Carol Lynne Smith
Professor, Department of Psychology

Professional Preparation and Previous Appointments

B.A. (Summa Cum Laude), Psychology, Brown University, 1970.
Ph.D. Personality & Developmental Studies, Harvard University, 1976.
Postdoctoral Fellow, Department of Psychology, MIT., 1976-77.
Research Associate, Department of Psychology, MIT., 1977-78.
Lecturer, Department of Psychology, Psychology, University of Massachusetts at Boston, 1978-1980.
Assistant Professor, Department of Psychology, University of Massachusetts at Boston, 1980-1986.
Associate Professor, Department of Psychology, University of Massachusetts at Boston, 1986-2008
Professor, Department of Psychology, University of Massachusetts at Boston 2008--

Biographical sketch

I joined the Critical and Creative Thinking Program in 1980, when I was hired as an assistant professor in Psychology who would participate in the CCT program. Over the years, I have taught several courses in CCT: Advanced Cognitive Psychology (Psych 650) a required course in the CCT Program; Children and Science course (CCT 652) a specialty course in the science track of CCT, and the Seminar on Scientific thinking (another specialty course in the science track of CCT co-taught in the past with Prof. Arthur Millman in the Philosophy Department.)

My research focuses on characterizing student intuitive theories (in particular, student matter theories and epistemologies of science) and understanding the dynamics of conceptual change both in children and adults. My research with children has examined the role of models, analogies, and metaconceptual understanding in facilitating the process of conceptual change within schooling contexts as well as the general impact of schooling on metacognitive development. I have also collaborated with Arthur Millman in the Philosophy Department in doing a case study of the reasoning processes used by Darwin in the development of his theory of natural selection, based on an analysis of his scientific notebooks.

Most recently, I have worked on several teams (sponsored by the National Research Council of the National Academy of Science) that are developing and exploring the idea of organizing K-12 science standards, instruction and assessments around *long-term learning progressions* in particular domains—most specifically a long-term learning progression for understanding matter and the atomic molecular theory. I view learning progressions as hypotheses about how knowledge can evolve, given key instructional experiences, from the initial ideas students have in preschool (lower anchor) to the ideas of modern science that are the target of instruction (upper anchor). These hypotheses are constrained by prior cognitive developmental research on children's initial conceptions and our understanding of processes of conceptual change; they are also actively tested through long- term teaching studies, such as the one I am currently working on with researchers and developers from TERC who are working with students in grade 3-5. I also served on the NRC's Committee on Science Learning, K-8, which authored *Taking Science to School*—a book synthesizing current developmental, learning, and instructional research that informs K-8 science education. A central argument of that book is that enhancing students' understanding of science involves weaving together four "strands" of development: developing students' knowledge, use, and interpretation of scientific explanations, developing students' abilities to generate and evaluate scientific evidence and explanations, developing students' understanding of the nature of scientific knowledge and how it develops, and developing students' ability to participate productively in scientific practices and discourse. Further, promoting these developments requires careful attention to critical and creative thinking, reflection, and student, voice, motivation and identity.

In my work with CCT and M.Ed. students, I have taught them how to devise and analyze clinical interviews in order to assess student thinking and conceptual understanding. I have also worked with

them in creating curriculum interventions that would enhance both students' domain specific knowledge and their metacognitive understandings of how knowledge is created and justified in science.

Teaching and Advising

Courses for CCT and GCOE: Graduate
Advanced Cognitive Psychology (CCT 651L and Psych 550L)
Children and Science (CCT 652)
Synthesis (CCT 694)
Understanding Science and Mathematics Seminar (EDC 697 E) (once every year 1996-1999)

Recent courses in Psychology: Undergraduate
Introduction to Psychology (Psych 101)
Infancy and Child Development (Psych 341)
Cognitive Development (Psych 447)
Cognitive Psychology (Psych 450)

Advisees in CCT:
Completed Masters in CCT, as major advisor for:
Judy Donovan
Barbara Waters
Terry Caffelle
Lauren Foley
Shari Sprong
Rache Yoffe
Linda Cromwell Clark
Halima Madden
David Zwicker
Karen Cavanaugh
Bob Blackler
Pin Yu Chen
Jenne Todd
Matt Jans
Kit Irwin
Julie Barrett
Kristin Capezio
Marie Levy-Pabst
Diana Truong

