Publications by Dr. Lauren Resnick
1985-1998

Bill, V. L., Leer, M. N., Reams, L. E., & Resnick, L. B. (1992). From cupcakes to equations: The structure of discourse in a primary mathematics classroom. *Verbum*, *15*(1), 63-85.

This article is an early report on a research program aimed at understanding the structure of socially shared reasoning in various situations of work, learning, and civic participation. According to recent research, much reasoning and thinking can be understood best as socially distributed processes in which an intellectual product emerges from the coordinated activity of several individuals. This has given rise to new research areas in cognition and learning, including the forms of discourse—especially oral conversation—that are the vehicles for distributed cognition. In documenting and analyzing the discourse in an unusual primary mathematics classroom, the authors describe the intellectual content and the linguistic and social structure of conversation. [Topics: 5a, 6, 12] 1992-015

Collins, A., Greeno, J. G., & Resnick, L. B. (1994). Learning environments. In T. Husen & T. N. Postlethwaite (Eds.), *International encyclopedia of education* (2nd ed.) (Vol. 6, pp. 3297-3302). Oxford: Pergamon.

Educational psychology has undergone a subtle shift in perspective: from teaching to learning. That change reflects a move away from the information transmission view of traditional learning environments to a more constructivist view of learning environments. This article identifies and describes six different environment types. Elements of all six are found in most teaching and learning environments, but the most effective learning environments combine the advantages of each type. A parallel shift in recognizing that learning and work are not separate has resulted in efforts to incorporate some of the characteristics of work environments into school learning environments. [Topics: 1, 2] 1994-019

Greeno, J. G., Collins, A., & Resnick, L. B. (1996). Cognition and learning. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 15-46). New York: Macmillan.

Research on cognition and learning has advanced fundamental scientific understanding and informed educational practice. This chapter reviews research that has significantly influenced or is beginning to influence the character of educational practice in terms of three general perspectives: empiricist, rationalist, and pragmatist-sociohistoric. Within these perspectives, the authors discuss theoretical developments in the nature of knowing, the nature of learning and transfer, and the nature of motivation and engagement. They consider issues of education practice, including designing learning environments, formulating curricula, and constructing authentic assessments, as well as prospects for continued development of the theoretical perspectives and research involving design experiments. [Topics: 1, 16] 1996-022

Hill, C. A., & Resnick, L. B. (1995). Creating opportunities for apprenticeship in writing. In J. Petraglia (Ed.), *Reconceiving writing, rethinking writing instruction* (pp. 145-158). Mahwah, NJ: Erlbaum.

Business and industry regard good communication skills as a key to employees' success and complain that many college graduates they hire cannot write. After contrasting workplace writing with academic writing, the authors conclude that most writing instruction within the university does not adequately prepare students for writing in various professions and that radical revision of such instruction may be necessary. [Topics: 1, 12, 14] 1995-015

Joram, E., Resnick, L. B., & Gabriele, A. J. (1995). Numeracy as cultural practice: An examination of numbers in magazines for children, teenagers, and adults. *Journal for Research in Mathematics Education*, *26*, 346-361.

The authors compared the characteristics of rational numbers in various magazines. Their analysis indicates that adults are often presented with rational numbers that are related to each other and that, although teenagers have covered all the mathematics concepts frequently found in adults' texts, numbers in teenagers' texts do not appear to form a transition to those found in adults' texts. Implications for preparing students for the numeracy demands of everyday life are discussed. [Topics: 5a, 16] 1995-017

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

Lesgold, S. B., Peled, I., & Resnick, L. B. (1989). *Using semantic computer models for learning about number systems and word problems*. Pittsburgh, PA: University of Pittsburgh, LRDC.

This report is a description of TRAINWORLD, a computer system of representing numbers by trains of different lengths and arithmetic operators by machines that operate on those trains. The different types of machines for adding and subtracting correspond to the semantic categories for addition and subtraction word problems: combine, change, and compare. Results of trials with first graders, working both individually and in pairs, are presented. Children were classified into three levels of competence based on their work with the trains and machines, and the levels are described. [Topics: 5a, 7] 1989-039

Levine, J. M., Resnick, L. B., & Higgins, E. T. (1993). Social foundations of cognition. *Annual Review of Psychology, 44*, 585-612.

This article reviews research dealing with the impact of social factors on both the content of people's cognitions and the processes by which cognitive activities proceed. [Topics: 8, 14] 1993-028

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., & Resnick, L. B. (1998). Help seeking, achievement motivation, and the social practice of intelligence in school. In S. A. Karabenick (Ed.), *Strategic help seeking: Implications for learning and teaching* (pp. 39-60). Mahwah, NJ: Erlbaum.

