning in School Subject Matters:
   a. Math
   b. Science
   c. Literacy (includes reading, writing, English, etc.)
   d. Social Science (includes history, geography, political science, and social studies)
6. Reasoning and Thinking
7. Learning and Technology
8. Group and Intergroup Processes
9. Memory and Learning
10. Concept Acquisition
11. Developmental Psychology
12. Language and Communication Processes
13. The Nature of Skill and Expertise
14. Social and Cultural Influences on Learning
15. Texts (includes text comprehension, learning from written material, and text processing)
16. Learning and Teaching in the Classroom

NRCSL Publications 1985-1991

Beck, I. L. (1985). Five problems with children's comprehension in the primary grades. In J. Osborn, P. T. Wilson, & R. C. Anderson (Eds.), *Reading education: Foundations for a literate America* (pp. 239-253). Lexington, MA: Heath & Co.
This chapter examines reader and text characteristics that may cause a young reader's processing system to become overloaded. Recommendations are made for a two strand approach to reading instructions that integrates practice of lower-order skills on fairly easy text with opportunities to interact with more sophisticated textual material. [Topics: 12, 16] 1985-003

Beck, I. L. (1986). Using research on reading. *Educational Leadership*, 43(7), 13-15.
This article describes how becoming sensitive to the sometimes subtle relationship between background knowledge and text information can add to a teacher's repertoire of ways to promote students' understanding of what they read. [Topics: 12, 16] 1986-001

Beck, I. L. (1989). Improving practice through understanding reading. In L. B. Resnick and L. E. Klopfer (Eds.), *Toward the thinking curriculum: Current cognitive research. Yearbook of the Association for Supervision and Curriculum Development* (pp. 40-58). Alexandria, VA/Hillsdale, NJ: ASCD/Erlbaum.
This chapter describes how an understanding of the reading process can be a tool for helping to improve instructional practice. Highlighted in this discussion are the roles of word recognition efficiency, text structure, and background knowledge. [Topics: 6, 12, 16] 1989-002

Beck, I. L. (1989). Reading and reasoning: Reading programs are effective vehicles for enhancing reasoning skills. *The Reading Teacher*, 42(9), 676-682.
This article discusses how to take advantage of reading interactions to promote students' reasoning. The emphasis is on moving activities that are useful for developing higher-order thinking into the core of reading instruction. [Topics: 6, 12, 16] 1989-003

Beck, I. L., & McKeown, M. G. (1985). Teaching vocabulary: Making the instruction fit the goal. *Educational Perspectives*, 23(1), 11-15.
This article addresses the issue of what makes for effective instruction in vocabulary. The emphasis is that different types of instruction are indicated depending on the goal of the instruction. [Topics: 10, 12, 16] 1985-004

Beck, I. L., & McKeown, M. G. (1987). Getting the most from basal reading selections. *The Elementary School Journal*, 87(3), 343-356.
This article examines instructional procedures for background knowledge and vocabulary development as presented in basal reading programs. Recommendations are made for tailoring instruction to individual needs and classroom goals. [Topics: 12, 15, 16] 1987-001

Beck, I. L., & McKeown, M. G. (1988). Toward meaningful accounts in history texts for young learners. *Educational Researcher*, 17(6), 31-39.
This article examines instructional sequences from four fifth-grade textbook series' treatments of the American Revolution. The work draws on cognitive research on comprehension and learning to bring into focus issues of learning that have direct bearing on textbook content and organization. [Topics: 5d, 15, 16] 1988-001

Beck, I. L., & McKeown, M. G. (1989). Expository text for young readers: The issue of coherence. In L. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 47-66). Hillsdale, NJ: Erlbaum.
This chapter focuses on coherence, the extent to which the sequence of ideas in a text makes sense and the presentation of information makes the nature of ideas and their relationships apparent. The construct of coherence is used for examining the comprehensibility of expository texts from basal reading textbooks. [Topics: 5c, 12, 15] 1989-004

Beck, I. L., & McKeown, M. G. (1991). Conditions of vocabulary acquisition. In P. D. Pearson (Ed.), *The handbook of reading research* (Vol. 2, pp. 789-814). New York: Longman.
This chapter examines current issues in vocabulary research. The first of two sections discusses what it means to know a word, issues in vocabulary size and growth, and how word knowledge is measured. The second section considers sources for learning vocabulary, focusing on context and direct instruction. [Topics: 10, 12, 16] 1991-004

Beck, I. L., & McKeown, M. G. (1991). Social studies texts are hard to understand: Mediating some of the difficulties. *Language Arts*, 68, 482-490.
This article explores characteristics of expository texts that may make them difficult for young students and then describes research done with expository texts to address these problems. Suggestions for classroom instruction are also included. [Topics: 6, 15, 16] 1991-005

Beck, I. L., McKeown, M. G., & Gromoll, E. W. (1989). Learning from social studies texts. *Cognition and Instruction*, 6(2), 99-158.
This article addresses issues in elementary social studies learning and makes suggestions for developing students' understanding by using

resources such as tradebooks. [Topics: 5d, 15, 16] 1989-005

Beck, I. L., McKeown, M. G., & Omanson, R. C. (1987). The effects and uses of diverse vocabulary instructional techniques. In M. G. McKeown & M. E. Curtis (Eds.), *The nature of vocabulary acquisition* (pp. 147-163). Hillsdale, NJ: Erlbaum.

This chapter synthesizes a program of research to improve reading comprehension through vocabulary development. Discussion is then devoted to using the ideas from the research in setting up a classroom vocabulary program. [Topics: 10, 12, 16] 1987-002

Beck, I. L., McKeown, M. G., Sinatra, G. M., & Loxterman, J. A. (1991). Revising social studies text from a text-processing perspective: Evidence of improved comprehensibility. *Reading Research Quarterly, 26*, 251-276.

This article presents a study aimed at making revisions to fifth grade social studies texts based on a cognitive perspective, describing the revisions, and demonstrating their effects empirically. Recall and question data from fifth graders who read either original textbook versions or the revised versions showed that the revised versions were more effective. [Topics: 5d, 12, 15] 1991-007

Bickel, W. E. (1989). Essay review of: *The client perspective on evaluation* by J. Nowakowski (Ed.). *Contemporary Psychology, 34*(9), 503.

This article is a review and critique of a recent book on the value of taking a client perspective for the organization of evaluation research. [Topic: 3] 1989-006

Bickel, W. E. (1990). The effective schools literature: Implications for research and practice. In T. B. Gutkin & C. R. Reynolds (Eds.), *The Handbook of School Psychology* (2nd ed., pp. 847-867). New York: Wiley & Sons.

This chapter summarizes recent research on effective schools for low achieving students and indicates new directions for research and practice based upon this work. [Topic: 4] 1990-004

Bickel, W. E. (1991). Essay review of: *Keeping students in school* by M. T. Orr. *Contemporary Psychology, 36*(1), 73.

This article is a review and critique of a recent book on effective programs for addressing the early school exit issue. [Topic: 4] 1991-008

Bickel, W. E., & Bickel, D. D. (1986). Effective schools, classrooms, and instruction: Implications for special education. *Exceptional Children, 52*(6), 489-500.

This article reviews the literatures on the characteristics of effective schools, classrooms, and instructional processes. Central findings from these literatures are summarized, as are important cautions in interpreting this knowledge base. The implications for special education of the effectiveness literatures are discussed. It is the position of the authors that both special and regular educators can learn much from recent research in order to design more powerful and integrated instructional programs for students with special needs. [Topics: 4, 17] 1986-050

Bickel, W. E., & Cooley, W. W. (1985). Decision-oriented educational research in school districts: The role of dissemination processes. *Studies in Educational Evaluation, 11*, 183-203.

Using case material from evaluations conducted in the Pittsburgh Public Schools, the authors discuss the role of the evaluator in the dissemination process to enhance the utilization of research-based information. [Topic: 3] 1985-005

Chi, M. T. H. (1985). Changing conception of sources of memory development. *Human Development, 28*, 50-56.

Previously, explanations for memory development focused on acquisition of general strategies and metaknowledge. Recently, emphasis has shifted to the knowledge base as a whole, including general world-knowledge and domain-specific knowledge and procedures. Evidence is presented from the memory development literature showing why strategies and metaknowledge, although undoubtedly important in development, are not sufficient factors to account for memory development, especially if considered in isolation. Current research on the influence of the general knowledge base and the kinds of questions that must be considered by future research are summarized. [Topics: 2, 9, 11] 1985-008

Chi, M. T. H. (1985). Interactive roles of knowledge and strategies in the development of organized sorting and recall. In S. Chipman, J. Segal, & R. Glaser (Eds.), *Thinking and learning skills: Current research and open questions* (Vol. 2, pp. 457-485). Hillsdale, NJ: Erlbaum.

This chapter addresses the issue of how existing knowledge in semantic memory affects children's use of cognitive strategies. The author proposes that strategy use is not a simple matter of whether a given cognitive strategy is or is not available to and usable by the child depending on his stage of maturation. Instead, it appears that the use of a given cognitive strategy has a complex interaction with the amount and structure of the content knowledge to which the strategy is to be applied. Such a view suggests the possibility that maturation is correlated, but not causally related to the rate at which more knowledge is acquired,

and also implies that the acquisition of this knowledge facilitates the acquisition and use of strategies. [Topics: 2, 6, 11] 1985-009

Chi, M. T. H. (1987). Representing knowledge and metaknowledge: Implications for interpreting metamemory research. In F. E. Weinert & R. H. Kluwe (Eds.), *Metacognition, motivation, and understanding* (pp. 211-232). Hillsdale, NJ: Erlbaum.

Children's memory development has traditionally been interpreted in terms of the development of control processes or strategies. However, careful consideration of the child's knowledge base reveals that so-called strategic deficiencies in young children may derive from an inadequate knowledge representation rather than the absence of mature strategies. This chapter is divided into four sections. The first section briefly describes why a knowledge emphasis is important in cognitive developmental psychology. The second section postulates a representational framework for the discussion of various forms of knowledge. Within the framework proposed, the third section evaluates the term metamemory and related research. The concluding section provides a general discussion. [Topics: 2, 9, 11] 1987-005

Chi, M. T. H. (1988). Children's lack of access and knowledge reorganization: An example from the concept of animism. In F. Weinert & M. Perlmutter (Eds.), *Memory development: Universal changes and individual differences* (pp. 169-194). Hillsdale, NJ: Erlbaum.

A popular interpretation for young children's limited performance is the concept of lack of access. This concept assumes that the knowledge that is needed to perform a task is available to the child, except that the child cannot access this knowledge or use it. This chapter attempts to understand this idea in terms of knowledge organization and how knowledge might be reorganized to facilitate access. The exact nature and definition of lac' of access are postulated and preliminary exploratory data to demonstrate what lack of access could mean for young children is presented in the domain of animism. [Topics: 2, 9] 1988-006

Chi, M. T. H. (1989). Assimilating evidence: The key to revision? [Commentary on P. Thagard's Explanatory Coherence]. *Behavioral and Brain Sciences, 12*(3), 470-471.

This commentary explores the application of Paul Thagard's theory of explanatory coherence within the field of psychology, with particular attention given to two crucial but unresolved issues: 1) How does conceptual change occur? and 2) What kinds of transition mechanisms are responsible for these changes? The most promising aspect of Thagard's theory is that it could potentially uncover precisely what factors contribute to restructuring (or to conceptual change) without postulating an explicit transition mechanism. Thagard's model, ECHO, is critiqued, both in terms of its potential to serve this purpose, as well as in terms of its actual accomplishments to date. [Topics: 2, 6, 9] 1989-013

Chi, M. T. H., & Bjork, R. (1991). Modeling expertise. In D. Druckman & R. A. Bjork (Eds.), *In the mind's eye: Enhancing human performance*. Washington, DC: National Academy Press.

This chapter has four main sections. In the first section, the authors note that complex cognitive skills may not be readily learned by modelling or imitating expert behavior. In the second section, they review ways in which experts excel, other than in the given skill itself, and the ways their abilities and other skills are not exceptional. Since their expertise is based on the knowledge that they possess, which in turn generates the actions they take, the authors focus in the third section on the difficult process of extracting an expert's knowledge. Several knowledge elicitation methods are reviewed. Finally, the last section focuses on how knowledge extracted from experts can be imparted to novices. [Topics: 2, 13] 1991-010

Chi, M. T. H., & Ceci, S. J. (1987). Content knowledge: Its role, representation and restructuring in memory development. In H. W. Reese (Ed.), *Advances in child development and behavior* (Vol. 20, pp. 91-142). New York: Academic Press.

Only since the mid-1970s have researchers directly examined the role of knowledge in memory development. The authors begin this chapter with a discussion of the forces that are responsible for this shift in emphasis. Next, they selectively review specific studies that demonstrate the causative role of knowledge in producing age-related differences in memory. Finally, drawing upon empirical studies and theoretical analyses, they examine how the knowledge structure changes with development. In this discussion, the authors emphasize the role of one type of knowledge as it relates to memory, namely content knowledge. This near exclusive emphasis on content knowledge is a result of its demonstrable influence on children's memory performance. [Topics: 2, 6, 9] 1987-006

Chi, M. T. H., & Glaser, R. (1985). Problem solving ability. In R. J. Sternberg (Ed.), *Human abilities: An information-processing approach* (pp. 227-250). New York: Freeman.

This chapter presents an overview of the general characteristics of human problem solving ability. Two important factors that influence problem solving are the nature of the task (the task environment) and the knowledge brought to the problem by the solver. The centrality of these two factors dictates the organization of this chapter. In the first main section, the authors consider puzzle problems and general processes of solution. In the second, they discuss the solving of problems that require domain knowledge. The authors also consider various task environments that involve insight, creativity, and ill-structured problems. [Topics: 2, 6, 13] 1985-010

Chi, M. T. H., & Greeno, J. G. (1987). Cognitive research relevant to education. *Psychology and Educational Policy, 517*, 39-57.

