NEARLY FIVE DECADES OF RESEARCH ON LEARNING AND INSTRUCTION

The mission of the Learning Research and Development Center (LRDC) at the University of Pittsburgh is to advance the science of learning by bringing together leading researchers in the cognitive, social, and educational sciences. This mission has guided LRDC in its programs of basic and applied research, its demonstration projects, and its direct support of school improvement and reform. In LRDC’s multidisciplinary setting, scientists study learning in its cognitive, neural, social, and organizational aspects, making research and development links to formal education practice, policy, and out-of-school settings.

Although the general mission of LRDC has remained constant, the center has pursued this mission by promoting research that evolves over time, informed by varied perspectives across multiple disciplines. LRDC’s research portfolio includes large programs of extended duration as well as single-investigator projects that are generally of smaller scope and shorter length.

LRDC research projects are organized around the following broad areas:

- **Cognitive Neuroscience**
- **Higher-Level Learning Processes**
- **Informal Learning**
- **Learning Policy**
- **Learning Technology**
- **Reading and Language**
- **Research to Reform School Practice**
- **Social and Motivational Factors in Learning**
COGNITIVE NEUROSCIENCE

LRDC has developed a strong research component in cognitive neuroscience in recognition of the importance of the neurosciences in the study of learning. LRDC researchers are active in the Center for the Neural Basis of Cognition, a partnership of the University of Pittsburgh and Carnegie Mellon University.

LRDC research ranges from basic studies of brain systems relevant to learning to studies that help to build the bridge from the study of the brain to educational problems. Walter Schneider's research includes studies of the neural networks that support cognitive control and skill acquisition. He recently initiated a new effort to develop methods for studying cortical connectivity and the changes that occur in functional areas within the human brain as knowledge is acquired. He is working with Christian Schunn and Natasha Tokowicz on how to monitor brain activity to identify effective learning states and accelerate learning. Julie Fiez has two major strands of work. One investigates the neural basis of verbal working memory in spelling and reading skill, while the other studies how basic learning systems in the brain help to shape language and mathematical cognition. Mark Wheeler uses brain imaging technology to study the interaction of perception, attention, memory, and decision making in the brain’s capacity to learn.

In addition to these core studies, LRDC faculty members apply cognitive neuroscience to a range of domains. In foreign language learning, researchers examine how the brain responds to words in learning a second language. In studies of reading, researchers use event-related potentials and functional magnetic resonance imaging to study reading comprehension, word reading, and how a learning system may help to shape eye movements. In the realm of math and science, faculty members are using cognitive neuroscience to understand higher-level reasoning processes.

By virtue of its strong support for collaborative research, LRDC has a history of brain studies that contribute to the advancement of education and training. The center is now poised to apply neuroimaging methods to studies of how the brain changes with learning.

Faculty
Julie Fiez
Charles Perfetti
Erik Reichle
Walter Schneider
Christian Schunn
Natasha Tokowicz
Mark Wheeler
HIGHER-LEVEL LEARNING PROCESSES

At LRDC, researchers have a rich tradition of study focused on understanding the cognitive processes underlying higher-level reasoning in complex tasks. Researchers conduct fundamental work in laboratories, work sites, and other environments and use these findings to inform research on the mechanisms underlying reasoning in classroom content, such as math and science.

Research in this area cuts across almost all thematic areas in the center. Mary Kay Stein’s work studying rich mathematical tasks and curricula has contributed much to the understanding of cognition in the classroom. Lauren Resnick’s work using an instructional concept called accountable talk examines reasoning in student discussions about classroom content. Christian Schunn studies the reasoning of scientists and engineers in situ and relates these studies to reform science curricula. Combining his background in law and computer science, Kevin Ashley studies legal reasoning to understand cognitive processing, which in turn informs his work on case-based reasoning.

Other research, past and present, has focused on physics learning, reasoning, and problem solving; the applications of computer technologies to student learning and reasoning; and learning in less well-structured social science (e.g., political science) and humanities (e.g., history) domains. Seminal work on the role of self-explanation in higher-level learning was conducted by former LRDC scientist Micki Chi.

Faculty
Kevin Ashley
Alan Lesgold
Timothy Nokes
Charles Perfetti
Lauren B. Resnick
Christian Schunn
Mary Kay Stein
INFORMAL LEARNING

Informal learning studies at LRDC examine what it means to learn and change as a result of experiences in everyday contexts. Much of the informal learning research at the University of Pittsburgh Center for Learning in Out-of-School Environments (UPCLOSE) is conducted beyond the center’s four walls—in museums, workplaces, community settings, on the Web, and at home.

Projects include Kevin Crowley’s work on community robotics, museum learning, and after-school clubs; Jennifer Lin Russell’s research on the implications of formal school policy on informal organizations; and Kim and Louis Gomez’s work on using technology and informal learning activity structures to build and sustain new learning cultures in schools. Other projects of note include Gaea Leinhardt’s Museum Learning Collaborative, which linked researchers and museums to create a community of scholars dedicated to a common research agenda. Related work includes Frits Pil’s research on organizational learning, adaptability, and change in a host of industries.

LRDC is actively working on professional development and policy issues in informal learning as well. The center developed and continues to host informalscience.org, the field’s primary Web site for collecting, sharing, and using research and evaluation work in informal science, and coleads the national Center for Advancement of Informal Science Education (CAISE). CAISE works to connect the informal science education community across the entire field, which includes film and broadcast media; science centers and museums; zoos, aquariums, and nature centers; digital media; and after-school programs, to name a few.