In this chapter, the authors explore a broad conceptualization of learning and skill acquisition that links strategy learning with motivation and connects social competence to cognitive development. Active and effective help seeking is viewed as a crucial strategy that is part of adaptive, intelligent practice in learning settings. Such an approach is regarded as being central to bridging the equity gap in U.S. education. [Topics: 10, 14] 1998-030

Nersessian, N. J., & Resnick, L. B. (1989). Comparing historical and intuitive explanations of motion: Does naive physics have a structure? *Proceedings of the Eleventh Annual Conference of the Cognitive Science Society* (pp. 412-417). Hillsdale, NJ: Erlbaum.

Are students' explanations of motion generated by an underlying structure? This article addresses that question by exploring striking parallels between intuitive explanations and those offered by medieval scholastics. Using the historical record, it is possible to reconstruct an inferential structure that generates medieval explanations. The authors posit a parallel structure for intuitive explanations. [Topic: 5b] 1989-046

Peled, I., & Resnick, L. B. (1987). Building semantic computer models for teaching number systems and word problems. In J. C. Bergeron, N. Herscovics, & C. Kieran (Eds.), *Proceedings of the 11th Annual Conference of the Psychology of Mathematics Education* (Vol. 2, pp. 184-190). Montreal: International Group for the Psychology of Mathematics Education.

This article presents issues concerning the construction of models for teaching mathematical concepts and problem solving. As an example of this decision-making process, the authors suggest a computer-based model for teaching natural numbers. This model, which represents natural numbers as well as the operations of addition and subtraction, is aimed at facilitating the solution of word problems. The chapter shows how research on children's informal knowledge of numbers and algorithms, together with research on how children solve word problems, is taken into account. [Topics: 5a, 7, 16] 1987-047

Pontecorvo, C., Orsolini, M., Burge, B., & Resnick, L. B. (1996). *Children's early text construction.* Mahwah, NJ: Erlbaum.

Until recently, cognitive and psycholinguistic research on reading has driven the study of written language education, and methods of teaching children to read have dominated the educational scene. This book presents an alternative view. Writing has emerged as a central aspect of becoming literate. Research has shown that writing is a highly complex activity involving a degree of planning unknown in everyday conversational uses of language and that young children show a surprisingly sophisticated understanding of the representational constraints of alphabetic writing systems long before they can read conventional writing on their own. This volume explores the relationship between acquisition of language and familiarity with written texts; the reciprocal "permeability" between spoken and written language; the initial phases of text construction by children; and the educational conditions that facilitate written language acquisition and writing practice. [Topics: 1, 5c, 12, 15] 1996-048

Pontecorvo, C., Orsolini, M., & Resnick, L. B. (1996). Introduction. In C. Pontecorvo, M. Orsolini, B. Burge, & L. B. Resnick (Eds.), *Children's early text construction* (pp. ix-xvi). Mahwah, NJ: Erlbaum.

Pointing to the challenges to traditional assumptions about reading and writing that will follow, this introduction sets out the questions that will be examined. They concern the impact of written texts on children's acquisition of oral language and also the ways in which children work with, interpret, and eventually come to understand the system of writing with which their culture surrounds them. A main point of discussion is the role of the linguistic environment in children's literacy development.[Topics: 1, 5c, 12, 15] 1996-049

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

Reiner, M., Chi, M. T. H., & Resnick, L. B. (1988). Naive materialistic belief: An underlying epistemological commitment. *Proceedings of the Tenth Annual Conference of the Cognitive Science Society* (pp. 544-551). Hillsdale, NJ: Erlbaum.

A considerable amount of research has focused on students' naive beliefs about electricity, energy, heat, and light. These studies show, in general, that many misconceptions can be traced to students' prescientific beliefs about the world. In this article, the authors explore a basic prescientific commitment--a naive materialistic belief--held by students as well as adults that can account for many of the naive conceptions reported in the literature. An examination of students' explanation of light, heat, electrical circuits, energy, and force suggests that they conceive of these entities in terms of the properties and behavior of real material. Thus, it is proposed that a basic materialistic conception may underlie students' beliefs and understanding of various physics concepts. [Topics: 2, 5b, 6] 1988-041

Resnick, D. P., & Resnick, L. B. (1985). Standards, curriculum, and performance: A historical and comparative perspective. *Educational Researcher*, *14*(4), 5-20.

This article considers how educational standards are established and maintained and how they can be improved in American schools. The authors argue that curriculum (what is taught) and assessment (the way we judge what is learned) together play the largest role in shaping what is demanded in schools and thus what our students can expect to learn. Neither issue has received adequate attention in current debate over the state of our schools and the compelling need for school reform. This article addresses both issues in a historical and comparative perspective, arguing that higher standards are within reach through the development of new and parallel initiatives in curriculum and evaluation. The authors outline potential improvements through upgrading the curriculum, utilizing new forms of assessment, and rethinking the concept of

tracking to focus on high standards in the middle school. [Topic: 3] 1985-038

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, D. P., & Resnick, L. B. (1989). Varieties of literacy. In A. E. Barnes & P. N. Stearns (Eds.), *Social history and issues in human consciousness: Some interdisciplinary connections* (pp. 171-196). New York: New York University Press.