The authors consider cognitive research relevant to the teaching of higher-order skills in problem-solving and reasoning as well as to the understanding of general concepts. It is recognized that instruction in specific content knowledge and procedures for solving specific problems often fail to produce transfer. It would be desirable, therefore, to increase the generality of knowledge that students acquire. One approach is to focus on general methods and strategies of problem-solving—a necessary goal of education because we can predict neither what knowledge students will need nor what problems they will have to solve during life. [Topics: 2, 6, 9] 1987-007

Chi, M. T. H., & VanLehn, K. A. (1991). The content of physics self-explanations. *The Journal of the Learning Sciences, 1*(1), 69-105.

Several earlier studies have found that 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 contained in the example line itself. This article analyzes the specific content of self-explanations generated by students while studying physics examples. Results suggest that in generating self-explanations, students both deduce from prior knowledge and generalize from example statements, yielding new general knowledge that helps complete an otherwise incomplete understanding of domain principles and concepts. The relevance of this research for instruction and models of explanation-based learning is also discussed. [Topics: 2, 5b, 10] 1991-011

Chi, M. T. H., Chiu, M. H., & de Leeuw, N (1991). *Learning in a non-physical science domain: The human circulatory system.* Pittsburgh, PA: University of Pittsburgh, LRDC.

This report explores four dimensions of difference between physics topics and the biology topic of the human circulatory system. First, physics requires nomological deductions from principles, while the human circulatory system requires the understanding of component interactions. Second, difficulty in physics arises from the mismatch of sensory information and scientific conceptions. In biology, difficulties arise from the complexity or the difficulty of direct observation. Third, the pattern of misconceptions is more robust in physics. Finally, removing physics misconceptions requires radical change, but removing circulatory misconceptions does not. Analysis of talking out-loud protocols on the circulatory system demonstrated that misconceptions were generally removed when the text addressed them, and that the nature of change was incremental rather than radical. [Topics: 5b, 10, 15] 1991-012

Chi, M. T. H., Chiu, M. H., de Leeuw, N., & LaVancher, C. (1991). *The use of self-explanations as a learning tool.* Pittsburgh, PA: University of Pittsburgh, LRDC.

This report explores misconceptions and their removal, focusing on the human circulatory system. There is an ontological distinction between this domain and physical science domains. While naive notions of certain physics concepts are incompatible with their scientific conceptions, naive understandings of the circulatory system are not. This distinction predicts that misconceptions about the circulatory system should be relatively easy to remove, and evidence is presented to that effect. One avenue for misconception removal is the use of self-explanations. Students prompted to self-explain each line of a text showed significant improvement from pre-test to post-test, while control group students who did not self-explain did not show this improvement. [Topics: 5b, 10, 15] 1991-013

Chi, M. T. H., Hutchinson, J. E., & Robin, A. F. (1989). How inferences about novel domain-related concepts can be constrained by structured knowledge. *Merrill-Palmer Quarterly, 35*(1), 27-62.

Three studies are focused on (a) the definition of structure in a specific domain of knowledge (in this case, dinosaurs), and (b) the relationship between how knowledge is structured and how it is used. The evidence suggests that the knowledge of children who are experts on dinosaurs is structured hierarchically into well-defined families and family groups.

Furthermore, within each level of this hierarchy, the knowledge appears to be locally cohesive. Greater hierarchical structure allows expert children to use domain features to generate causal explanations, use categorical reasoning, induce attributes about novel dinosaurs, and sort dinosaurs into well-defined family types. The consequences of hierarchically structured knowledge is that expert children can use it to constrain their inferences, whereas novices must rely on their general world knowledge, thereby making less accurate and often inappropriate inferences. [Topics: 2, 11, 13] 1989-016

Chi, M. T. H., Robin, A. F., Striley, J., & Fallshore, M. (1989). *Possible source of misunderstanding about the circulatory system.* Pittsburgh, PA: University of Pittsburgh, LRDC.

This report contrasts misconceptions in the physical and biological sciences. While understanding physics requires one to acquire and understand scientific laws, understanding the circulatory system requires one to understand the interactions among components. Misconceptions or misunderstandings of the circulatory system can derive from the omission in textbooks of causal relations among components. [Topics: 5b, 10, 15] 1989-017

Chipman, S. F., Segal, J. W., & Glaser, R. (Eds.). (1985). *Thinking and learning skills: Research and open questions* (Vol. 2). Hillsdale, NJ: Erlbaum.

This volume assembles leading researchers' analyses of findings from cognitive and instructional psychology that speak to the problem of fostering higher order thinking skills. Research on the influence of knowledge on problem solving suggests that instruction on these skills be carried out in the context of school subject matters. [Topics: 1, 6, 14] 1985-011*

Cooley, W. W., & Bickel, W. E. (1986). *Decision-oriented educational research.* Boston, MA: Kluwer-Nijhoff Publishing.

In this book, the authors describe a strategy for increasing the quality and use of evaluation research in educational systems. Decision-Oriented Educational Research (DOER) is based upon eleven actual cases of evaluation research conducted in the Pittsburgh Public Schools over the course of a five year period. [Topic: 3] 1986-004*

Ernst, A. M., & Ohlsson, S. (1989). *The cognitive complexity of the regrouping and augmenting algorithms for subtraction: A theoretical analysis* (Tech. Rep. No. KUL-89-06). Pittsburgh, PA: University of Pittsburgh, LRDC.

This study shows that the pedagogical arguments about the difficulty of matnematical skills cannot be based on subject matter analysis alone, but must be grounded in psychological theory. Described are two psychological models, implemented as production systems, that simulate the cognitive processes involved in subtraction, including the perceptual-motor processes. The results of running the models favor augmenting over regrouping, consistent with the pattern of empirical results in the research literature, but contrary to the current instructional practice in American schools. [Topics: 2, 5a] 1989-023

Fincher-Kiefer, R. H., Post, T. A., Greene, T. R., & Voss, J. F. (1988). On the role of prior knowledge and task demands in the processing of text. *Journal of Memory and Language, 27,* 416-428.

Two experiments addressed the question of whether demands produced by the processing of domain-related information varied as a function of a person's domain knowledge. The results, taken with other findings, indicate that domain knowledge influences processing at a situational model or mental model level but not at a microlevel or propositional level. The results also suggest that a motivational component influences the processing of high knowledge individuals yielding greater concentration, and support the use of M. Daneman and P. A. Carpenter's (1980) reading span task as an index of processing efficiency. [Topic: 2] 1988-009

Gagne, R., & Glaser, R. (1987). Foundations in learning research. In R. M. Gagne (Ed.), *Instructional technology: Foundations* (pp. 49-83). Hillsdale, NJ: Erlbaum.

The how-to-do-it knowledge that informs work in the design of instructional technologies is reviewed here. The range of research on fundamental aspects of cognition that is treated includes memory, knowledge structures, and self-regulation, each of which must be intensively considered where the aim is to support learning effectively. [Topics: 1, 2, 7] 1987-012

Gitomer, D. H., & Glaser, R. (1987). If you don't know it work on it: Knowledge, self-regulation and instruction. In R. E. Snow & M. Farr (Eds.), *Aptitude, learning and instruction: Conative and affective process analyses* (Vol. 3, pp. 301-325). Hillsdale, NJ: Erlbaum.

Two characteristics of performance that are acquired through learning and experience are examined: well-organized knowledge structures and self-regulatory skills. This discussion focuses on the role these characteristics play in the progress from novice to competent performance and addresses related developmental research to illustrate implications of new findings on

cognitive skill acquisition for instructional theory. [Topics: 1, 6] 1987-013

Gitomer, D. H., Curtis, M. E., Glaser, R., & Lensky, D. B. (1987). Processing differences as a function of item difficulty in verbal analogy performance. *Journal of Educational Psychology, 79*(3), 212-219.
This article describes a study that evaluated processing of verbal analogies by recording eye fixation patterns during problem solution. On difficult problems, high-verbal individuals tended to adapt their processing strategies to a much greater extent than did low-verbal students. Current models cannot account for variation in performances when experimental items resemble aptitude test items. Instead, models that incorporate both individual differences and item characteristics are needed. [Topic: 12] 1987-014

Glaser, R. (1985). Cognition and adaptive education. In M. C. Wang & H. J. Halberg (Eds.), *Adapting instruction to individual differences* (pp. 82-90). Berkeley, CA: McCutchan.
This chapter comments on two recurring themes in this volume: the range of variables that makes for the complexities of learning and teaching; and the need for research on the noncognitive aspects of learning that play an essential role in the acquisition of skill and knowledge through schooling. [Topics: 1, 16] 1985-012

Glaser, R. (1985). Foreword. In R. C. Anderson, E. H. Hiebert, J. A. Scott, & I. A. G. Wilkonson (Eds.), *Becoming a nation of readers: The report of the commission on reading* (pp. v-viii). Pittsburgh, PA: National Academy of Education.
This foreword to a national report on reading surveys the research that set the stage for the report. [Topics: 1, 12] 1985-013

Glaser, R. (1985). Learning and instruction: A letter for a time capsule. In S. F. Chipman, J. W. Segal, & R. Glaser (Eds.), *Thinking and learning skills: Research and open questions* (Vol. 2, pp. 609-618). Hillsdale, NJ: Erlbaum.
This chapter in a volume of articles on the development of higher order thinking skills examines issues in research on subject matter learning and debates about instruction that were characteristic of the late 1970s and early 1980s. [Topics: 1, 6] 1985-014

Glaser, R. (1986). Intelligence as acquired proficiency. In R. J. Sternberg & D. K. Detterman (Eds.), *What is intelligence? Contemporary viewpoints on its nature and definition* (pp. 77-83). Norwood, NJ: Ablex.
Intelligence as acquired proficiency in intellectual cognitive performances is the topic of this chapter. Two types of performance, artifactually constrained proficiency and naturally constrained proficiency, influence the characteristics of intelligence performances. So viewed, intelligence is trainable and amenable to support, and its limits can be delineated. [Topics: 6, 16] 1986-006

Glaser, R. (1986). The integration of instruction and testing. In E. Freeman (Ed.), *The redesign of testing in the twenty-first century: Proceedings of the 1985 ETS Invitational Conference* (pp. 45-58). Princeton, NJ: Educational Testing Service.
Cognitive psychology makes possible methods of achievement testing that index stages of competence by monitoring the development of specific knowledge, skills, and cognitive processes. This article describes the theoretical advances that can inform the design of tests that capture changes in performances and that can be integral to instruction. [Topics: 3, 16] 1986-008

Glaser, R. (1987). Introduction: Further notes toward a psychology of instruction. In R. Glaser (Ed.), *Advances in instructional psychology* (Vol. 3, pp. vii-xxv). Hillsdale, NJ. Erlbaum.
This introduction to a volume assembling contributions from leading researchers treats major themes in studies of reading, mathematics learning, and cross-cultural analyses of classroom practices. [Topics: 1, 5a, 5c] 1987-016

Glaser, R. (1987). Learning theory and theories of knowledge. In E. DeCorte, J. G. L. C. Lodewijks, R. Parmentier, & P. Span (Eds.), *Learning and instruction* (pp. 397-414). Oxford/Leuven. Pergamon Press/Leuven University Press.
Acquired knowledge and reasoning skills, especially the organized knowledge evident in proficient performers' problem representation, are the focus of this discussion. The ways that both the artifactual knowledge structures of subject-matter disciplines and the natural knowledge structures studied by developmental psychologists facilitate learning are examined. [Topics: 2, 5a, 5b] 1987-017

Glaser, R. (1987). The integration of instruction and testing: Implications from the study of human cognition. In D. C. Berliner & B. V. Rosenshine (Eds.), *Talks to teachers* (pp. 329-341). New York: Random House.
This chapter's theme is that learning assessments (tests) should not provide merely a score, a label, a grade level, or a percentile, but also instructional scoring that makes apparent the requirements for increasing competence. [Topics: 1, 3] 1987-018

Glaser, R. (1988). Cognitive science and education. *International Social Science Journal, 40*(1), 21-44.
This article examines the current state of the relationship between cognitive science and education by focusing on two areas of investigation: the analysis of the competence (knowledge and skill) acquired in different

subject-matter domains and theoretically grounded approaches to designing conditions for learning and instructional interventions that reflect advancing knowledge of competence. [Topics: 1, 5a, 5b, 5c, 5d] 1988-010

Glaser, R. (1988). Commentary: Cognitive and environmental perspectives on assessing achievement. In E. Freeman (Ed.), *Assessment in the service of learning: Proceedings of the 1987 ETS Invitational Conference* (pp. 37-44). Princeton, NJ: Educational Testing Service.

The challenge in developing new forms of testing that reflect advances in knowledge of human cognition will be to mesh cognitive and environmental perspectives. The first allows the development of instruments that can measure progress along well-defined dimensions of competence; the second encourages attention to notions of achievement that are enabling and support future performances. [Topics: 1, 3] 1988-011

Glaser, R. (1989). Expertise and learning: How do we think about instructional processes now that we have discovered knowledge structures? In D. Klahr & K. Kotovsky (Eds.), *Complex information processing: The impact of Herbert A. Simon* (pp. 269-282). Hillsdale, NJ: Erlbaum.

This essay comments on the impact of cognitive analyses of human performance on the design of new forms of instruction. Citing programs that aim to produce specific competencies that have been described in key studies of the past two decades, the discussion turns to research on experts' rapid pattern recognitions and representational abilities. The focus here is the possibilities that lie in studies of effective self-elaboration of problems for revealing ways to foster quick acquisition of these tactics. [Topics: 1, 13] 1989-026

Glaser, R. (1989). Knowledge-derived competence. In K. W. Schaie & C. Schooler (Eds.), *Social structure and aging: Psychological aspects* (pp. 113-120). Hillsdale, NJ: Erlbaum.