Also reader on 21 CCT Masters or Syntheses

Other Mentoring**:**
Directed 4 undergraduate Honors projects; co-directed the dissertation work of 3 Ed.D students at Harvard Graduate School of Education. Reader for 4 Psychology Masters and 3 Psychology Ph.D.(Clinical Program), 3 Biology Masters and 1 Biology Ph.D. (Science Education)

Service
CCT Program
Member, Administrative Committee, 1994-present
Co-chair of Personnel Committee, 1994-1995, 1995-96
Member, Admissions Committee, 2006-2007

Member, Search Committee for CCT Program, 1996-97, 97-98

Other GCOE:
Member Science Education Faculty Search Committee (2010-2011)
Member, Tenure and Promotion Committee for Robin Codding (Fall 2009)
TEAMS/BC Grant, 1994-1995, 1995-1996, 1996-1997
Member, Campus Coordinating Council for Teacher Education Committee, 1994-1995
Member, Review committee on Undergraduate Teacher Preparation Program, 1995-96
Member of GCOE Faculty Search Committee, 1996-97

Psychology Department (selected recent)
Associate Chair, 2009—
Executive Committee, 2009-
Personnel, 1994-2008 (Chair, 1994-1999, 2000-2001; 2003-2004; 2006-2007)
Curriculum, 1995-1997, 2006-2007, 2009- (Chair, Fall 1995-Spring 1996)
Chair, Periodic Multi-year Review Committee, spring 2009
Chair 4th year Review Committee for Zsuzsa Kaldy, 2006-2007
Chair, 4th year Review Committee for Karla Klein Murdock, 2000-2001
Member, Tenure & Promotions Committee (for all cases between 1994-present)
Developmental Search Committee, 2001; 2002 (Chair 2002)
Member, Human Subjects Committee, 1994-1995, 1995-1996
Member, Biopsych Content Committee, 1998-99
Chair, Foundational Skills Committee, 1998-99

Related University Service (selected, recent)
Member Collegiate Personnel Committee (2010-2011)
Member Dean's Search Committee for CLA Majors Advisor (2009-2010)
Member 4th year review committee for Hispanci Studies (2009-2010)
Member, Developmental Sciences Workgroup, 2007-2008
Periodic Multi-Year Review Committee Hispanic Studies (Member, of 1 review, chair of other)
Member, 4th year Review Committee Hispanic Studies (2 cases)
Member, Collegiate Personnel Committee, 1997-98
Member, Science Education Discussion Group, 1995-96, 1996-97
Member, Science Teaching Workshop Committee, 1997-98
Member, Library Committee, 2002

Service to Profession (selected recent)
Reviewed the new National Research Council Science Frameworks in July 2010 (read draft document of over 200 pages and submitted detailed comments on framework in July 2010)
Reviewer for many journals (e.g., *Cognition and Instruction*, *Topics in Cognitive Science, Early Childhood Research Quarterly, Journal of Applied Developmental Psychology, Journal of Research in Science Education*, *Science Education*) and grants (e.g., NSF)
Served on Advisory Boards for NSF Grants (e.g., Brian White, Varelas & Pappas, Goldberg & Hammer)
Member of Design team charged with writing a report for the National Research Council's Committee on K-12 Test Design for Science Achievement. The report synthesized research to propose a learning progression for matter and the atomic-molecular theory and discussed ways this research could be used to elaborate on science standards and guide the development of relevant large-scale assessment items. Completed both Interim and Final Report (Fall 2003-August 2004)
Member of the Committee on Science Learning, K-8, sponsored by The National Academies and charged with writing a book summarizing current research on science teaching and learning, grades K-8. (September 2004-June 2006) This led to the publication of a book.

Community:

Workshops for teachers (Sharon Public Schools, Fulcrum Institute, TERC) on children's ideas in science, Developed activities for Tiffany Cunningham's Summer Science Camp for elementary school children (held at UMB, July 1998), advised on curriculum development issues Wellesley public schools; Gave presentations to Dorchester High School Students on early social and moral development; Served on panel for the Mass State Department of Education to advise on performance tests for elementary and middle school studies; member of Cambridge Partnership (organization of researchers and Cambridge schools to consider ways to improve science education); as part of TEAMS grant served on Elementary Science Working Group (collaborative with Wheelock, UMB, and the Russell School in Boston and the Graham and Parks School in Cambridge)

Grants, Fellowships & Awards (selected)