This chapter stresses the need to consider literacy as a social rather than an individual experience and each literate act as a social act involving a transaction between a writer and reader, through the medium of a text. Understanding the meaning of literacy for its participants, therefore, necessitates analyzing both the nature of texts and the activities and expectations associated with the roles of reader and writer in different literacy transactions. The authors identify six paradigmatic transactions, suggest a framework for comparing and contrasting those relationships, and discuss implications for the current literacy debate and for educational policy. [Topics: 12, 14] 1989-052

Resnick, D. P., & Resnick, L. B. (1996). Performance assessment and the multiple functions of educational measurement. In R. Mitchell & M. Kane (Eds.), *Implementing performance assessment: Promises, problems, and challenges* (pp. 23-38). Mahwah, NJ: Erlbaum.

After exploring the differences between direct measures of desired learning outcomes and indirect indicators of performance, the authors describe under what conditions each should be used. Four purposes of educational assessment are considered: learning improvement, certification, accountability, and monitoring. The analysis concludes with a review of the social context and support that measures for each function require. [Topics: 3, 4] 1996-050

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). *Education and learning to think.* Washington, DC: National Academy Press.
This monograph explores the nature of higher order skills and the changing status of higher order thinking in educational theory and practice. The author examines the teachability of such skills and argues that the notion of basic skills should be modified, because learning to read, write, and do mathematics requires the activation of higher order thinking. She recommends that instruction incorporate this perspective and reflect the advances made in understanding the cognitive processes documented in recent research. The role of educational institutions in cultivating not only skills for thinking but also the disposition to think critically is discussed. [Topic: 1] 1987-053

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. (Ed.). (1989). *Knowing, learning, and instruction: Essays in honor of Robert Glaser.* Hillsdale, NJ: Erlbaum.

This volume brings together recent research by leading cognitive, developmental, and social psychologists on knowledge construction, the knowledge-dependent nature of learning, and emerging questions about situational and social influences on learning. The assembled chapters emerged from a symposium on cognition and instruction held in honor of the Learning Research and Development Center's twentieth anniversary and are presented as a festschrift for LRDC's founder, Robert Glaser. [Topic: 1] 1989-054

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. (1990). Literacy in school and out. *Daedalus, 119*(2), 169-185.

This article examines forms of literacy practice in school and in everyday life and concludes that schools are too isolated from everyday ways of using the written word to serve as the only source of literacy competence in society. To raise our general levels of literacy, it will be necessary to supplement formal literacy instruction by providing young people with literacy apprenticeships in communities, workplaces, and other settings where people use the written word for practical, informational, and pleasurable purposes. [Topics: 12, 14] 1990-060

Resnick, L. B. (1992). From protoquantities to operators: Building mathematical competence on a foundation of everyday knowledge. In G. Leinhardt, R. Putnam, & R. A. Hattrup (Eds.), *Analyses of arithmetic for mathematics teaching* (pp. 373-429). Hillsdale, NJ: Erlbaum.

Mathematical ideas based on additive composition are accessible to children and may be universally mastered, even by people with little or no schooling. But many children have great difficulty learning school mathematics. This chapter lays out the nature of informal, everyday mathematics knowledge and considers two hypotheses that may underlie persistent difficulty in learning school mathematics. The author develops a theory of the differences between everyday and formal mathematics, showing how the former differs from but can develop into the latter. Finally she suggests what this analysis means for elementary mathematics instruction. [Topic: 5a] 1992-057

Resnick, L. B. (1992-93). Standards, assessment, and educational quality. *Stanford Law and Policy Review, Winter,* 53-59.

American students need to learn skills in new ways and at much higher standards than ever before. Consequently, teachers will need to teach in new ways and with different expectations for their students than many have held previously. Real educational improvement requires interlocked and coherent changes in various components of the education system. Performance standards, represented in assessments, are a powerful means of beginning the process of systemic educational change. Alternative approaches to setting education standards and assessing student achievement are being developed to create a system of assessments that can be benchmarked to a shared set of national standards and tailored to local school environments. Such standards can provide tangible personal goals for students and teachers, as well as professional development opportunities for teachers who participate in their design and implementation. [Topics: 3, 4] 1993-041

Resnick, L. B. (1994). Performance puzzles. *American Journal of Education, 102,* 511-526.

This article explores issues involved in using assessments as a means of defining standards and in encouraging efforts to meet them. The author

compares and contrasts our current standardized tests with performance assessment as it is developing in the U.S. She also considers issues related to defining learning domains in ways that do not encourage training that is narrowly focused on specific assessment items. [Topics: 3, 4] 1994-058

Resnick, L. B. (1994). Situated rationalism: Biological and social preparation for learning. In L. A. Hirschfeld & S. A. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 474-493). Cambridge: Cambridge University Press.