This commentary on a conference paper on the Seattle Longitudinal Study data base, which describes cognitive changes with age for birth cohorts, argues that heuristic processes are only part of individual variation in cognitive proficiency and that much else resides in domain-specific processes that have been nurtured over the course of life-span development. [Topic: 2] 1989-027

Glaser, R. (1990). Expert knowledge and the thinking process. *Chemtech, 20,* 394-397.

This article is an account in a professional magazine for chemists of the general characteristics of expertise. The implications of research on expert performance for instruction are also discussed. [Topics: 1, 13] 1990-020

Glaser, R. (1990). Expertise and assessment. In M. C. Wittrock (Ed.), *Cognition and testing.* Englewood Cliffs, NJ: Prentice Hall.

Studies of expertise have investigated the nature of the knowledge and cognitive processes that underlie developing competence in various domains of learning. Findings on the nature of expertise can serve as a basis for integrating cognitive theory with psychometric techniques in the design of achievement tests that assess growing proficiency in subject-matter learning. [Topics: 3, 13] 1990-081

Glaser, R. (1990). *Testing and assessment: O tempora! O mores!* Paper presented at the Horace Mann lecture at the University of Pittsburgh, Pittsburgh, PA.

Trends, over the course of this century, in testing and in assessment are sketched to trace the influences of past techniques and traditions on current practices. The use of assessments of achievement as general educational indicators has kept them decoupled from instructional systems and not well suited to providing useful feedback for learning and teaching. Principles and practices that are emerging for integrating testing and instruction are considered. [Topics: 3, 16] 1990-022

Glaser, R. (1990). The reemergence of learning theory within instructional research. *American Psychologist, 45*(1), 29-39.

Instructional programs that aim to produce specified forms of competence are of increasing value to the interactive growth of learning theory and its applications. Four such programs are reviewed here. Approaches to future integration of various principles of learning in the design of conditions that foster the acquisition of key components of competence are discussed. [Topics: 1, 2] 1990-023

Glaser, R. (1990). Toward new models for assessment. *International Journal of Educational Research, 14*(5), 475-483.

The results of assessments of student achievement strongly influence how students assess themselves, what they aspire to, and how much effort they put into their activities. Unless we examine the impact of assessments and consider new approaches to their design, we neglect a major opportunity to improve education. [Topics: 1, 3] 1990-024

Glaser, R. (1991). Intelligence as an expression of acquired knowledge. In H. A. H. Rowe (Ed.),

Intelligence: Reconceptualization and measurement (pp. 47-56). Hillsdale, NJ: Erlbaum.
This chapter proposes a conception of intellectual proficiency that rests on advances in our understanding of the acquisition of knowledge, the characteristics of expertise, and performance in unfamiliar domains. On the view that learning and experience are central to intelligence, it discusses dimensions of competence that can serve as a basis for assessing the growth of intellectual proficiency. [Topics: 1, 3] 1991-019

Glaser, R. (1991). The maturing of the relationship between the science of learning and cognition and educational practice. *Learning and Instruction* (Vol. 1, pp. 129-144). Great Britain: Pergamon Press.
Several lines of instructional research suggest that a strong and mutually beneficial relationship is evolving between studies of learning and innovative programs of instruction. A set of representative programs in major areas of inquiry is discussed. [Topics: 1, 5b, 5c] 1991-083

Glaser, R., & Bassok, M. (1989). Learning theory and the study of instruction. In M. R. Rosenzweig & L. W. Porter (Eds.), *Annual review of psychology* (Vol. 40, pp. 631-666). Palo Alto, CA: Annual Reviews.
Two decades of intensive cognitive science research on competence have yielded grounds and methods for new approaches to building a cognitive theory of learning. The reemergence of learning theory is discussed through analysis of four representative programs of research on instructional intervention. Analytic accounts are given of the principles that guided the design of a program for developing procedural skill, a program for fostering metacognition, a program facilitating the use of mental models, and a program for training the inference processes needed to build organized knowledge. [Topics: 1, 3, 16] 1989-028

Glaser, R., & Pellegrino, J. W. (1987). Aptitudes for learning and cognitive processes. In F. Weinert & R. Kluwe (Eds.), *Metacognition, motivation, and understanding* (pp. 267-288). Hillsdale, NJ: Erlbaum.
This summary report of research attempts to identify directly the cognitive processing components of performance on tasks used to assess aptitude. The immediate goal is to analyze test tasks, develop process models of task performance, and utilize these models as a basis for describing individual differences. The ultimate goal is to use the knowledge gained to design conditions for learning that could be adjusted to these individual characteristics. [Topics: 3, 13] 1987-022

Glaser, R., & Takanishi, R. (Eds.). (1986). Introduction: Creating a knowledge base for education: Psychology's contributions and prospects. *American Psychologist, 41*(10), 1025-1028.
This introduction to a special issue on education of the American Psychologist discusses major advances in research on learning, teaching, and classroom practices, as well as on training, assessment, and other educational processes. [Topics: 1, 3, 7] 1986-010

Glaser, R., Lesgold, A., & Lajoie, S. (1987). Toward a cognitive theory for the measurement of achievement. In R. R. Ronning, J. Glover, J. C. Conoley, & J. C. Witt (Eds.), *The influence of cognitive psychology on testing and measurement* (pp. 41-85). Hillsdale, NJ: Erlbaum.
This chapter argues that achievement measurement should be based on advanced knowledge of learning and of the course of acquisition of competence in subject matters. It suggests a set of cognitive principles to guide the design of measures of achievement. [Topic: 3] 1987-023

Glaser, R., Raghavan, K., & Schauble, L. (1988). Voltaville, a discovery environment to explore the laws of dc circuits. *Proceedings of the 1988 International Conference on Intelligent Tutoring Systems* (pp. 61-66). Montreal, Canada: University of Montreal.
VOLTAVILLE is the initial prototype of a discovery environment designed to foster skills of scientific inquiry. In the context of learning principles of D.C. electric circuits, students conducted experiments and protocols were taken of their effective strategies and their misconceptions. The significance of the results to deepening understanding of science learning and to advances in instruction are explored. [Topics: 1, 5b] 1988-013

Gobbo, C., & Chi, M. T. H. (1986). How knowledge is structured and used by expert and novice children. *Cognitive Development, 1*, 221-237.
This research contrasts the knowledge structures of expert and novice children in the domain of dinosaurs, as well as how this knowledge is used. Several measures were developed to assess differences in knowledge structures, such as how frequently children use connecting words in their production protocols, and the frequency with which they switch topics in their discussion of a dinosaur. How children use their knowledge was assessed by measures such as the frequency with which they infer new implicit information or make semantic comparisons about unknown dinosaurs. These differences in the structure and use of knowledge suggest that expert children can

better use and access their knowledge than novice children because it is more cohesive and integrated. [Topics: 2, 11, 13] 1986-011

Gregg, M., & Stainton, C. (1991). *Geography in the news: Word-level coding manual* (Tech. Rep. No. CLIP-91-02). Pittsburgh, PA: University of Pittsburgh, LRDC.

This report is a word-level coding manual for geographic references found in text. Eleven categories account for words or phrases that name or provide specific or generic geographic information. Operational definitions and examples are provided for each category, subcategory, and sub-subcategory to illustrate the constraints of each. [Topics: 5d, 15] 1991-020

Gregg, M., Stainton, C., & Leinhardt, G. (1990). *Where is geography? Three studies of thinking and teaching* (Tech. Rep. No. CLIP-90-04). Pittsburgh, PA: University of Pittsburgh, LRDC.

Three studies of geographic literacy were conducted in order to begin to assess both the demands for geographic knowledge placed on adults in our society and the school-based opportunities for acquiring this knowledge. By using analytic tools from cognitive psychology to code and analyze data from three sources, the authors are able to draw some conclusions about the structure of people's geographic knowledge and to provide some curricular recommendations. [Topics: 5d, 6, 16] 1990-025

LeMahieu, P., & Leinhardt, G. (1985). Overlap: Influencing what's taught. A process model of teachers' content selection. *Journal of Classroom Interaction, 21*(1), 2-11.

This article reviews the mechanism by which overlap affects instructional content. The authors describe the concept of overlap between instruction and assessment and the potential influence of tests on teachers' curricular content choices. [Topics: 3, 4, 16] 1985-017

Leinhardt, G. (1985). Instructional time: A winged chariot? In C. W. Fisher & D. C. Berliner (Eds.), *Perspectives on instructional time* (pp. 263-282). New York: Longman Press.

The use of instructional time in classroom research is traced in a series of three major field studies—one focusing on student achievement, a second on opportunity to learn, and a third on measures of instructional process. These studies demonstrate several important developmental trends in the use of time as a metric in classroom research and the author presents six basic findings from research on instructional time. [Topics: 3, 4, 16] 1985-018

Leinhardt, G. (1986). Expertise in mathematics teaching. *Educational Leadership, 43*(7), 28-33.

Findings from a contrastive study of expert and novice elementary mathematics teachers are reviewed and examples from one expert's teaching are used to discuss elements of expertise. These elements include maximizing time usage and content coverage; using effective routines and activity structures in constructing lessons; developing meaningful, content-based agendas for lessons; and providing rich explanations that build on students' prior knowledge, use well known representations to introduce new material, provide complete demonstrations, and prove the legitimacy of the new concept or procedure. [Topics: 13, 16] 1986-019

Leinhardt, G. (1988). Expertise in instructional lessons: An example from fractions. In D. A. Grouws & T. J. Cooney (Eds.), *Perspectives on research on effective mathematics teaching* (pp. 47-66). Hillsdale, NJ: Erlbaum.

This chapter describes major components of expertise in the teaching of elementary mathematics, drawing primarily on findings from a contrastive study of novice and expert teachers teaching fractions. Lesson segments, routines, scripts, agendas, and explanations are described and a model of an expert explanation of specific subject matter is presented. [Topics: 5a, 13, 16] 1988-017

Leinhardt, G. (1988). Getting to know: Tracing students' mathematical knowledge from intuition to competence. *Educational Psychologist, 23*(2), 119-144.

This article describes four different classes of student knowledge in mathematics--intuitive, concrete, computational, and conceptual. Based on observations and interviews with teachers and students in the classrooms of two expert elementary mathematics teachers, a detailed portrait is provided of how the different types of knowledge interacted and evolved in these children over time, resulting in their own understanding. Suggestions for future research are also presented. [Topics: 2, 5a, 16] 1988-018

Leinhardt, G. (1988). Situated knowledge and expertise in teaching. In J. Calderhead (Ed.), *Teachers' professional learning* (pp. 146-168). London: Falmer Press.

In this chapter, expert teachers' knowledge of teaching is discussed in terms of the anthropological and psychological construct of situated knowledge. As an example, the author traces the (partially hypothetical) development of one teacher's knowledge of how to teach a particular math topic to second graders. Four scenarios of teaching and learning subtraction with regrouping, taken across 40 years in this

teacher's lifetime, are presented and discussed. [Topics: 6, 13, 16] 1988-019

Leinhardt, G. (1989). Development of an expert explanation: An analysis of a sequence of subtraction lessons. In L. B. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 67-124). Hillsdale, NJ: Erlbaum. (Also in *Cognition and Instruction*, 1987, 4(4), 225-282)

This chapter traces the teaching and learning that occurred during an 8-day unit on subtraction with regrouping in an expert teacher's second-grade classroom. Detailed analyses of this expert's lessons focused both on the teacher's explanations and on students' knowledge growth (assessed before, during, and after instruction). Content analyses generated models of the teacher's and students' knowledge. A structural analysis of the lessons generated a model of an expert explanation in elementary mathematics. [Topics: 5a, 13, 16] 1989-032

Leinhardt, G. (1989). Math lessons: A contrast of novice and expert competence. *Journal for Research in Mathematics Education*, 20(1), 52-75.

From a study of novice and expert teachers, three important elements needed for constructing expert mathematics lessons are identified and described: rich agendas, consistent but flexible lesson structures, and explanations that meet the goals of clarifying concepts and procedures and having students learn and understand them. The novice-expert contrast highlighted the nature of the competencies expert teachers possessed and suggested some areas of instruction for future teachers. [Topics: 5a, 13, 16] 1989-033

Leinhardt, G. (1990). *Towards understanding instructional explanations* (Tech. Rep. No. CLIP-90-03). Pittsburgh, PA: University of Pittsburgh, LRDC.

This report discusses the nature of instructional explanations as they differ from common, disciplinary, and self explanations. Each type is examined and compared with respect to specific features (problem type, initiation, evidence, form, and audience). Given this context, three examples of instructional explanations are explored, one by a teacher in history, one by a student in history, and one by teachers and students together in mathematics. [Topics: 5a, 5d, 13, 16] 1990-032

Leinhardt, G. (1990). A contrast of novice and expert competence in math lessons. In J. Lowyck & C. M. Clark (Eds.), *Teacher thinking and professional action* (pp. 75-97). Leuven, Belgium: Leuven University Press.

Using techniques from ethnography and cognitive psychology, lessons taught by novice and expert elementary math teachers were observed, analyzed, and compared to reveal specific competencies expert teachers possess. The author identifies three important elements in expert teachers' math lessons: rich agendas, consistent but flexible lesson structures, and explanations that meet specific goals. [Topics: 5a, 13, 16] 1990-034

Leinhardt, G. (1990). Capturing craft knowledge in teaching. *Educational Researcher*, 19(2), 18-25.