Co-Investigator on 3-1/2 year National Science Foundation Grant entitled "The Development of Scientific Thinking and Conceptions of Science in College Science Students" (Dr. Neil Stillings, Hampshire College, Principal Investigator, and Dr. Mary Anne Ramirez, Hampshire College, Co-Investigator), 2000—2004 (Award amount: $997,613 for 3 and 1/2 years)

Principal Investigator on 3-year McDonnell Foundation Grant entitled "Explanatory Model Construction: The Case of the Theory of Matter" , 1995-1998 (Award amount: $411, 668 for 3 years)

Principal Investigator on 3-1/2 year National Science Foundation Grant entitled "Using conceptual models to facilitate conceptual change: The case of a theory of matter.", 1991-1995. (Award amount: $656,768 for 3 and 1/2 years)

Publications (selected)

Wiser, M., Smith, C., & Doubler, S. (in press). Learning Progressions as tool for curriculum development: Lessons from the Inquiry Project. In A. Alonzo & A. Gotwals (Eds.), Learning Progressions in Sciences. Sense Publishing.

Smith, C. (2009) Conceptual change. In E. Anderman (Ed.) Psychology of classroom learning: An encyclopedia. Detroit: MacMillan Reference.

Wiser, M. and Smith, C. (2008) Teaching about matter in grades K-8: When should the atomic-molecular theory be introduced? In S. Vosniadou (Ed.) International handbook of research on conceptual change. (pp.205-239). Mahwah, NJ.: Lawrence Erlbaum Associates, Inc.

Smith, C. (2007) Bootstrapping processes in the development of students' commonsense matter theories: Using analogical mappings, thought experiments, and learning to measure to promote conceptual restructuring. Cognition and Instruction, 25(4), 337-398.

National Research Council (2007) Taking Science to School: Learning and Teaching Science in Grades K-8. Washington, D.C.: The National Academies Press. (R. Duschl, H. Schweingruber, and A. Shouse were co-editors of the book; I was member of the NRC Committee that wrote the book.)

Smith, C., Wiser, M., Anderson, C., and Krajcik, J. (2006) (Focus Article of combined double issue of journal): Implications of Research on Children's Learning for Standards and Assessment: A Proposed Learning Progression for Matter and Atomic-Molecular Theory. Measurement, 14 (1&2), 1-98. (Focus Article in a combined double issue of journal, that included critical commentaries on our article.)

Smith, C. and Wenk, L. (2006) The Relation Among Three Aspects of College Freshmen's Epistemology of Science. Journal of Research in Science Teaching, 43 (8), 747-85.

Smith, C., Solomon, G., and Carey, S. (2005). Never getting to zero: Elementary school students' understanding of the infinite divisibility of matter and number. Cognitive Psychology 51, 101-140.

Snir, J., Smith, C., and Raz, G. (2003) Linking Phenomena with Competing Underlying Models: A Software Tool for Introducing Students to the Particulate Model of Matter. Science Education, 87, 794-830.

Smith, C. (2003). Conceptual change. In J. Guthrie (Ed.), Encyclopedia of Education, 2nd Edition. New York: MacMillan Reference.

Smith, C., Maclin, D., Houghton, C. and Hennessey, M.G. (2000) Sixth graders' epistemologies of science: The impact of school science experiences on epistemological development. Cognition and Instruction, 18(3), 349-422.

Millman, A. & Smith, C.L. (1997) Darwin's use of analogical reasoning in theory construction. Metaphor and Symbol, 12, 159-187.

Smith, C., Maclin, D., Grosslight, L. and Davis, H. (1997) Teaching for understanding: A comparison of two approaches to teaching students about matter and density. Cognition and Instruction, 15 (3), 317-393.

Smith, C. and Unger, C. (1997) What's in dots-per-box? Conceptual bootstrapping with stripped down visual analogs. Journal of the Learning Sciences, vol 6 (2), 143-181.

Snir, J. and Smith, C. (1995) Constructing understanding in the science classroom: Integrating laboratory experiments, student and computer models, and class discussion in learning scientific concepts. In D. Perkins, J. Schwartz, M. West, and S. Wiske (Eds.), Software Goes to School (pp. 233-254), Oxford: Oxford University Press.

Snir, J., Smith, C. L., & Grosslight, L. (1993). Conceptually enhanced simulations: A computer tool for science teaching. Journal of Science Education and Technology, 2 (2), 373-388. (Also reprinted as Chapter 7 in the book Software Goes to School, 1995, Oxford University Press, pp. 116-129.)