This chapter examines the relations between two lines of thinking among psychologists and social scientists that appear to be contradictory. One line, called conceptual rationalism, seeks biological foundations for specific concepts that are central in human development. The second, known as situated cognition, argues that knowledge is acquired in and attuned to specific social and historical situations and that conceptual development can be understood only in terms of the situational contexts of action. The author contends that the two views, which share important epistemological assumptions, can be combined to provide a theory of cognitive development and functioning. Resnick develops a view of learning and development called situated rationalism, illustrates it with examples from mathematics and science learning, and considers its implications for education. [Topics: 1, 2, 10] 1994-059

Resnick, L. B. (1995). From aptitude to effort: A new foundation for our schools. *Daedalus, 124*, 55-62.

A changing U.S. economy demands that educators raise overall achievement levels and make opportunities for achievement more equitable. The author argues that all students must learn the high-level, embedded, symbolic thinking skills that our society now requires and that we must move from an aptitude-oriented education system to one designed primarily to foster effort. She considers five features and the implications of such a system. [Topics: 3, 4, 14] 1995-045

Resnick, L. B. (1995). Inventing arithmetic: Making children's intuition work in school. In C. A. Nelson (Ed.), *Basic and applied perspectives on learning, cognition, and development* (pp. 75-101). Mahwah, NJ: Erlbaum.

When young children enter school, they know a great deal about quantities and their relations. The organization of that knowledge seems to be consistent with the formal structures of mathematics. Why, then, do many children have difficulty learning math in school? In answering this question, the author raises some fundamental questions about the nature of knowledge and cognitive competence, the relations between cognition and social processes, and the role of chooling in adaptive sociocognitive development. [Topics: 1, 2, 5a] 1995-046

Resnick, L. B. (1995). Making high school count. In M. Higginbotham (Ed.), *What governors need to know about education reform* (pp. 85-89). Washington, DC: National Governors' Association.This essay was part of a report intended to provide U.S. governors with diverse perspectives and insights into education reform issues. Raising questions about the current meaning of the high school diploma, Resnick asserts that it has little meaning today and that educators by themselves cannot make it count. She describes four steps (standards, certificates, deregulation, and professional development) that can make the diploma meaningful and provides questions to evaluate how far a state has gone in setting standards that work. [Topics: 3, 4] 1995-047

Resnick, L. B. (1996). Situated learning. In E. De Corte & F. E. Weinert (Eds.), *International encyclopedia of developmental and instructional psychology* (pp. 341-347). Oxford: Elsevier. The human sciences can be characterized as a working out of the tensions between the biological and the social and between the particular and the general. The author examines the relations between two lines of thinking that appear to be contradictory-- conceptual rationalism and situated cognition-- and argues that these views share important epistemological assumptions and can be combined to provide a theory of cognitive development and functioning. This view, called situated rationalism, is elaborated with illustrations from mathematics and science learning, and its implications for education are considered. [Topics: 6, 14, 16] 1996-051

Resnick, L. B. (1996). Situated rationalism: The biological and cultural foundations for learning. *Prospects, 26*(1), 37-53. Also published in French as Le rationalisme situe: Les fondements biologiques et culturels de l'apprentissage. *Perspectives, 26*, 39-58; and in Spanish as El racionalismo situado: Los fundamentos biologicos y culturales del aprendizaje. *Perspectivas, 26,* 39-57.

The human sciences can be characterized as a working out of the tensions between the biological and the social and between the particular and the general. The author examines the relations between two lines of thinking that appear to be contradictory--conceptual rationalism and situated cognition--and argues that these views share important epistemological assumptions and can be combined to provide a theory of cognitive development and functioning. This view, called situated rationalism, is elaborated with illustrations from mathematics and science learning, and its implications for education are considered. [Topics: 6, 14, 16] 1996-052

Resnick, L. B. (1997). Getting to work: Thoughts on the function and form of the school-to-work transition. In A. Lesgold, M. J. Feuer, & A. M. Black (Eds.), *Transitions in work and learning: Implications for assessment* (pp. 249-263). Washington, DC: National Academy Press.

The author discusses three functions of a school-to-work system: selection, preparation, and repair of the nation's broad social fabric. She then

considers the institutional arrangements and technical resources needed for each and how to design a system meeting those needs. [Topics: 3, 4, 18] 1997-045

Resnick, L. B. (1997). Research and public policy activism: What relationship? "The vision thing": Educational research and AERA in the 21st century. Part 2: Competing visions for enhancing the impact of educational research [Presidents' Essay Series]. *Educational Researcher, 26*(5), 12-27.