This exploration raises some problems and poses some solutions in identifying the craft knowledge of teaching. Craft knowledge, or wisdom of practice, is one important component in the design and validation of new national teacher assessments. The prototype assessment exercises for National Board certification are one site in which such craft knowledge has been used. From that experience and others, some guides for inspecting exercises are suggested. [Topics: 3, 13, 16] 1990-035

Leinhardt, G. (1991). Evaluating the *New Handbook of Teacher Evaluation*. *Educational Researcher*, 20(6), 23-25.

Review of J. Millman & L. Darling-Hammond (1990). *The New Handbook of Teacher Evaluation: Assessing Elementary and Secondary School Teachers*. Newbury Park, CA: Sage Publications. [Topic: 3] 1991-031

Leinhardt, G., & Bickel, W. (1989). Instruction's the thing wherein to catch the mind that falls behind. In R. Slavin (Ed.), *School and classroom organization* (pp. 197-246). Hillsdale, NJ: Erlbaum. (Also in *Educational Psychologist*, 1987, 22(2), 177-207)

This chapter explains the social and historical background of separate compensatory and special education programs but argues that separate programs can no longer be justified. The authors review evidence from numerous studies to show that the features of effective instructional strategies are effective across programs and they discuss the implications of effective instruction research for future research, reform policies, and current educational practices. [Topics: 4, 16] 1989-034

Leinhardt, G., & Greeno, J. (1986). The cognitive skill of teaching. *Journal of Educational Psychology*, 78(2), 75-95. (Also in P. Goodyear (Ed.), *Teaching knowledge intelligent tutoring*. Norwood, NJ: Ablex, 1991).

The complex cognitive skill of teaching is described in terms of two fundamental knowledge systems: lesson structure and subject matter. A formal model of the process of instruction in elementary mathematics is presented and examined in light of empirical data from both

expert and novice teachers. Instructional segments are carefully analyzed in order to clarify the nature of instructional action and goal systems that support competence in this socially dynamic and complex task domain. [Topics: 13, 16] 1986-051

Leinhardt, G. & Ohlsson, S. (1990). Tutorials on the structure of tutoring from teachers. *Journal of Artificial Intelligence in Education*, 2(1), 21-46.
This article examines how five exemplary elementary math teachers use meta-communication to facilitate the task of the learners in their classrooms. Based on theoretical considerations, the authors hypothesize the five categories of meta-communication.Results of the study generated some principles for the design of good instruction. [Topics: 2, 13, 16] 1990-036

Leinhardt, G., & Putnam, R. T. (1986). Profile of expertise in elementary school mathematics teaching. *Arithmetic Teacher*, 34(4), 28-29.
This article describes three distinct programs of expert-novice research that each revealed important aspects of expertise in teaching. Based on these findings, a profile of expertise in elementary mathematics instruction was developed. Experts have specialized pedagogical content knowledge; they provide explanations that are cohesive and tightly connected to the representations being used; they have intricate mental agendas for lessons; and they develop and continually refine curriculum scripts for frequently taught topics. [Topics: 13, 16] 1986-020

Leinhardt, G., & Putnam, R. T. (1987). The skill of learning from classroom lessons. *American Educational Research Journal*, 24(4), 557-587.
This article presents a model of the skills a student needs to have to make sense of a mathematics lesson taught by a good teacher. The model of the learner contains a variety of cognitive competencies: an action system, a lesson parser, an information gatherer, a knowledge generator, and an evaluator. A description of how the model functions during a two-day lesson sequence provides an empirical example. [Topics: 2, 13, 16] 1987-026

Leinhardt, G., & Smith, D. (1985). Expertise in mathematics instruction: Subject matter knowledge. *Journal of Educational Psychology*, 77(3), 247-271.
This expert-novice study explores the relationship between teachers' classroom behavior and their subject matter knowledge of a topic, in this case fractions. Among the experts studied, some displayed rich conceptual knowledge of fractions and others relied on precise knowledge of algorithms. Implications of these knowledge differences are discussed. [Topics: 5a, 13, 16] 1985-019

Leinhardt, G., Putnam, R. T., Stein, M. K., & Baxter, J. (1991). Where subject knowledge matters. In J. Brophy (Ed.), *Advances in research on teaching: Teachers' subject matter knowledge and classroom instruction* (Vol. 2, pp. 87-113). Greenwich, CT: JAI Press.
Subject-matter knowledge is one important element in the complex cognitive skill of teaching. Focusing on elementary mathematics instruction, this chapter discusses how the nature of a teacher's subject-matter knowledge influences his or her teaching. Four sites are examined for teachers' use of subject-matter knowledge: agendas, curriculum scripts, explanations, and representations. [Topics: 5a, 13, 16] 1991-032

Leinhardt, G., Weidman, C., & Hammond, K. M. (1987). Introduction and integration of classroom routines by expert teachers. *Curriculum Inquiry*, 17(2), 135-176.
Successful teachers establish, rehearse, and maintain a set of routines (shared socially scripted behaviors) to reduce the cognitive complexity of the instructional environment and allow instruction to proceed fluidly and efficiently. From extensive observations of 6 experts' classrooms, three types of routines were identified: management, instructional support, and teacher-student exchange. Approximately 85% of the routines introduced in the first four days of school were still in use at midyear. [Topics: 13, 16] 1987-027

Leinhardt, G., Zaslavsky, O., & Stein, M. K. (1990). *Annotated bibliography of selected articles on graphing and functions* (Tech. Rep. No. CLIP-90-01). Pittsburgh, PA: University of Pittsburgh, LRDC.
Brief descriptions of 30 research papers and articles on the teaching or learning of functions, graphs, and graphing are provided. This annotated bibliography was the first stage in a project that led to a major review of research in this area. [Topics: 5a, 10] 1990-037

Leinhardt, G., Zaslavsky, O., & Stein, M. K. (1990). Functions, graphs, and graphing: Tasks, learning, and teaching. *Review of Educational Research*, 60(1), 1-64.
This review of the introductory instructional substance of functions and graphs analyzes research on the tasks associated with functions and some of their representations, as well as analyzing the nature of student learning and various approaches to teaching. This is a review of a specific and significant part of the mathematics curriculum, reflecting the issues raised by recent theoretical research concerning

how specific context and content contribute to learning and meaning. [Topics: 1, 5a, 10, 16] 1990-038

Lesgold, A. (1988). Toward a theory of curriculum for use in designing intelligent instructional systems. In H. Mandl & A. Lesgold (Eds.), *Learning issues for intelligent tutoring systems* (pp. 114-137). New York: Springer-Verlag.
This chapter specifies the kinds of knowledge that an intelligent instructional system must have: knowledge of curriculum goals and subgoals, knowledge of the subjects to be taught, and metacognitive knowledge. [Topic: 7] 1988-021

Lesgold, A. & Glaser, R. (Eds.). (1989). *Foundations for a psychology of education.* Hillsdale, NJ: Erlbaum.
This volume brings together leading scholars' reviews of aspects of cognitive psychology that are significant to advances in educational theory and practice. [Topic: 1] 1989-037*

Lesgold, A., & Hammond, K. L. (1985). Do we look for independence or near decomposability [Commentary on an article by Humphreys & Evett]. *The Behavioral and Brain Sciences, 8,* 716-717.
Lexical recognition may take place via processes that are nearly decomposable, that is, where interactions within a subsystem are stronger than interactions between subsystems. Looking at lexical recognition this way can have clinical and pedagogical uses. [Topics: 5c, 12] 1985-021

Lesgold, A., Resnick, L. B., & Hammond, K. (1985). Learning to read: A longitudinal study of word skill development in two curricula. In G. E. MacKinnon & T. G. Waller (Eds.), *Reading research: Advances in theory and practice* (Vol. 4, pp. 107-138). New York: Academic Press.
This chapter describes a 5-year longitudinal study of the development of reading skill, particularly of the relationship between automatic word recognition and comprehension. Efficient word recognition early in the study was correlated with superior reading comprehension later. The study suggests that efficient, automatic word recognition should be a goal of early reading instruction. [Topic: 5c] 1985-022

Levine, J. M. (1989). Reaction to opinion deviance in small groups. In P. B. Paulus (Ed.), *Psychology of group influence* (2nd ed., pp. 187-231). Hillsdale, NJ: Erlbaum.
This chapter presents a critical review of recent theoretical and empirical work on reaction to opinion deviance in small groups. [Topic: 8] 1989-040

Levine, J. M., & Moreland, R. L. (1986). Outcome comparisons in group contexts: Consequences for the self and others. In R. Schwarzer (Ed.), *Self-related cognitions in anxiety and motivation* (pp. 285-303). Hillsdale, NJ: Erlbaum.
This chapter extends Levine and Moreland's (1987) analysis of outcome comparisons in group contexts by emphasizing the affective, cognitive, and behavioral consequences of such comparisons. [Topic: 8] 1986-027

Levine, J. M., & Moreland, R. L. (1987). Social comparison and outcome evaluation in group contexts. In J. C. Masters & W. P. Smith (Eds.), *Social comparison, social justice, and relative deprivation: Theoretical, empirical, and policy perspectives* (pp. 105-127). Hillsdale, NJ: Erlbaum.
This chapter presents a model of the process by which individuals evaluate their outcomes in group contexts. [Topic: 8] 1987-033

Levine, J. M., & Moreland, R. L. (1989). Social values and multiple outcome comparisons. In N. Eisenberg, J. Reykowski, & E. Staub (Eds.), *Social and moral values: Individual and societal perspectives* (pp. 195-210). Hillsdale, NJ: Erlbaum.
This chapter extends Levine and Moreland's (1987) analysis of outcome comparisons in group contexts by emphasizing multiple, as opposed to single, comparisons. [Topic: 8] 1989-041

Levine, J. M., & Moreland, R. L. (1990). Progress in small group research. *Annual Review of Psychology, 41,* 585-634.
This article critically reviews research done in the last decade dealing with small group processes. [Topic: 8] 1990-044

Levine, J. M., & Moreland, R. L. (1991). Culture and socialization in work groups. In L. Resnick, J. Levine, & S. Teasley (Eds.), *Perspectives on socially shared cognition* (pp. 257-279). Washington, DC: American Psychological Association.
This chapter discusses the content of work group culture and the socialization practices that are used to instill this culture in new members. [Topic: 8] 1991-034

Levine, J. M., & Russo, E. M. (1987). Majority and minority influence. In C. Hendrick (Ed.), *Review of personality and social psychology: Group processes* (Vol. 8, pp. 13-54). Newbury Park, CA: Sage.
This chapter presents a critical review of recent theoretical and empirical work on majority and minority influence. [Topic: 8] 1987-034

McKeown, M. G., & Beck, I. L. (1988). Learning vocabulary: Different ways for different goals. *Remedial and Special Education, 9*(1), 42-46.
This article discusses the features of effective vocabulary instruction. The design of a vocabulary program for intermediate grades is then presented. The emphasis is that the nature of the activities should depend on the goal of

instruction, the nature of the words taught, and the characteristics of the learners. [Topics: 10, 12, 16] 1988-028

McKeown, M. G., & Beck, I. L. (1990). The assessment and characterization of young learners' knowledge of a topic in history. *American Educational Research Journal*, 27(4), 688-726.
This article focuses on the background knowledge that young learners bring to their study of history by characterizing students' knowledge of events leading to the Revolutionary War just before and a year after they study the topic in school. Results of interviews with students suggest that their knowledge is characterized by simple associations and a lack of connected structures. [Topics: 2, 5d, 16] 1990-045

McKeown, M. G., Beck, I. L., Omanson, R. C., & Pople, M. T. (1985). Some effects of the nature and frequency of vocabulary instruction on the knowledge and use of words. *Reading Research Quarterly*, *20*(5), 522-535.
This article reports the study of two types of vocabulary instruction, one requiring only associations between words and definitions, the other presenting elaborated word meanings and diverse contexts. Frequency of encounters with words was also varied. Rich instruction showed an advantage for comprehension of stories and interpretation of contexts containing the taught words. [Topics: 10, 12, 16] 1985-027

McQuaide, J., Fienberg, J., & Leinhardt, G. (1991). *Transcript of George Polya's film Let Us Teach Guessing* (Tech. Rep. No. CLIP-91-01). Pittsburgh, PA: University of Pittsburgh, LRDC.
This report consists of a transcript of George Polya's film Let Us Teach Guessing. It includes drawings of all of the visual elements in the lesson and thus provides in print format a valuable tool for analyzing the presentation of mathematical concepts by this eminent teacher. It was prepared for use in an ongoing research project which has as its theme the relationship between teaching and learning in particular subject-matter areas. [Topics: 5a, 13] 1991-037

Means, M. L., & Voss, J. F. (1985). Star Wars: A developmental study of expert and novice knowledge structures. *Journal of Memory and Language*, 24, 746-757.
Using the domain of the movie Star Wars, this article examines differences in the knowledge structures of experts and novices within each of six grade levels. A probe procedure determined whether a subject could successfully identify a basic action and its related goals within a hierarchical structure. It was concluded that age-related representational differences were due primarily to the differential prior knowledge of schema. Expert-novice differences were attributed to differential ability to utilize thematic and major goal knowledge to interpret actions for older individuals, and to experts' ability to interpret specific story actions for younger individuals. [Topic: 2] 1985-028

Mitchell, A. A., & Chi, M. T. H. (1986). Measuring knowledge within a domain. In P. Nagy (Ed.), *The representation of cognitive structures* (pp. 89-121). Toronto: Ontario Institute for Studies in Education.
An important concern in education is the measurement of students' knowledge within a domain. Recently, student knowledge has also become an important psychological variable. Within the information-processing paradigm, it is thought to be one of the most important variables which affects behavior. Little effort, however, has been directed at actually measuring differences in the content and organization of information within a domain between individuals with high and low levels of knowledge. This is largely due to the fact that developing procedures and measures of the content and structure of knowledge must necessarily be based on a theory of memory. In this chapter, the authors discuss models of memory and procedures based on these models for measuring knowledge. [Topics: 1, 2, 9] 1986-028

Mukhopadhyay, S., Resnick, L. B., & Schauble, L. (1990). Social sense-making in mathematics: Children's ideas of negative numbers. In G. Booker, J. Cobb, & T. N. de Mendicuti (Eds.), *Proceedings of the Fourteenth Psychology in Mathematics Education Conference* (Vol. 3, pp. 281-288). Mexico City, Mexico: International Group for the Psychology of Mathematics Education.
This article reports on a narrative story-telling methodology that was used to tap children's use of a debts-and-assets model to support calculations with negative numbers. Children showed superior performance on problems posed in the context of the story, in contrast to their ability to solve isomorphic problems presented as formal equations. Performance was most enhanced for underschooled children from India, who were very familiar with the social situations and problems depicted. The debts-and-assets analogue appeared to encourage the use of a Dividend Number Line model, resulting in difficulties when children had to perform calculations involving crossing over the zero amount from a debts to an assets status. [Topic: 5a] 1990-048

Nelson-Le Gall, S. (1985). Help-seeking behavior in learning. In E. W. Gordon (Ed.), *Review of research in education* (Vol. 12, pp. 55-90). Washington, DC: American Educational Research Association.