Carey, S. & Smith, C. (1993). On understanding the nature of scientific knowledge. Educational Psychologist. 28 (3), 235-251. (Also reprinted as Chapter 3 in the book Software Goes to School, 1995, Oxford University Press, pp. 39-55.)

Smith, C., Snir, J., & Grosslight, L. (1992) Using conceptual models to facilitate conceptual change: The case of weight/density differentiation. Cognition and Instruction, 9 (3), 221-83.

Grosslight, L., Unger, C., Jay, E. & Smith, C. (1991) Understanding models and their use in science: conceptions of middle and high school students and experts. Journal of Research in Science Teaching, 28, 9, 799-822.

Smith, C.L. & Millman, A. (1986). Understanding conceptual structures: A case study of Darwin's early thinking. In D. Perkins, J. Bishop, and J. Lochhead (Eds.) Thinking: Progress in Research & Teaching. Hillsdale, NJ: Lawrence Erlbaum Associates, 322-331.

Smith, C.L., Carey, S. & Wiser, M. (1985). On differentiation: A case study of the development of the concepts of size, weight, and density. Cognition, 21, 177-237.

Recent Commissioned Papers

Wiser, M. and Smith, C. (2009) How Does Cognitive Development Inform the Choice of Core Ideas in Physical Science? Paper Commissioned by the National Research Council for presentation and distribution at their Expert Meeting on Core Ideas in Science, Washington, D.C. August 17th; both the commissioned paper (manuscript 29 single spaced pages) and the Powerpoint presentation are currently posted on their Conference website.

Smith, C., Wiser, M., Anderson, A. Krajcik, J. and Coppola, B. (2004) Implications of Research on Children's Learning for Assessment: Matter and Atomic Molecular Theory (Final Report). (Paper was commissioned by the National Research Council's Committee on K-12 Test Design for Science Achievement; and presented and distributed at their August, 2004 meeting in Cape Cod. Mark Wilson, chair of the committee, has solicited the paper for publication in a journal that he edits.)

Teaching Materials and Educational Software

I have supervised the development of curriculum materials for over 5 different teaching studies. An early version of these materials were made available for distribution to teachers by the Educational Technology Center (Weight and Density Lesson Plans, September, 1988, printed by the Educational Technology Center, Harvard Graduate School of Education). In 1995, we completed a new version of prototype lesson plans for distribution to interested teachers (along with our prototype software), entitled Archimedes and Beyond (156 pages). In 1996, Deborah Maclin, Dr. Snir, and I developed an educational video entitled "Models of Matter".

Presentations since 1995 (selected)

Smith, C., Wiser, M., & Carraher, D. (2010) Using a comparative longitudinal study to test some assumptions about a learning progression for matter. Paper presented at NARST (National Association for Research in Science Teaching), March 24, 2010, Philadelphia, PA

Wiser, M. and Smith, C. (2009) How Does Cognitive Development Inform the Choice of Core Ideas in Physical Science? Paper Commissioned by the National Research Council for presentation and distribution at their Expert Meeting on Core Ideas in Science, Washington, D.C. August 17th; both the commissioned paper (manuscript 29 single spaced pages) and the Powerpoint presentation are currently posted on their Conference website.

Wiser, M. and Smith, C. (June, 2009) Learning Progressions: What are they? What are they for? Presentation to the Massachusetts Science and Technology/Review Panel (charged with redoing the state K-12 science standards over the next 2 years), at their June 11, 2009 meeting, Holiday Inn, Marlboro.

Wiser, M., Smith, C., and Doubler, S. (June 2009) Learning Progressions as Tools for Curriculum Development: Lessons from the Inquiry Project. Paper presented at a Plenary Session of the Learning Progressions in Science (LeaPS) Conference, June, 2009, Iowa City, IA; full paper distributed on the Conference CD (manuscript 26 single spaced pages.)

Carraher, D., Smith, C., Wiser, M., Schleiman, A. & Cayton-Hodges, G. (June 2009) Assessing Students Evolving Understandings of Matter. Paper presented at a Plenary Session of the Learning Progressions in Science (LeaPS) conference, June, 2009, Iowa City, IA; full paper distributed on the LeaPS Conference CD (manuscript 28 single spaced pages.)