This article is one of a series of brief essays by former presidents of the American Educational Research Association about the future of the association and of educational research generally. Resnick discusses whether or not AERA can and/or should play an activist role in shaping public policy. [Topic: 4] 1997-046

Resnick, L. B. (1997). Student performance portfolios. In H. J. Walberg & G. D. Haertel (Eds.), *Psychology and educational practice* (pp. 158-1175). Berkeley, CA: McCutchan.

This chapter explores issues involved in using assessments as a means of defining standards and in encouraging efforts to meet them. The author compares and contrasts our current standardized tests with performance assessment as it is developing in the United States. She also considers issues related to defining learning domains in ways that do not encourage training that is narrowly focused on specific assessment items. [Topics: 3, 4] 1997-047

Resnick, L. B., Bill, V., & Lesgold, S. (1992). Developing thinking abilities in arithmetic class. In A. Demetriou, M. Shayer, & A. Efklides (Eds.), *Neo-Piagetian theories of cognitive development: Implications and applications for education* (pp. 210-230). London: Routledge.

Cultivating cognitive abilities in the context of the regular school program will require substantial revision of basic subject-matter instruction. This chapter discusses a project that has revised the primary grades arithmetic program in order (a) to link formal instruction to children's intuitive knowledge of counting and protoquantitative relations and (b) to shape a general disposition to engage in mathematical thinking and reasoning. Early results showed dramatically improved math scores. This interpretation- and discussion-oriented mathematics program proved suitable even for children who were not socially favored or, at the outset, educationally able. [Topics: 1, 5a] 1992-058

Resnick, L. B., Bill, V., Lesgold, S., & Leer, M. (1991). Thinking in arithmetic class. In B. Means, C. Chelemer, & M. S. Knapp (Eds.), *Teaching advanced skills to at-risk students: Views from research and practice* (pp. 27-53). San Francisco: Jossey-Bass.

This chapter describes results of a two-year effort to apply the following assumptions to early mathematics teaching for disadvantaged children: that all children can begin their educational lives engaging in active thinking and problem solving; that, when thinking-oriented instruction is carefully organized for this purpose, children can

acquire the traditional basic skills in the process; and that children can acquire and apply the fundamentals of a discipline and believe in their own capacities as learners and thinkers. Based on achievement test data, interviews, class observations, and school reports, the program appeared effective for children of all ability levels. [Topic: 5a] 1991-055

Resnick, L. B., Briars, D., & Lesgold, S. (1992). Certifying accomplishments in mathematics: The New Standards examination system. In I. Wirszup & R. Streit (Eds.), *Proceedings of the University of Chicago School Mathematics Project International Conference on Mathematics Education Vol. 3 Developments in school mathematics education around the world* (Vol. 3, pp. 186-207). Reston, VA: National Council of Teachers of Mathematics.

The current shift in curriculum emphasis from basic skills to a focus on complex forms of thinking and problem solving is stimulating a similar shift in examination practice. Through the New Standards Project, a partnership of states and school districts led by LRDC and the National Center on Education and the Economy, testing and assessment could become tools in this educational reform movement. This article describes the New Standards Project and ongoing efforts to develop new forms of assessment and a different system for using assessment information. Specific examples of New Standards mathematics assessment problems and students' responses are provided. [Topics: 3, 4, 5a] 1992-059

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., & 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., & Collins, A. (1994). Cognition and learning. In T. Husen & T. N. Postlethwaite (Eds.), *International encyclopedia of education* (2nd ed.) (Vol. 2, pp. 835-838). Oxford: Pergamon.
What does it mean to know something? How do we use what we know? How do we learn it? Answers to these questions—central to a broadly-defined field of cognitive research—will deeply influence choices about what is taught, how classrooms and other environments for learning are organized, and what is expected for educational institutions. This essay examines the implications of three major themes in cognitive theory: constructivism; recent conceptions of learning and cognitive change; and distributed cognition. [Topics: 1, 2, 6] 1994-060

Resnick, L. B., & Hall, M. W. (1998). Learning organizations for sustainable education reform. *Daedalus, 127,* 89-118.
Today, there is an urgent need for the public education system to reflect a new core theory of learning and aptitude. The new core proposed here combines knowledge-based constructivism a position that moderates the century-long polarity between passive drill pedagogies and child-centered discovery pedagogies with effort-based learning that allows all students to reach high standards of achievement. Organizing the public education system to reflect the new core will require significant changes in classroom practice, and implementing those changes will require equally significant changes in the ways schools and districts function. By building learning organizations around this new core, we are working toward education reform that is both radical and sustainable. [Topics: 4, 16] 1998-039

Resnick, L. B., & Harwell, M. (1998, March). *High Performance Learning Communities: District #2 achievement* [A report to the Office of Educational Research and Improvement]. Pittsburgh, PA: University of Pittsburgh, Learning Research and Development Center. [Topic: 4] 1998-040