This chapter provides an examination of social-cognitive, motivational, and situational factors influencing children's effectiveness in using other children as learning resources. First a brief, critical overview of extent theories of help-seeking behavior is presented. The bases for the reconceptualization of help seeking as a general learning and problem-solving strategy that can be identified in the developmental psychological literature are highlighted in this presentation. This overview is presented as background to an integrative review of empirical studies of children's active use of others in learning situations which then follows. [Topics: 14, 16] 1985-029

Nelson-Le Gall, S., & DeCooke, P. A. (1987). Same-sex and cross-sex help exchanges in the classroom. *Journal of Educational Psychology, 79*(1), 67-71.

This article reports on a study which combined interviews and naturalistic observations of the same children to examine same-sex and cross-sex help exchanges in reading and math classes among third- and fifth-grade boys and girls. Overall, girls were perceived by their classmates to be more academically competent and more likable as helpers than were boys. Nevertheless, girls were not the targets of cross-sex help seeking more than boys were. Both boys and girls sought help more frequently from same-sex than from opposite-sex classmates. When help seeking occurred between opposite-sex classmates, girls were more likely than boys to report liking these helpers as much as their same-sex helpers. The implications of these findings for children's learning and peer status are discussed. [Topics: 14, 16] 1987-041

Nelson-Le Gall, S., & Glor-Scheib, S. (1985). Help seeking in elementary classrooms: An observational study. *Contemporary Educational Psychology, 10*, 58-71.

This article reports on a study which explores how elementary school children employ help seeking as a means of problem solving in the classroom. In-depth naturalistic observations were made of high-, average-, and low-ability students in reading and math classes at the first-, third-, and fifth-grade levels. Overall, children's rates of help seeking were higher in math than in reading. Boys and girls did not differ overall in the amount of help sought. Boys and girls did differ, however, in the type of help they requested. Children of different ability levels were found to vary not only in rate of help seeking and type of help requested, but also in the type of responses elicited from their helper choices. Implications of these findings for children's achievement, learning, and social adjustment in the classroom are discussed. [Topics: 14, 16] 1985-031

Nelson-Le Gall, S., & Glor-Scheib, S. (1986). Academic help-seeking and peer relations in school. *Contemporary Educational Psychology, 11*, 187-193.

This article describes a study which investigated the relationship between peer relations and help-seeking behaviors. The subjects were 26 third grade and 48 fifth grade boys and girls. The roster-rating technique was used to obtain measures of children's perceived academic competence and social attractiveness in their reading and math classes. Intensive naturalistic observation of a subset of these children in their classrooms provided data on actual help-seeking behavior. The relationship between peer status and academic help-seeking was found to vary with the target of the help-seeking overture and the type of help requested. [Topics: 14, 16] 1986-029

Nelson-Le Gall, S., & Scott-Jones, D. (1985). Teachers' and young children's perceptions of appropriate work strategies. *Child Study Journal, 15*(1), 29-42.

Two studies were conducted to examine teachers' and young children's perceptions of the appropriateness of various work strategies. In Study 1, teachers responded to interview questions about the appropriateness of persistence without help in relation to help-seeking and other strategies children use to accomplish difficult tasks. Study 2 examined preschool, kindergarten, and first-grade children's beliefs about this issue. Findings indicated that there was some disagreement between teachers and children about the relative appropriateness of seeking help from others versus persisting without help as a response to task difficulty. The implications of the findings for achievement motivation research and classroom practices are discussed. [Topics: 14, 16] 1985-032

Ohlsson, S. (1986). Some principles of intelligent tutoring. *Instructional Science, 14*, 293-326.

Research on intelligent tutoring systems is discussed from the point of view of providing moment-by-moment adaptation of both content and form of instruction to the changing cognitive needs of the individual learner. The implications of this goal for cognitive diagnosis, subject-matter analysis, teaching tactics, and teaching strategies

are analyzed. The results of the analyses are stated in the form of principles about intelligent tutoring. A major conclusion is that a computer tutor, in order to provide adaptive instruction, must have a strategy which translates its tutorial goals into teaching actions, and that, as a consequence, research on teaching strategies is central to the construction of intelligent tutoring systems. [Topic: 1] 1986-031

Ohlsson, S. (1987). Sense and reference in the design of interactive illustrations for rational numbers. In R. Lawler & M. Yazdani (Eds.), *Artificial intelligence and education: Learning environments and tutoring systems* (Vol. 1, pp. 307-344). Norwood, NJ: Ablex.

It is a common tactic in the teaching of arithmetic to provide the learner with pictures and embodiments of various kinds. However, the pedagogy of illustrations is not well understood. Analysis of the concept or meaning in relation to arithmetic shows that full understanding of arithmetic implies intellectual possession of a number of different intellectual constructions, among them a teleological, an analytical, and a referential semantics for arithmetic. It is argued that the primary purpose of illustrations for elementary arithmetic is to clarify the semantics of the language of arithmetic. An informal analytical semantics for rational number concepts is presented. Construction of a referential semantics for the concept of ratio leads to the conjecture that illustrations for the rational numbers are necessarily incomplete in the sense that they can, in principle, only illustrate some aspects of rational numbers. The results of these analyses are summarized in a prescriptive theory. [Topics: 2, 5a, 9] 1987-043

Ohlsson, S. (1988). *The conceptual basis of subtraction with regrouping: A mathematical analysis* (Tech. Rep. No. KUL-88-02). Pittsburgh, PA: University of Pittsburgh, LRDC.

The purpose of this report is to identify a knowledge base, list of concepts and principles, and to derive the standard subtraction algorithm from it. Such a derivation requires a theory of the place value notation, which is also developed in this report. The result of the enterprise consists of (a) the concepts and principles presupposed in the derivation, and (b) the concepts and principles constructed on the way to the description of the subtraction algorithm. Some difficulties with partial or approximate explanations are discussed, and the hypothesis advanced that conceptual knowledge is not generative in the sense envisioned by mathematics educators. [Topics: 2, 5a] 1988-032

Ohlsson, S. (1988). Computer simulation and its impact on educational research and practice. *International Journal of Educational Research, 12*(1), 5-34.

The use of computer simulation as a technique for building formal models of mental processes forces the cognitive psychologist to consider the content of knowledge, in particular strategic or heuristic knowledge. The rationale and work mode of simulation research are summarized. A short review illustrates the range of phenomena with educational relevance to which the simulation technique has been applied. Computer simulation and education are predicted to interact in several ways in the future, most directly through computerized teaching tools like intelligent tutoring systems and systems for automatic cognitive diagnosis. [Topics: 1, 7] 1988-033

Ohlsson, S. (1990). Cognitive science and instruction: Why the revolution is not here (yet). In H. Mandl, E. DeCorte, N. Bennett, & H. F. Friedrich (Eds.), *Learning and instruction. European research in an international context: Social and cognitive aspects of learning and instruction* (Vol 2.1, pp. 561-600). Oxford: Pergamon Press.

Although advances in instructional technology have been made, they fall short of expectations. The author argues that our current theory of cognition cannot, in principle, support a revolution in the design of instruction. The current theory explains how an agent orchestrates a set of primitive capabilities to attain some goal in a given situation. However, schools aim to teach concepts and principles, rather than skills. The problematic part of instruction--the part for which a theory-based revolution is most urgently needed--is the promotion of conceptual understanding. Before the design of instruction can be based on cognitive theory, a need exists to augment the current theory with hypotheses about the form, function, and origin of conceptual, as opposed to procedural, knowledge. [Topic: 1] 1990-053

Ohlsson, S. (1991). *Young adults' understanding of evolutionary explanations: Preliminary observations.* Pittsburgh, PA: University of Pittsburgh, LRDC.

To appreciate the intellectual power of scientific theories, students must construct their own scientific explanations rather than consume the explanations of others. Biological evolution is an advantageous subject matter in which to study students' explanatory reasoning because evolutionary explanations do not require either mathematics or special-purpose notations. Cognitive objectives for introductory instruction in evolution are proposed in this report. The

performance of 20 students on theory recall, reading comprehension, and three explanation tasks shows that the students were very far from reaching those objectives. Most students appear to be neither Darwinians, Lamarckians, nor Christian fundamentalists, but to regard evolution as a primitive teological process for which no explanation is needed and which happens when the organism needs to change in order to survive. When students do focus on the mechanism of evolution, they locate the source of change in genetic or mental processes. [Topics: 5b, 9, 16] 1991-042

Ohlsson, S., & Hall, N. (1990). *The cognitive function of embodiments in mathematics instruction* (Tech. Rep. No. KUL-90-02). Pittsburgh, PA: University of Pittsburgh, LRDC.

Educators frequently recommend a teaching scenario for arithmetic in which an arithmetic procedure is first explained in terms of an embodiment, then introduced with respect to an expanded procedure or some other pedagogical notation. Finally, the expanded procedure is transformed into the target procedure. The authors explain the workings of this teaching scenario in terms of three learning mechanisms: proceduralization; analogical procedure construction; and simplification. The authors present a theory predicting a major determinant of the pedagogical effectiveness of this teaching scenario. [Topic: 5a] 1990-056

Ohlsson, S., & Rees, E. (1991). The function of conceptual understanding in the learning of arithmetic procedures. *Cognition and Instruction, 8*(2), 103-179.

The authors propose a theory of conceptual understanding and its role in the learning and execution of arithmetic procedures. Their hypothesis is that conceptual understanding constrains problem states and, thereby, enables the learner to monitor his or her own performance and to detect and correct his or her errors. They have implemented their theory in the Heuristic Searcher (HS), a computer model that learns arithmetic procedures. Their theory provides a new interpretation of the role of conceptual understanding in arithmetic learning, generates testable predictions about human behavior, deals successfully with theoretical issues that cause difficulties for other theories of learning, and fares well on evaluation criteria such as generality and parsimony. [Topics: 5a, 7, 9] 1991-047

Perfetti, C. A. (1985). *Reading ability*. New York: Oxford Press.

This book is concerned with the general question of how can differences in reading ability be explained? The role of phonology and lexical processes in reading are examined. Comprehension and speech processes in skilled reading are covered. Individual differences in reading and the relationship between verbal efficiency and reading, and finally, reading instruction are discussed. [Topic: 12] 1985-034*

Perfetti, C. A. (1986). Cognitive and linguistic components of reading ability. In B. Foorman & A. Siegel (Eds.), *Learning to read: Cognitive universals and cultural constraints* (pp. 11-40). Hillsdale, NJ: Erlbaum.

Whether there are cognitive universals in learning to read will doubtless prove a difficult question. However, a search for generalizations about reading processes may suggest some constraints on the form of such universals or at least may suggest what kinds of processes are candidates for universals. There are two general questions to pose: (1) What is the nature of ability differences in reading? and (2) How does a child become a skilled reader? Within each of these questions, specific possibilities concerning the role of linguistic and cognitive components will be raised. The author draws on both his own research and on the advances provided in general by cognitive science. Although each conclusion will be based predominately on work with English-speaking populations, the author offers all conclusions in the belief that they may, with appropriate qualification, be general. [Topic: 12] 1986-033

Perfetti, C. A. (1986). Continuities in reading acquisition, reading skill, and reading disability. *Remedial And Special Education (RASE), 7*(1), 11-21.

Reading instruction and remediation are best grounded when based on observation of the continuities among various problems in reading. The problems of reading acquisition, reading skill, and reading disability are linked by their shared connection to word decoding. Learning to read depends on eventual (but not initial) mastery of coding procedures, and even skilled reading depends on coding processes that are low in cost to processing resources. Reading disability may also be understood as representing a point on an ability continuum that contains a wide range of coding ability. Instructional goals of word reading skill, including rapid and fluent word recognition, follow from these considerations. [Topic: 5c] 1986-034

Perfetti, C. A. (1986). Reading acquisition and beyond: Decoding includes cognition. In N. L. Stein (Ed.), *Literacy in American schools: Learning to read and write* (pp. 40-60). Chicago IL: The University of Chicago Press.

The definition of literacy is a tricky business, but it is important for the study of the development of reading skill. This chapter discusses the importance of decoding in reading acquisition and beyond. There is good evidence to conclude that decoding is important to the development of reading skill. However, what this means in detail is an interesting question, and this is where the definition issue comes in. So, although the author's primary concern lies with the development of reading skill, he begins with some issues concerning the definition of literacy that affect how the development of reading skill is viewed. [Topic: 5c] 1986-035

Perfetti, C. A. (1987). Language, speech, and print: Some asymmetries in the acquisition of literacy. In R. Horowitz & S. J. Samuels (Eds.), *Comprehending oral and written language* (pp. 355-369). New York: Academic Press.