Wiser, M., Smith, C., Asbell-Clarke, J. & Doubler, S. (2009) Developing and refining a learning progression for matter: The Inquiry Project grades 3-5. Paper written and presented at a symposium for a

Learning Progression for Matter, American Educational Research Association meeting, April 14, 2009, San Diego, CA.

Smith, C. (December, 2008) Developing and assessing a learning progression for matter in the elementary school years. Colloquium presented at the Graduate College of Education, Rutgers University, December 10, 2008, New Brunswick, NJ.

Smith, C. L. (June 24, 2008) Introduction to Research on Children's Ideas in Science. Presentation at Teacher Workshop, Dana Hall School, June 24, 2008.

Smith, C. L. (February, 2008) Bootstrapping processes and conceptual change. Presentation at TERC, Cambridge, MA. February 26, 2008.

Smith, C. (July 9, 2007) Introduction to research on children's ideas in science. Fulcrum Summer Institute for Teachers. Tufts University, Medford, MA

Smith, C. (June 27, 2007) Children's ideas About Matter, Inquiry Project Professional Development Conference for Teachers, TERC, Cambridge, MA.

Smith, C. L. (Dec. 5, 2006) Learning Progressions: State of the State. Presentation at the BOSE Meeting (Board on Science Education, National Research Council), December 5, 2006. (videoconference), Beckman Center, Irvine, California.

Smith, C. (Dec 7, 2006) Thoughts on Designing Learning Progressions for the Particulate Theory of Matter. Fulcrum Institute Talk (talk was videotaped for later dissemination), Tufts University, Medford MA.

Wenk, L. and Smith, C. (2004) The Impact of First-Year College Science Courses on Epistemological Thinking: A Comparative Study. Paper presented at the National Association for Research in Science Teaching, Vancouver, British Columbia, April 2, 2004.

Smith, C. and Wenk, L. (2003) The Relation Among Three Aspects of College Freshmen's Epistemology of Science. Paper presented at the National Association for Research in Science Teaching meeting, Philadelphia, PA, March 26, 2003.

Smith, C. and Solomon, G. (2003) Getting to Zero: Elementary school students' understanding of the infinite divisibility of number and matter. Paper presented at the Society for Research in Child Development meetings, Tampa, Florida, April 26, 2003.

Smith, C., Snir, J., and Raz, G. (April, 2002). Can middle schoolers understand the particulate theory of matter as an explanatory model? An exploratory study. Poster presented at a symposium on Epistemology and Learning at the American Education Research Association meetings, New Orleans, LA.

Smith, C. (April, 2001). Conceptual bootstrapping in childhood: Theories of Matter and Weight and Density Differentiation. Paper presented at Symposium on Conceptual Bootstrapping at the Society for Research in Child Development meetings, Minneapolis, MN.

Smith, C., Maclin, D., Houghton, C., & Hennessey, M.G. (1999). Can 6th Graders Develop a Coherent Constructivist Epistemology of Science? A Comparative Study. Paper presented at NARST, March 30, 1999.

Snir, J. and Smith, C. (1997) Designing software to teach students about the particulate model of matter. International Conference on Science, Mathematics & Technology Education, Hanoi, Vietnam, January 7, 1997.

Smith, C., Houghton, C. Maclin, D., and Hennessey, M.G. (1997) Understanding sixth graders' epistemologies of science: Teasing apart the effects of schooling and development. Paper presented at a symposium at the American Educational Research Association Meetings, Chicago, IL, March 28, 1997.

Smith,C. and Snir, J. (1997) Initial Case studies of explanatory model construction: Understanding the particulate theory of matter. Cognitive Studies and Educational Practice Conference, McDonnell Foundation, Seattle, WA, October 25, 1997.

Smith, C. (1996) Do middle school students have common-sense theories of matter? Poster Presented at the Jean Piaget Society Meetings, Philadelphia, PA., June 7, 1996.

Smith, C. (1996) Conceptual coherence in the elementary school years: Student epistemology and commonsense matter theories. Cognitive Studies and Educational Practice Conference, McDonnell Foundation, St. Louis, Mo., Nove. 9, 1996.

Smith, C., Hennessey, G., and Carey, S. (1995) A comparative study of 6th grade students' understanding of the notion of "interpretive framework". Cognitive Studies and Educational Practice Conference, McDonnell Foundation, Vanderbilt, Tennessee, Sept. 28, 1995.