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., & Klopfer, L. E. (Eds.). (1989). *Toward the thinking curriculum: Current cognitive research (1989 Yearbook of the Association for Supervision and Curriculum Development).* Alexandria, VA/Hillsdale, NJ: Association for Supervision and Curriculum Development/Erlbaum.
Designed as the 1989 yearbook of the Association for Supervision and Curriculum Development (ASCD), this monograph assembles the ideas and recent research findings of 15 researchers and educators aimed at improving school curricula. It lays the groundwork for an approach to curriculum and teaching that is based on recent conceptions of the nature of thinking and has been validated by cognitive research. Thinking and learning are treated not as separate parts of the instructional process but as activities that must be integrated throughout the entire curriculum. [Topic: 1] 1989-055

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., Levine, J. M., & Teasley, S. D. (Eds.). (1991). *Perspectives on socially shared cognition.* Washington, DC: American Psychological Association.
In most psychological research, social and cognitive processes have been studied separately. Aiming to integrate these processes, this book looks beyond psychology to related disciplines that have traditionally taken a less individualistic view of human behavior. The result is a survey of recent work from several disciplines that seeks to merge the social and cognitive perspectives. [Topic: 14] 1991-056

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., & Nelson-Le Gall, S. (1997). Socializing intelligence. In L. Smith, J. Dockrell, & P. Tomlinson (Eds.), *Piaget, Vygotsky and beyond* (pp. 145-158). London: Routledge.
This chapter, prepared for a conference celebrating the births of Piaget and Vygotsky, explores a conception of intelligence founded partly on Vygotsky's cultural and developmental theories, which find full expression only when joined with Piaget's constructivist lines of epistemological theory. The authors, arguing for a view of intelligence as social practice, examine what intelligence is, who has it, and the role of social institutions in developing and sustaining it. [Topics: 6, 14] 1997-048

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

Resnick, L. B., & Nolan, K. (1995). Where in the world are world-class standards? *Educational Leadership*, *52*(6), 6-10.
The authors report some findings of their research on education standards in other countries, featuring work from France, Germany, Japan, Sweden, and the Netherlands. They use this research to argue that setting clear, consistent, demanding, public standards helps students perform well. Evidence from around the world indicates that exams calling for complex, demanding tasks can be given to a wide range of students, perhaps even to all students. [Topics: 3, 16] 1995-048

Resnick, L. B., & Nolan, K. L. (1995). Standards for education. In D. Ravitch (Ed.), *Debating the future of American education: Do we need national standards and assessments?* (pp. 94-119). Washington, DC: The Brookings Institution.
The New Standards Project focuses the standards movement by defining functional standards. These standards require content statements, performance descriptions, good enough criteria, and benchmark examples of student work with commentary. Because they are desired goals rather than bureaucratic impositions, functional standards help educators and students to raise performance. New Standards is developing functional standards for language arts, mathematics, science, and applied learning. Teachers inform and learn from the process by administering and scoring reference exams and analyzing portfolios. Students produce benchmark performances by building portfolios using New Standards handbooks. The success of this work indicates that concrete models of functional standards can improve learning for all. [Topics: 3, 4] 1995-049

Resnick, L. B., Nolan, K. J., & Resnick, D. P. (1995). Benchmarking education standards. *Educational Evaluation and Policy Analysis*, *17*(4), 438-461.
Recently, standards have become the currency of education reform efforts in the U.S. The reform community requires clear descriptions of world-class content and performance standards. But there is no international consensus on what constitutes world-class education. The New Standards Project has designed research to describe standards in other countries by using the case-study approach of ethnography to collect data (e.g., curricula, texts, exams, student work, and professional views). The review/analysis of the data is organized by a set of fundamental questions, the answers to which constitute a contextualized account of what students are expected to know and be able to do. [Topics: 3, 4] 1995-074

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., & Resnick, D. P. (1990). Tests as standards of achievement in schools. In G. R.

Anrig (Ed.), *The uses of standardized tests in American education: Proceedings of the 1989 ETS Invitational Conference* (pp. 63-80). Princeton, NJ: Educational Testing Service.

In this paper, the authors explore the significant links between educational reform and testing in America. They analyze the nature of current educational reform goals and their implications, the assumptions about the nature of knowledge and competence that are built into standardized tests, and the ways in which assessments function as elements in social systems. The authors propose alternative forms of assessment more compatible with educational goals of thinking and reasoning and suggest how these methods can be used in public accountability, instructional guidance, and certification testing. [Topic: 3] 1990-061

Resnick, L. B., & Resnick, D. P. (1991). Assessing the thinking curriculum: New tools for educational reform. In B. R. Gifford & M. C. O'Connor (Eds.), *Changing assessments: Alternative views of aptitude, achievement, and instruction* (pp. 37-75). Boston: Kluwer.