This chapter addresses four general points about the relationship between speech and print: 1) The similarity between speech and print is essentially asymmetrical in some important ways; 2) The asymmetry in similarity between speech and print changes as a child's reading ability improves; 3) For the child who has succeeded at decoding, the commonalities between speech and print are more important than the differences; and 4) For those who have acquired vast reading experience, speech processes become more like reading in some conditions. [Topic: 12] 1987-048

Perfetti, C. A. (1988). Verbal efficiency in reading ability. In G. E. MacKinnon, T. G. Waller, & M. Daneman (Eds.), *Reading research: Advances in theory and practice* (Vol. 6, pp. 109-143). New York: Academic Press.

This chapter summarizes the central features of a theory of reading ability. The theory, the verbal efficiency theory, postulates several component processes in reading comprehension and assumes that individual differences can arise in any of these components. The theory assumes, however, that these processes vary in their potential for efficiency and automaticity, and it is these processes, especially word identification, that are most responsible for differences in reading ability. Research in support of the theory is reviewed and instructional implications are discussed. [Topic: 12] 1988-037

Perfetti, C. A. (1989). The cooperative language processors: Semantic influences in an autonomous syntax. In D. A. Balota, G. B. Flores d'Arcais, & K. Rayner (Eds.), *Comprehension processes in reading* (pp. 205-230). Hillsdale, NJ: Erlbaum.

A main goal of this chapter is to raise the possibility of a parser that is determined (i.e., makes a commitment at each choice point) only for high level constituents and local attachments triggered by syntactic features. In the absence of such features, the parser is less determined to make the full range of intermediate attachments between low level and high level constituents. [Topic: 12] 1989-048

Perfetti, C. A. (1989). There are generalized abilities and one of them is reading. In L. B. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honor of Robert Glaser* (pp. 307-335). Hillsdale, NJ: Erlbaum.

Reading is a restricted domain-general human ability. A restricted ability arises from constraints on the underlying mental process. The generality of an ability is its application across different domains making use of the same restricted processes. [Topic: 12] 1989-049

Perfetti, C. A. (1991). On the value of simple ideas in reading instruction. In S. Brady & D. Shankweiler (Eds.), *Phonological processes in literacy: A tribute to Isabelle Y. Liberman* (pp. 211-218). Hillsdale, NJ: Erlbaum.

The notion that reading is a matter of decoding words and comprehension has been argued. This simple view of reading is examined in this chapter. The alphabetic principle, its role in reading, and the difference between language and reading are also briefly discussed. [Topics: 5c, 12] 1991-048

Perfetti, C. A., & Curtis, M. E. (1986). Reading. In R. F. Dillon & R. J. Sternberg (Eds.), *Cognition and instruction* (pp. 13-57). New York: Academic Press.

Reading as a curriculum is on two levels. The first is reading as the object of instruction and so reading acquisition is addressed. The second is reading as a means of instruction so the processes of skilled reading comprehension are examined. [Topics: 5c, 12] 1986-036

Perfetti, C. A., & McCutchen, D. (1987). Schooled language competence: Linguistic abilities in reading and writing. In S. Rosenberg (Ed.), *Advances in applied psycholinguistics reading, writing, and language learning* (Vol. 2, pp 105-141). New York: Cambridge University Press.

In this chapter, the authors propose that there are general principles of language competence that, with schooling, come to support reading and writing. Schooled language competence is a restricted set of linguistic abilities that are partly distinct from general cognitive skills. Reading especially depends on the reflexive operation of these abilities. Writing, while sharing a dependence on basic language abilities, requires the development of a much more controlled,

nonreflexive cognitive ability that interacts with language processes. [Topic: 12] 1987-049

Perfetti, C. A., Beck, I., Bell, L. C., & Hughes, C. (1987). Phonemic knowledge and learning to read are reciprocal: A longitudinal study of first grade children. *Merrill-Palmer Quarterly*, 33(3), 283-319.
An important question is the relationship between phonological awareness and learning how to read. The authors report a longitudinal study of first grade readers that examined this relationship by using tasks of phonological awareness that differ in their demands on analytic processes as opposed to synthetic processes. They found that phonemic deletion, a task that requires analysis, has a reciprocal relation with first-grade progress in learning to read. Phoneme blending, a task that requires synthesis rather than analysis, has a simpler causal relationship with reading progress. The general conclusion is that phonological awareness is both a cause and an effect of progress in reading. [Topic: 12] 1987-050

Perfetti, C. A., Beverly, S., Bell, L., Rodgers, K., & Faux, R. (1987). Comprehending newspaper headlines. *Journal of Memory and Language*, 26, 692-713.
This article reports a series of experiments on how people understand newspaper headlines, which are notorious for omitting articles, prepositions, and conjunctions. The authors contrast a syntactic hypothesis with a problem solving hypothesis for how readers try to understand the ambiguities that result. The results favor the syntactic hypothesis, and support the more general idea that comprehension of linguistic inputs is initially controlled by automatic syntactic procedures. [Topic: 12] 1987-051

Putnam, R. T., Lesgold, S. B., Resnick, L. B., & Sterrett, S. G. (1987). Understanding sign change transformations. In J. C. Bergeron, N. Herscovics, & C. Kieran (Eds.), *Proceedings of the 11th International Conference on the Psychology of Mathematics Education* (Vol. 1, pp. 338-344). Montreal: International Group for the Psychology of Mathematics Education.
The study reported here examined students' understanding of sign-change rules in elementary algebra, focusing on their informal, intuitive understanding of quantities in situations and their ability to link this understanding to formal mathematical expressions. The authors believe that increasing students' understanding of the referential meaning of algebra's formal symbol system may facilitate the learning of formal rules and the application of algebra to problem solving and learning more advanced mathematics. The ultimate goal of this research is to develop ways to improve students' understanding of the symbolic manipulations they learn in algebra. [Topic: 5a] 1987-052

Putnam, R. T., deBettencourt, L. U., & Leinhardt, G. (1990). Understanding of derived fact strategies in addition and subtraction. *Cognition and Instruction*, 7(3), 245-285.
This article reports on a study which examined children's justifications and evaluations of derived-fact strategies--strategies for solving addition and subtraction problems by using known combinations--to explore their knowledge of underlying part-whole relationships. Both LD and normal students' explanations of the derived-fact strategies for addition were examined. Students' explanations were used to develop a partial model of the knowledge underlying the derived-fact strategies. [Topics: 5a, 10] 1990-057

Rabinowitz, M., & Chi, M. T. H. (1986). An interactive model of strategic processing. In S. J. Ceci (Ed.), *Handbook of the cognitive, social, and neuropsychological aspects of learning disabilities* (pp. 83-102). Hillsdale, NJ: Erlbaum.
This chapter asserts that learning disabled children perform poorly because of deficiencies in strategic processing which derive from the relationship between existing knowledge in semantic memory and the use of cognitive strategies. Specifically, the authors argue that both the decision to use a strategy and the efficiency with which a strategy can be used are based on a complex interaction with the conceptual knowledge to which the strategy is to be applied. The influence of this knowledge on processing is illustrated with the aid of a computer simulated environment in which a spreading activation memory system is modelled. [Topics: 2, 6] 1986-037

Rabinowitz, M., & Glaser, R. (1985). Cognitive structure and process in highly competent performance. In F. D. Horowitz & M. O'Brien (Eds.), *The gifted and talented: A developmental perspective* (pp. 75-98). Washington, DC: American Psychological Association.
What allows people to perform in highly competent ways? In contrast to attributing such performance to general intelligence, recent approaches characterize intelligence and aptitude in terms of competent processes. The research reviewed here compares skilled and novice performances in terms of such components and gives particular attention to the role of knowledge. [Topic: 13] 1985-036

Rabinowitz, M., Gobbo, C., & Glaser, R. (1985). *Individual differences in integrating information for*

problem solving. Pittsburgh, PA: University of Pittsburgh, LRDC.
Problem solving in educational settings often requires reading information on unfamiliar topics and determining which issues are important or relevant to problem solution. This report presents a study of such unstructured problem solving, in which individual differences in students' strategies were examined. The results show significant individual differences in identifying relevant and irrelevant concepts. [Topic: 6] 1985-037

Raghavan, K., & Katz, A. (1989). Smithtown: An intelligent tutoring system. *Technological Horizons in Education Journal*, *17*(1), 50-53.
This article describes Smithtown, one of a family of new instructional aids known as intelligent tutoring systems (ITSs). It employs artificial-intelligence methods to assist students in beginning-economics courses to improve their problem-solving skills. [Topic: 7] 1989-050

Raghavan, K., Schauble, L., & Glaser, R. (1991). A graphic notation to support reflection in scientific reasoning. In L. Birnbaum (Ed.), *Proceedings of the 1991 International Conference on the Learning Sciences* (pp. 370-374). Charlottesville, VA: Association for the Advancement of Computers in Education.
Previous research on students' scientific reasoning in the context of computer-based laboratories indicates the relationship between goal-driven, plan-oriented activity and success at discovering the laws and regularities. Students who learn the most are skillful at coordinating the complex set of subgoals that comprise experimentation. Students who fail to learn typically fail to reflect upon the inferential meaning of their experimentation activity. To support users in this reflective evaluation, the authors have developed a graphic Discovery and Reflection Notation (DARN) that depicts student activity with the laboratory from three perspectives: the Student View, the Plan View, and the Expert View. Each of the views organizes that student's activities in a different way. [Topics: 6, 7, 9] 1991-053

Reimann, P., Raghavan, K., & Glaser, R. (1988). *REFRACT, a discovery environment for geometrical optics*. Pittsburgh, PA: University of Pittsburgh, LRDC.
A computer-based laboratory environment called REFRACT provides a discovery environment for learning about refraction. The theoretical framework of inductive learning involved in REFRACT provides the basis for building cognitive simulation models of learning in the domain. [Topic: 5b] 1988-040

Resnick, D. P., & Resnick, L. B. (1988). Understanding achievement and acting to produce it: Some recommendations for the NAEP. *Phi Delta Kappan*, *69*, 576-579.
This article analyzes the National Assessment of Education Progress (NAEP), the 25-year-old report card for U.S. education that is being redesigned. Urging that it be shaped to do more than collect data, the authors stress the need for NAEP to provide information on educational inputs and mediating variables if it is to be of significant use to education policy makers at the state and district levels. Criteria are offered to help determine what additional information should be included, and examples of appropriate input variables are provided with suggestions for more sophisticated analyses of these data. [Topic: 3] 1988-042

Resnick, L. B. (1985). Cognition and instruction: Recent theories of human competence and how it is acquired. In B. L. Hammonds (Ed.), *Psychology and learning: The master lecture series* (Vol. 4, pp. 123-186). Washington, DC: American Psychological Association.
Since researchers in various branches of psychology found common ground in the study of cognition, they have been joined by researchers in other disciplines, forming a new cognitive science research community. These changes have sparked both research on complex forms of knowledge and skill and development of new research methods and forms of theorizing. A new scientific method specifically suited to the study of human mental functioning is gradually emerging. Against that backdrop, this chapter sketches how intellectual competence is acquired in four domains and suggests directions for future research, especially research focused on improving instruction. [Topic: 1] 1985-039

Resnick, L. B. (1985). Instructional psychology. In T. Husen & T. N. Postlethwaite (Eds.), *International encyclopedia of education: Research and studies* (Vol. 5, pp. 2569-2581). Oxford: Pergamon Press.
Instructional psychology is concerned with the processes of learning educational subject matter and with the nature of interventions designed to enhance that learning. This chapter illustrates the major trends and issues in the field by considering cognitive research in four broad areas of direct relevance to the school: reading, mathematics, science, and problem solving. It describes an emerging body of research on aptitude and intelligence that may eventually change conceptions of these individual differences constructs. The chapter also discusses some steps that may be necessary to link cognitive

instructional psychology more directly to practical educational concerns. [Topic: 1] 1985-040

Resnick, L. B. (1986). The development of mathematical intuition. In M. Perlmutter (Ed.), *Perspectives on intellectual development: The Minnesota Symposium on Child Psychology* (Vol. 19, pp. 159-194). Hillsdale, NJ: Erlbaum.

Why, despite children's informal mathematical competence, is formal mathematics so difficult for many to learn? Part of that problem appears to emanate from the dual function of mathematical symbols, which refer to both mathematical entities and mathematical abstractions. Mathematical language, therefore, is both an object of mathematical reasoning and a tool of such reasoning. This chapter considers the nature of children's intuitive knowledge of mathematics, the complexity of coordinating symbols and referents in mathematical development, and the role of each in school mathematics learning. The author concludes with several proposals for future research. [Topic: 10] 1986-038

Resnick, L. B. (1987). Constructing knowledge in school. In L. S. Liben (Ed.), *Development and learning: Conflict or congruence?* (pp. 19-50). Hillsdale, NJ: Erlbaum.

The arguments developed in this chapter suggest that it is unproductive to assume that there are two different kinds of knowledge acquisition, one for formal and another for informal situations. Although constructive processes are involved in both school learning and informal learning situations, the quality of the constructions depends on the kinds of representations used in reasoning. The author, therefore, discourages focusing on distinctions between learning and development, recommending instead that attention be focused on the processes by which knowledge construction proceeds and on how various environmental stimuli shape and constrain those processes. [Topic: 1] 1987-054

Resnick, L. B. (1987). Instruction and the cultivation of thinking. In E. De Corte, H. Lodewijks, R. P. Parmentier, & P. Span (Eds.), *Learning and instruction: European research in an international context* (Vol. 1, pp. 415-442). Oxford: Leuven University Press/Pergamon Press.