In this chapter, the authors explore the significant links between educational reform and testing in America. They analyze the nature of current educational reform goals and their implications, the assumptions about the nature of knowledge and competence that are built into standardized tests, and the ways in which assessments function as elements in social systems. The authors propose alternative forms of assessment more compatible with educational goals of thinking and reasoning and suggest how these methods can be used in public accountability, instructional guidance, and certification testing. [Topic: 3] 1991-054

Resnick, L. B., Saljo, R., Pontecorvo, C., & Burge, B. (1997). *Discourse, tools, and reasoning: Situated cognition and technologically supported environments*. Berlin: Springer-Verlag.

The concept of situated cognition may represent a fundamental challenge to traditional views of psychology, cognitive science, and educational research. For example, psychologists and cognitive scientists typically assume that performance in the special conditions of the laboratory is a valid way of discovering peoples' general cognitive competencies, just as educators believe that the special environment of school can produce general abilities applicable in a variety of non-school situations. An alternative view is that each situation calls for and shapes cognitive processes of specific kinds and that the science of cognition requires studying cognitive processes in the many specific environments in which people think, reason, and act. This view unites the diverse interdisciplinary group of scholars whose work is published here. [Topics: 6, 7, 14] 1997-049

Resnick, L. B., Salmon, M. H., & Zeitz, C. M. (1991). The structure of reasoning in conversation. *Proceedings of the Thirteenth Annual Conference of the Cognitive Science Society* (pp. 388-393). Hillsdale, NJ: Erlbaum.

This methodologically oriented article focuses on the reasoning that occurs in discussions of controversial social issues by groups of peers in informal settings. In the project reported here, rather sophisticated argument structures emerged and conversational interaction stimulated the development of arguments. Both a system for coding elements of reasoning and a method for displaying the interactive structure of reasoning in conversations were developed. With these tools, further analysis can help expose how people reason cooperatively in social settings. [Topic: 6] 1991-057

Resnick, L. B., Salmon, M., Zeitz, C. M., Wathen, S. H., & Holowchak, M. (1993). Reasoning in conversation. *Cognition and Instruction, 11*, 347-364.

To achieve the reasoning and thinking curriculum of the future, we must first understand reasoning as a competence that is central to everyday, workplace, and academic functioning. This article focuses on the shared reasoning that occurs in discussions of controversial social issues by groups of peers in informal settings. Rather sophisticated argument structures emerged, and conversational interaction stimulated the development of arguments. A system for coding elements of reasoning and a method for displaying the interactive structure of reasoning in conversation were developed. These tools will help in further analyzing how people reason cooperatively in social settings. [Topics: 6, 8, 12] 1993-075

Resnick, L. B., & Singer, J. A. (1993). Protoquantitative origins of ratio reasoning. In T. P. Carpenter, E. Fennema, & T. A. Romberg (Eds.), *Rational numbers: An integration of research* (pp. 107-130). Hillsdale, NJ: Erlbaum.

This chapter lays the groundwork for a theory of the intuitive origins of proportion and ratio reasoning. The authors argue that children have a set of protoquantitative schemas that allow them to reason about ratio- and proportion-like relations without using numbers. Two such schemas form the basis of their protoquantitative knowledge: a fittingness schema (the idea that two things go together based on an external dimension) and a covariation schema (the idea that two size-ordered series covary, either directly or inversely). In elementary school, children also learn—separately—about properties of numbers, including their factorial structure. Central to the authors' theory is the proposal that these two types of knowledge—factorial number sense and protoquantitative schemas about physical material in the world—must eventually merge to give children a means to model quantitatively situations requiring the use of ratios and proportions. [Topics: 1, 2, 5a] 1993-042

Resnick, L. B., & Wirt, J. G. (1996). Introduction and overview. *Linking school and work: Roles for standards and assessment*. San Francisco: Jossey-Bass.

For most of this century, we have been able to absorb most young people without a college education into stable jobs with reasonable earnings. But conditions have changed. Young people now coming out of high school or community college are being offered low-skill, low-wage jobs. We are faced with a dual problem: to help young people find their way into whatever jobs the market offers and to prepare both young people and the economy at large for a new high-performance future. The chapters that follow suggest ways of reaching those goals, including developing new standards-based credentialing programs. [Topics: 3, 4, 14] 1996-053

Resnick, L. B., & Wirt, J. G. (Eds.). (1996). *Linking school and work: Roles for standards and assessment.* San Francisco: Jossey-Bass.
Some school reform leaders believe that a key strategy for improving the effectiveness of schools is to set clear standards for what students should be able to do based on the skills required for well-paying careers. They argue that current teaching approaches are ill-suited to furthering these goals. Stressing that new forms of assessment can evaluate student performance in authentic situations and help foster needed changes in teaching, the authors in this volume address the major issues and challenges we face in realizing a national system of performance standards and assessments for education. This book grew out of the work of the SCANS Commission. [Topics: 3, 4, 14] 1996-054