Research in cognition and learning is demonstrating that various mental activities associated with higher order thinking are implicated in all competent mental functioning and that traditional distinctions between higher order thinking and basic skills should be abandoned. The author points out that, although defining higher order thinking is difficult, recognizing when it occurs is not. She lists characteristics of higher order thinking and presents evidence that aspects of mental functioning traditionally excluded from mass education are involved throughout learning. After reviewing programs for teaching higher order skills, the chapter suggests implications for education and research. [Topic: 1] 1987-055

Resnick, L. B. (1987). Learning in school and out. *Educational Researcher, 16*(9), 13-20.

Research on the nature of everyday, practical, real-world intelligence and learning is providing a basis for understanding what distinguishes practical from formal intelligence. Drawing on that work, this article explores four broad contrasts indicating that school is a special place and time for people--discontinuous with daily life and work. The author then considers where and how the economic, civic, and cultural aims of education can best be pursued and whether schooling should be reorganized to take into account what has been learned about the nature of competence in various aspects of our lives. [Topic: 1] 1987-056

Resnick, L. B. (1988). Treating mathematics as an ill-structured discipline. In R. I. Charles & E. A. Silver (Eds.), *The teaching and assessing of mathematical problem solving* (pp. 32-60). Hillsdale, NJ/Reston, VA: Erlbaum/National Council of Teachers of Mathematics.

Educators typically treat mathematics as a field with no open questions and no arguments. Consequently, children often think of mathematics as a collection of symbol manipulation rules, plus some tricks for solving stereotyped story problems, and fail to link symbolic rules to mathematical concepts or to believe that they can construct and defend mathematical ideas. The author considers the role of talk in promoting a different view of mathematics and better competence for quantitative thinking and raises a set of issues for further investigation if mathematics is to be taught as an ill-structured discipline. [Topic: 5a] 1988-043

Resnick, L. B. (1989). Developing mathematical knowledge. *American Psychologist, 44*(2), 162-169.

Recent research has led to a significant reconceptualization of the nature of children's number knowledge development. This article outlines infants' and preschoolers' implicit protoquantitative reasoning schemas and shows how these combine with early counting knowledge to produce mathematical concepts of number. Research on elementary school children's informal and invented arithmetic is reviewed, and implications for mathematics education are evaluated. [Topic: 5a] 1989-053

Resnick, L. B. (1990). Instruction and the cultivation of thinking. In N. J. Entwistle (Ed.), *Handbook of educational ideas and practices* (pp. 694-707). London: Routledge.
Research in cognition and learning is demonstrating that various mental activities associated with higher order thinking are implicated in all competent mental functioning and that traditional distinctions between higher order thinking and basic skills should be abandoned. The author points out that, although defining higher order thinking is difficult, recognizing when it occurs is not. She lists characteristics of higher order thinking and presents evidence that aspects of mental functioning traditionally excluded from mass education are involved throughout learning. After reviewing programs for teaching higher order skills, the article suggests implications for education and research. [Topic: 1] 1990-059

Resnick, L. B., & Chi, M. T. H. (1988). Cognitive psychology and science learning. In M. Druger (Ed.), *Science for the fun of it: A guide to informal science education* (pp. 24-31). Washington, DC: National Science Teachers Association.
The authors of this chapter consider what parts of Piaget's theory of cognitive development remain central to our understanding of how people think and learn about science and what parts should be modified in light of more recent relevant knowledge. Supported by cognitive research, the authors offer some constructivist principles to guide educational efforts, with suggestions for new approaches to science learning in informal settings that involve the organization of knowledge, elaborative engagement with new knowledge, and tools for developing mental models. [Topic: 1] 1988-044

Resnick, L. B., & Johnson, A. (1988). Intelligent machines for intelligent people: Cognitive theory and the future of computer-assisted learning. In R. S. Nickerson & P. P. Zodhiates (Eds.), *Technology in education: Looking toward 2020* (pp. 139-168). Hillsdale, NJ: Erlbaum.
This chapter considers some of the current and potential efforts in computer assisted instruction (CAI) in light of major themes from cognitive learning theory. The authors review various CAI efforts, considering both the implications of cognitive principles for the development of CAI and the consequences of these developments for theories of learning. They propose a reconceptualization of the place of CAI in the learning process and suggest that artificial intelligence can be useful in education only to the extent that it focuses its attention on extending, rather than replacing, human intelligence. [Topic: 7] 1988-045

Resnick, L. B., & Nelson-Le Gall, S. (1987). Meaning construction in mathematical problem solving. In J. C. Bergeron, N. Herscovics, & C. Kieran (Eds.), *Proceedings of the Eleventh Annual Conference of the Psychology of Mathematics Education* (Vol. 3, pp. 215-221). Montreal: International Group for the Psychology of Mathematics Education.
This article reports early results of a program of research that aims to improve children's mathematics learning by developing attitudes and strategies that support processes of interpretation and meaning construction in mathematics. The authors have examined processes of socially shared problem solving in which an adult and other children provide scaffolding for individuals' early problem-solving efforts. Different ways of scaffolding problem-solving efforts and building self-monitoring strategies are explored. These studies show that the intimate relationship between conceptual knowledge and problem solving in mathematics sets special constraints for instruction and learning. [Topic: 6] 1987-057

Resnick, L. B., & Omanson, S. F. (1987). Learning to understand arithmetic. In R. Glaser (Ed.), *Advances in instructional psychology* (Vol. 3, pp. 41-95). Hillsdale, NJ: Erlbaum.
This chapter examines the nature of understanding in procedural domains, how understanding is related to performance skill, and how understanding and procedural competence are learned. Although the empirical data of this study focus on subtraction, a domain central to the primary school curriculum, the study itself focuses on the more general principles of learning and understanding that the case of subtraction illustrates and on whether and how understanding may enhance procedural skill. The conclusion considers implications for a general theory of the relationships between conceptual and procedural learning and for approaches to instruction in elementary mathematics. [Topic: 1] 1987-058

Resnick, L. B., Cauzinille-Marmeche, E., & Mathieu, J. (1987). Understanding algebra. In J. A. Sloboda & D. Rogers (Eds.), *Cognitive processes in mathematics* (pp. 169-203). Oxford: Clarendon Press.
What does it mean to understand an algebra expression or an algebra rule? What roles does understanding play in children's learning of algebra? These questions motivated the research reported here, which is devoted to discovering the extent to which children beginning to learn algebra are able to relate formal expressions to

their situational and conceptual referents. The authors conclude that the challenge of learning algebra is both to relate the formalisms to the situations and mathematical principles that give them referential meaning and to construct an understanding of algebra as a powerful formal system that contains its own internal meaning. [Topic: 5a] 1987-059

Resnick, L. B., Lesgold, S., & Bill, V. (1990). From protoquantities to number sense. In G. Booker, J. Cobb, & T. N. de Mendicuti (Eds.), *Proceedings of the Fourteenth Psychology of Mathematics Education Conference* (Vol. 3, pp. 305-311). Mexico City, Mexico: International Group for the Psychology of Mathematics Education.

The research described in this article explores the efficacy of an early mathematics program that is aimed at developing number sense and is built entirely on children's invented procedures and on their informally acquired quantitative knowledge. In an effort to socialize children to think of themselves as reasoners about number, the classroom program routinely provided daily conversation about numbers and attention to quantitative examples in everyday situations. First year results show that the program produced large improvements in number sense and in conceptual competence across all ability levels. [Topic: 5a] 1990-062

Resnick, L. B., Nesher, P., Leonard, F., Magone, M., Omanson, S., & Peled, I. (1989). Conceptual bases of arithmetic errors: The case of decimal fractions. *Journal for Research in Mathematics Education, 20*(1), 8-27.

Examining children's efforts to make sense of new mathematics instruction, this article documents major categories of errors that appear consistently as children learn decimal fractions. It then establishes the conceptual sources of these errors. Whole number errors derive from children's applying rules for interpreting multidigit integers. Fraction errors derive from children's efforts to interpret decimals as fractions. Different curriculum sequences influence the probability that these classes of errors will appear. It is suggested that errors are a natural concomitant of students' attempts to integrate new material with established knowledge. [Topic: 5a] 1989-056

Schauble, L., & Glaser, R. (1990). Scientific thinking in children and adults. In D. Kuhn (Ed.), *Developmental perspectives on teaching and learning thinking skills: Contributions to human development* (Vol. 21, pp. 9-27). Switzerland: Karger.

A program of research on the use of scientific thinking skills in contexts of self-directed experimentation is described. Scientific reasoning is studied here in domains rich enough that prior beliefs significantly affect the reasoning process. The authors also continue a recent trend of investigating larger, coherent episodes of reasoning that occur over an extended period of time and that include the full cycle of hypothesis generation, experimentation, data interpretation, and hypothesis revision. The performance of adults is compared with the performance of children on these tasks. [Topics: 5b, 6, 11] 1990-065

Schauble, L., Glaser, R., Raghavan, K., & Reiner, M. (1991). Causal models and experimentation strategies in scientific reasoning. *The Journal of the Learning Sciences, 1*(2), 201-238.

The study described in this article explores how novices' conceptions of electric circuits affected their self-directed experimentation in a computer-based laboratory. The participants were 22 undergraduates with no formal college instruction in physics. Relations were found between students' causal models of circuits and their learning gains in the computer laboratory. In general, sophisticated models that had been identified in an independent problem solving task were related to sophisticated reasoning in the computer discovery task. [Topics: 2, 6, 10] 1991-060

Schauble, L., Klopfer, L. E., & Raghavan, K. (1991). Students' transition from an engineering model to a science model of experimentation. *Journal of Research in Science Teaching, 28*(9), 859-882.

The study reported in this article investigates the hypothesis that when children are engaged in science experiments, where the goal is to understand the relations among causes and effects, they often use the engineering model of experimentation, characterized by the more familiar goal of manipulating variables to produce a desired outcome. Sixteen fifth- and sixth-graders worked on two experimentation problems consistent with the science and engineering models, respectively. The science model was associated with broader explanation, more selectiveness about the evidence generated, and greater attention to establishing that some variables are not causal. [Topics: 5b, 6, 11] 1991-061

Schiano, D. J., Cooper, L. A., Glaser, R., & Zhang, H. C. (1989). Highs are to lows as experts are to novices: Individual differences in the representation and solution of standardized figural analogies. *Human Performance, 2*(4), 225-248.

Findings are reported from two experiments that compared the strategies used by high and low

scorers on standardized figural analogy tests to represent and solve problems. The findings converge to suggest specific aptitude-related differences in the representation and solution of standardized figural analogy problems. These differences resemble expert-novice differences in a number of other problem solving domains. [Topics: 3, 13] 1989-059

Schofield, J. W. (1986). Black-white contact in desegregated schools. In M. Hewstone & R. Brown (Eds.), *Contact and conflict in intergroup encounters* (pp. 79-92). Oxford, England: Basil Blackwell.

This chapter discusses second generation problems in desegregated schools including (a) the tendency toward resegregation, (b) the emergence of new and subtle forms of racism, and (c) disagreement over the goals of desegregation. It concludes by considering the implications of this analysis for policy and practice. [Topics: 4, 8, 14] 1986-041

Schofield, J. W. (1986). Causes and consequences of the colorblind perspective. In S. Gaertner & J. Dovidio (Eds.), *Prejudice, discrimination and racism: Theory and practice* (pp. 231-253). New York: Academic Press.

This chapter, based on an intensive four-year qualitative study of a desegregated middle school, examines the causes and consequences of the colorblind perspective--a view endorsed by the school's administrators and teachers which holds that the school and its staff should ignore race completely, treating it as a completely irrelevant individual characteristic. The adoption of this perspective reduced the potential for overt racial conflict; minimized initial awkwardness, discomfort, and embarrassment between individuals from different racial groups; and increased teachers' freedom of action in both constructive and destructive ways. It also had a number of largely unrecognized negative consequences, which included (a) promoting a climate conducive to aversive racism and (b) failure to respond to, and capitalize on, the diversity of the student body. [Topics: 4, 8, 14] 1986-042

Schofield, J. W. (1988). Social relations in desegregation. *Equity and Choice*, 4, 15-17.

The importance of thinking about desegregation as an ongoing process rather than a one-time event is emphasized in this article. In planning to maximize the chances that this process will have positive outcomes, it is useful to recognize the importance of structuring desegregated schools so that minority and majority group members (a) have equal status within the school, (b) are encouraged to cooperate with each other for mutually valued goals, and (c) understand clearly that the relevant school authorities, including both teachers and administrators, support the goal of desegregation. [Topics: 4, 8, 14] 1988-050

Schofield, J. W., & Anderson, K. (1987). Combining quantitative and qualitative components of research on ethnic identity and intergroup relations. In J. S. Phinney & M. J. Rotheram (Eds.), *Children's ethnic socialization: Pluralism and development* (pp. 252-273). Newbury Park, CA: Sage.

This chapter compares qualitative and quantitative approaches to research, focusing especially on research on ethnic identity and intergroup relations. It calls for a rapprochement between the two methods, then proceeds to suggest a number of ways in which qualitative approaches to research can be strengthened by incorporating practices more typical of quantitative approaches without undercutting the strengths typical of these approaches. [Topic: 3] 1987-063

Shute, V. J., & Glaser, R. (1990). A large-scale evaluation of an intelligent discovery world: Smithtown. *Interactive Learning Environments*, 1(1), 51-77.

An evaluation of Smithtown, a tutoring system designed to enhance an individual's scientific inquiry skills and to provide an environment for learning principles of basic microeconomics, is reported in this article. Two studies of individual differences in learning were conducted. Differentiating behaviors mirrored differences shown in studies of general problem solving and concept formation. [Topics: 1, 5b, 5d, 7] 1990-071

Shute, V. J., Glaser, R., & Raghavan, K. (1989). Inference and discovery in an exploratory laboratory. In P. L. Ackerman, R. J. Sternberg, & R. Glaser (Eds.), *Learning and individual differences: Advances in theory and research* (pp. 279-326). New York: Freeman.

The research described in this chapter employs a computer laboratory called Smithtown to study students' inductive inquiry skills. Students' effectiveness generally in collecting, organizing, and understanding data, concepts, and relationships in economics was shown to vary with their success in mastering domain information. [Topics: 1, 5b, 5d, 7] 1989-065

Shute, V., & Glaser, R. (1991). An intelligent tutoring system for exploring principles of economics. In R. E. Snow & D. Wiley (Eds.), *Improving inquiry in social science: A volume in honor of Lee J. Cronbach* (pp. 333-366). Hillsdale, NJ: Erlbaum.

This chapter describes the development of an intelligent tutoring system designed to investigate

students' problem solving and induction skills as well as their acquisition of knowledge of principles of economics. The microworld can detect effective and ineffective inquiry strategies by comparing student actions with optimal action sequences. Furthermore, the chapter discusses a partially implemented coach that can teach the inquiry strategies in the context of the domain knowledge. [Topics: 1, 5b, 5d, 7] 1991-068

Stein, M. K., Baxter, J., & Leinhardt, G. (1989). *Teacher subject matter knowledge and its relationship to classroom instruction* (Tech. Rep. No. CLIP-89-01). Pittsburgh, PA: University of Pittsburgh, LRDC.

This report investigates the level and kind of teacher subject-matter knowledge needed for elementary instruction. An experienced fifth-grade teacher was studied in the context of teaching functions and graphing. The teacher's subject-matter knowledge was compared to that of two math experts. Results of this comparison and an examination of lesson transcripts showed limitations in the teacher's subject matter knowledge and instances of missed opportunities in classroom presentations. [Topics: 5a, 13, 16] 1989-072

Stein, M. K., Baxter, J., & Leinhardt, G. (1990). Subject-matter knowledge and elementary instruction: A case from functions and graphing. *American Educational Research Journal*, 27(4), 639-663.

This article describes the relationship between teachers' subject-matter knowledge and their lesson presentations by reporting on a study of one experienced 5th-grade mathematics teacher teaching 25 lessons on functions and graphing. The teacher's subject matter knowledge (gleaned from lesson videotapes and interviews) was compared to that of a math educator. Specific limitations in the teacher's knowledge were identified and implications of this, both for instruction and for teacher education, are discussed. [Topics: 5a, 13, 16] 1990-076

Stein, M. K., Leinhardt, G., & Bickel, W. (1989). Instructional issues for teaching students at risk. In R. E. Slavin, N. L. Karweit, & N. A. Madden (Eds.), *Effective programs for students at risk* (pp. 145-194). Boston: Allyn and Bacon.

This chapter addresses the issue of how best to educate all types of low-achieving students. It reviews past efforts to serve separately compensatory education students, mildly handicapped students (including LD), and other slow learners. The authors argue that these students all benefit from the same kinds of effective instructional programs. Recent improvements in instructional practice and new findings in educational research support their position. [Topics: 4, 16] 1989-073

Vesonder, G. T., & Voss, J. F. (1985). On the ability to predict one's own responses while learning. *Journal of Memory and Language, 24*, 363-376.

Two experiments are reported in this article. The first concerns the issue of how accurately, in a multiple-trial learning situation, individuals are able to predict their own performance on a trial-by-trial basis over the entire course of acquisition.The data support previous findings, indicating that subjects are able to discriminate items they have learned in the course of acquisition from those they have not learned. The second experiment examines what information a person uses to predict his or her own acquisition performance and to what extent that information is unique to the particular individual doing the predicting. [Topic: 9] 1985-047

Voss, J. F. (1986). Social studies. In R. F. Dillon & R. J. Sternberg (Eds.), *Cognition and instruction* (pp. 205-239). New York: Academic Press.

This chapter presents a model of instruction in social studies. The model is based upon the information processing model of problem solving, especially as the model refers to the solving of ill-structured problems. [Topic: 5d] 1986-044

Voss, J. F. (1987). Basic and applied research as problem solving: An analysis of constraints. *International Journal of Psychology, 22*, 463-469.

This article considers the question of whether pure or basic research and applied research may be meaningfully differentiated. Basic and applied research are considered in terms of problem-solving, and the question addressed is how basic and applied research vary with respect to the constraints that are placed upon the investigator in relation to the problem-solving process. Three examples are presented, one of basic research, one of applied, and one between the constraints being examined in each case. The analysis of the three cases leads to the conclusion that basic and applied research are qualitatively different. [Topic: 1] 1987-069

Voss, J. F. (1987). Learning and transfer in subject-matter learning: A problem-solving model. *International Journal of Educational Research. Special issue: Acquisition and transfer of knowledge and cognitive skills, 11*, 607-622.

The growth of the cognitive movement, with its emphasis upon perception and memory, has been accompanied by a decrease in the study of learning, retention, and transfer as found in the traditional associationistic framework. A reconceptualization of learning and retention is

presented in this article, making these concepts subordinate to the concept of transfer, and emphasizing prior knowledge, skills, attitudes, and other characteristics of the individual. It is argued that the general information-processing model of problem solving, especially as applied to ill-structured problems, provides a conceptual framework for the study of learning, and is especially useful when considering learning in academic subject-matter domains. [Topics: 5c, 9, 14] 1987-070

Voss, J. F. (1988). Problem solving and reasoning in ill-structured domains. In C. Antaki (Ed.), *Analyzing everyday explanation: A casebook of methods* (pp. 74-93). London, England: SAGE.
This chapter, methodological in orientation, presents a description of analyses of ill-structured problems. Emphasis is placed upon how such analyses can help to understand thought processes, and limitations of the method are considered. [Topic: 6] 1988-064

Voss, J. F. (1989). On the composition of experts and novices. In E. Maimon, B. Nodine, & F. O'Connor (Eds.), *Thinking, reasoning, and writing*. White Plains, NY: Longman Press.
This chapter presents the position that the development of a better understanding of the processes underlying the solving of ill-defined problems, including the processes of informal reasoning, will lead to a better understanding of the complex acts of everyday behavior, including tasks such as writing. Brief summaries of research on the solving of ill-structured problems by experts and novices and of some research on informal reasoning are presented, indicating how such research on problem solving and reasoning may enhance our understanding of instruction in other complex tasks. [Topics: 6, 13] 1989-076

Voss, J. F. (1989). Problem solving and the educational process. In A. Lesgold & R. Glaser (Eds.), *Foundations for a psychology of education* (pp. 251-294). Hillsdale, NJ: Erlbaum.
This chapter presents a summary of problem solving and its relation to the educational process. A broad-based but not exhaustive literature survey emphasizes the importance of problem solving in instruction. [Topic: 6] 1989-077

Voss, J. F. (1990). Reasoning by argumentation. In H. Mandl, E. De Corte, N. Bennett, & H.F. Friedrich (Eds.), *Learning and instruction: European research in an international context* (Vol. 2.1, pp. 305-319). Oxford: Pergamon Press.
This chapter stresses the importance of the teaching of argumentation in reference to instruction in reasoning. Emphasis is placed on justification processes. [Topic: 6] 1990-077

Voss, J. F. (1991). Informal reasoning and international relations. In J. F. Voss, D. N. Perkins, & J. Segal (Eds.), *Informal reasoning and education* (pp. 37-58). Hillsdale, NJ: Erlbaum.
The two primary objectives of this chapter are to explore the nature of informal reasoning in international relations, a special case of reasoning in the social sciences, and to consider how instruction could help enhance the quality of informal reasoning found in the social sciences. The first section discusses the international relations context, serving as a setting for the second section, in which reasoning in international relations is considered, including the findings of several related studies. The third section addresses the question of how instruction may facilitate one's reasoning in the social science domain. [Topics: 6, 16] 1991-075

Voss, J. F., & Bisanz, G. L. (1985). Knowledge and the processing of narrative and expository text: Some methodological issues. In B. K. Britton & J. B. Black (Eds.), *Understanding expository text: A theoretical and practical handbook for analyzing explanatory text* (pp. 385-391). Hillsdale, NJ: Erlbaum.
In this chapter, the authors discuss some problems that occur when one attempts to study the role of knowledge and text processing. These problems include: difficulty in assessing knowledge; problems associated with the use of the contrastive method; issues related to scoring recall protocols; and the need to determine the interaction between text structure and the effects of knowledge. [Topic: 15] 1985-048

Voss, J. F., & Bisanz, G. L. (1985). Knowledge and the processing of narrative and expository texts. In B. K. Britton & J. B. Black (Eds.), *Understanding expository text: A theoretical and practical handbook for analyzing explanatory text* (pp. 173-198). Hillsdale, NJ: Erlbaum.
This chapter assesses the current state of research on how knowledge influences text processing. Interestingly, research on narrative text has tended to focus upon the role of knowledge while research on expository text has tended to focus on the role of text structure. Because of this differentiation, this chapter begins with a discussion on knowledge and the processing of narrative text. The second part focuses upon the role of knowledge in processing expository text, drawing comparisons to narrative when appropriate. Finally, there is a brief concluding section. [Topic: 15] 1985-049

Voss, J. F., & Means, M. L. (1989). Toward a model of creativity based upon problem solving in the social sciences. In J. A. Glover, R. R. Ronning, &

C. R. Reynolds (Eds.), *Handbook of creativity: Assessment, theory and research* (pp. 399-410). New York: Plenum Press.
This chapter presents a model of creativity that is based upon the solving of ill-structured social science problems, emphasizing the importance of the individual's knowledge base, the effective use of a variety of search mechanisms that provide for obtaining and evaluating information, and the operation of value and affect components. The fact that cited examples of creativity are seldom found in social sciences is largely attributed to social science research not meeting the criteria that are typically interpreted. Finally, some suggestions are proposed with respect to social science instruction that would hopefully lead to an increase of creativity in students. [Topics: 2, 6] 1989-078

Voss, J. F., & Post, T. A. (1988). On the solving of ill-structured problems. In M. T. H. Chi, R. Glaser, & M. J. Farr (Eds.), *The nature of expertise* (pp. 261-285). Hillsdale, NJ: Erlbaum.
Reitman (1965) and Simon (1973) have provided excellent analyses of the nature of ill-structured problems and how they are solved. The research reported in this chapter extends the analyses of Reitman and Simon by pointing to a number of the complexities of solving ill-structured problems. General issues are discussed that require consideration if a better understanding of the solving of such problems is to be established. [Topic: 6] 1988-065

Voss, J. F., Fincher-Kiefer, R. H., Greene, T. R., & Post, T. A. (1986). Individual differences in performance: The contrastive approach to knowledge. In R. J. Sternberg (Ed.), *Advances in the psychology of human intelligence* (Vol. 3, pp. 297-334). Hillsdale, NJ: Erlbaum.
This chapter presents a review of research involving the contrastive method, the extent to which a characteristic in question is related to performance on some other task. Of specific interest is use of this method when the characteristic in question is some type of knowledge assessment and the comparison task is performance on some type of information processing task. A methodologically centered summary of research is presented, providing a type of case study in the use of contrastive methodology. Finally, a critical evaluation of contrastive methodology is presented. [Topic: 13] 1986-045

Voss, J. F., Perkins, D. N., & Segal, J. W. (Eds.). (1991). *Informal reasoning and education*. Hillsdale, NJ: Erlbaum.
This edited book contains chapters that show how informal reasoning may be found in various subject matter domains and what constitutes the conceptual basis of informal reasoning. In addition, informal reasoning is considered in relation to instructional practice. [Topic: 6] 1991-076*

Voss, J. F., Vesonder, G. T., Post, T. A., & Ney, L. G. (1987). Was the item recalled and if so by whom? *Journal of Memory and Language, 26*, 466-479.
This article is concerned with the extent to which individuals can remember their own responses in a learning situation. The results generally indicate that a person can remember what was recalled in a dyad situation, but not whether he, she, or the other person recalled it. [Topic: 9] 1987-071

Voss, J. F., Wolfe, C. R., Lawrence, J. A., & Engle, R. A. (1991). From representation to decision: An analysis of problem solving in international relations. In R. J. Sternberg & P. Frensch (Eds.), *Complex problem solving: Principles and mechanisms* (pp. 119-158). Hillsdale, NJ: Erlbaum.
This chapter addresses the question of how problem representation is related to generation of alternatives in decision making. Four problem areas are studied. Two were taken from political science literature, the Cuban Missile Crisis and the American intervention in Korea, and two involved collecting problem solving protocols, one on German reunification and one on the anti-nuclear movement. [Topic: 6] 1991-077

Voss. J. F. (1990). On the solving of ill-structured problems: A review. *Unterrichts Wissenschaft, 18*, 313-317.
This article is concerned with the question of how people solve ill-structured problems. While not extensive, research on this question has produced a substantial database and theoretical framework. This article summarizes the progress and describes the issues that need to be addressed in order to better understand how such problem solving takes place. The first section, Definition of the Problem, presents a discussion of ill-structured problems. Section two, Developing the Database, presents a non-exhaustive research summary. The third section, Issues of Concern, describes the theoretical and methodological problems. The final section presents a brief summary. This article was published in a German journal, but is available from the author in English. [Topic: 6] 1990-078

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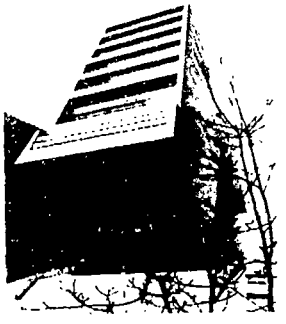

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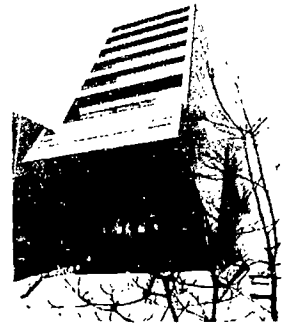

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