Schwarz, B. B., Kohn, A. S., & Resnick, L. B. (1992). Bootstrapping mental constructions: A learning system about negative numbers. In C. Frasson, G. Gauthier, & G. I. McCalla (Eds.), *Intelligent tutoring systems* (pp. 286-293). Montreal: Springer-Verlag.
This chapter proposes a new model for learning mathematical concepts that cannot develop informally. In this middle-out approach, the objects of the system can be mapped to both formal knowledge and real-life problems. The authors propose that reasoning with mental models is the key process governing the acquisition of knowledge within such learning systems and that it is similar to the acquisition of basic mathematical constructs in nonschool settings. They report on the development of a system for learning negative numbers and on a study that exposed two pairs of students to that system. [Topics: 5a, 6, 10] 1992-084

Schwarz, B. B., Kohn, A. S., & Resnick, L. B. (1993). Positives about negatives: A case study of an intermediate model for signed numbers. *Journal of the Learning Sciences, 3*(1), 37-92.
Although young children and unschooled adults acquire some mathematical knowledge through everyday experience, that knowledge appears to be limited to positive numbers that can be mapped directly to physical material. The authors analyze the concept of negative numbers and present findings from a study using a computerized environment as a model for the acquisition of negative numbers. The results support the use of certain environments for the acquisition of higher level mathematical concepts that cannot be learned informally. [Topics: 1, 5a, 10] 1993-076

Schwarz, B. B., Nathan, M. J., & Resnick, L. B. (1996). Acquisition of meaning for arithmetic structures with the Planner. In S. Vosniadou, E. De Corte, R. Glaser, & H. Mandl (Eds.), *International perspectives on the design of technology-supported learning environments* (pp. 61-80). Mahwah, NJ: Erlbaum.
Understanding arithmetic means understanding the theory, activities, and language of arithmetic. The authors propose that the primary function of an illustration in teaching arithmetic is to help the younger learner understand the language of mathematics by providing referential semantics. The Planner, a hypothetical world that contains recognizable but fictional entities that behave according to well-structured rules, was built to provide a language for arithmetic, on the assumption that children properly trained to use the objects of the Planner to model and solve word problems would construct effective mental representations for word problems. Although this experiment was almost devoid of instruction, the students solved difficult word problems about negative numbers and remembered the structure of those problems. The system captured learners' informal knowledge about the physical world without real-world constraints. [Topics: 5a, 7, 10] 1996-060

Simmons, W., & Resnick, L. B. (1993). Assessment as the catalyst of school reform. *Educational Leadership, 50*(5), 11-15.
American schools have a curriculum and a conception of learning and knowing that are inadequate for the 1990s and beyond. The goal of the New Standards Project is to build a revitalized education system using assessment as a tool for transforming instruction and learning. To do this, we need to establish world-class content and performance standards, a performance-based examination system that embodies those standards, and rubrics and procedures for scoring students' work reliably and fairly. We must also create a professional development system that will transform the way educators view teaching, learning, and assessment. These efforts are based on a strong commitment to provide every learner with the support he or she needs to have a fair opportunity to meet the standards. [Topics: 3, 4] 1993-055

Singer, J., Kohn, A., & Resnick, L. B. (1997). Knowing about proportions in different contexts. In P. Bryant & T. Nunes (Eds.), *Learning and teaching mathematics: An international perspective* (pp. 115-132). Hove, England: Psychology Press.
This chapter proposes that children's knowledge of proportions is composed of three distinct components. At the direct level, children have an immediate, non-analyzed understanding of proportions via a perceptual or analogous process. At the covariational level, children know

something about variables and how they may covary, either directly or inversely. At the formal level, children know how to manipulate numbers and variables to describe proportional relationships between entities. This conception of proportional knowledge helps explain why children sometimes behave appropriately in proportional reasoning tasks and sometimes do not; that is, different tasks tap different kinds of knowledge. [Topics: 2, 5a, 10] 1997-066

Singer, J. A., & Resnick, L. B. (1992). Representations of proportional relationships: Are children part-part or part-whole reasoners? *Educational Studies in Mathematics, 23,* 231-246.

This article describes an intensive study undertaken to determine children's representational strategies for relational numbers (e.g., proportions, ratios, fractions). Relational numbers have three quantities associated with them: a whole and two parts. Given these three quantities, children can form a representation based on a part-whole relationship or on a part-part relationship. Children in Grades 6 through 8 solved probability problems that varied information content and quantitative relationships among the quantities expressed in the problems. Quantitative and qualitative analyses revealed that children preferred a part-part representation to solve problems with relational quantities. [Topics: 2, 5a, 10] 1992-067