UPCLOSE is based on the tenet that new theories of learning are best developed, tested, and revised when they are embedded in the design of novel learning environments. LRDC provides an ideal environment for the interdisciplinary collaboration among researchers, designers, educators, content specialists, and the learners themselves, who are necessary for this work to be realized.

Faculty
Kevin Crowley
Kim Gomez
Louis Gomez
Gaea Leinhardt
Frits Pil
Jennifer Lin Russell
LEARNING POLICY

Established in 2007 as a joint venture between LRDC and Pitt’s School of Education, the Learning Policy Center (LPC) researches and advances ideas that lie at the intersection of policy and learning. LPC informs policymakers by conducting and disseminating its research on educational reform. It publishes regular policy briefs to keep policymakers apprised of learning research findings and works to influence policy decisions by actively engaging in policy work. The LPC Colloquium Series involves education stakeholders, including researchers, policymakers, and practitioners, in discussions of education reform challenges and solutions. LPC has established itself as a research center and as a conduit of knowledge about learning for education decision makers.

With Mary Kay Stein as its founding director, LPC is based on the belief that ambitious policies—such as standards-based reform—require professionals at all levels of the education sector to learn how to think and behave in new and complex ways. Stein’s research focuses on how teachers learn to implement new instructional programs, with particular attention to teachers’ use of curricular resources, access to expertise, and compliance with local and state policies. Thus, learning research and theory take a place at the table—alongside work in political science, organizational theory, and economics—as analytic tools for studying and informing education policy and its implementation.

In related research on learning organizations, the Evaluation for Learning (EFL) project, directed by William E. Bickel, works with local and national institutions on the design, evaluation, and strategic assessment of a wide variety of educational programs and reform efforts. A theme in the EFL work is using evaluative inquiry to support improved decision making by educational leaders, practitioners, and policy shapers. The work includes an examination of foundations in America as learning organizations and the role of evaluation in foundations to support organizational learning.

Faculty
William E. Bickel
Richard Correnti
Lauren B. Resnick
Jennifer Lin Russell
Mary Kay Stein
LEARNING TECHNOLOGY

Technology in the service of learning and teaching has been a continuous theme at LRDC. The focus changes, of course, with advancing technology and new understanding of learning processes. What is a constant is the belief that if technology is to serve learners and teachers, it must accommodate principles of learning and teaching in its design. This assumption is guiding LRDC’s current efforts.

The development of intelligent computer tutors has been a focus at LRDC for many years, from the physics tutors developed by former LRDC Senior Scientist Kurt VanLehn and colleagues to avionics tutors developed by Alan Lesgold and colleagues. More recently, LRDC researchers such as Diane Litman have been developing computational tutorial dialogue systems, through which students interact with computer tutors using typed or spoken natural language conversations. These systems engage students in conversations during both problem solving and post-solution reflection.

Researchers also are building systems to explore issues in learning via peer instruction. Approaches range from the development of automated computer dialogue agents that can participate in interactions for teaching science to Christian Schunn’s creation of Web-based environments for supporting human-peer interactions for teaching writing in the disciplines. Kevin Ashley is extending artificial intelligence technologies into ill-defined domains such as ethics and law. Ashley is combining his expertise in law and computer science to help students understand the process of U.S. Supreme Court decisions.

LRDC researchers also are part of the emerging discipline of educational data mining, or the use of educational databases to help inform educational and learning processes. Here, technology is being used to develop methods for exploring the unique types of data that come from educational settings in order to understand students and the settings in which they learn.
READING AND LANGUAGE

Reading and language have been important parts of LRDC for many years. Current work spans the range of basic research and applied research, from laboratory studies of the cognitive and linguistic processes of reading to classroom studies of reading comprehension and vocabulary learning.

Organizing much of this research are LRDC’s Reading and Language Laboratories, a grouping of projects across basic and applied reading and language areas. The basic research includes Charles Perfetti’s use of event-related potentials (ERPs) as markers of readers’ mental effort to integrate a word with their understanding of the text and as indicators of the learning that occurs when new words are encountered. Tessa Warren studies how readers combine semantic, pragmatic, and syntactic information in comprehending sentences and texts. Erik Reichle, in collaboration with Warren, uses eye tracking data to test models of where and when the eyes move during reading. Natasha Tokowicz uses behavioral and ERP methods to study bilingual processes, including how knowledge of a second language affects processing in one’s native language.

In addition to laboratory experiments, reading and language researchers carry out studies in classrooms ranging from grade school through college, including college language classes. Research on decoding, vocabulary learning, and comprehension has led to interventions by Margaret McKeown and Isabel Beck to support reading and test hypotheses about instructional effectiveness. For example, research on children’s comprehension led to the development of Questioning the Author, a reading comprehension instruction approach that has been adopted in dozens of schools across the country.

Faculty
Isabel Beck (Emeritus)
Julie Fiez
Diane Litman
Margaret McKeown
Charles Perfetti
Erik Reichle
Natasha Tokowicz
Tessa Warren
RESEARCH TO REFORM SCHOOL PRACTICE

LRDC has become a major source of expertise for school systems across the country as they attempt to restructure themselves to respond to the demands for higher standards in schooling for all students. The Institute for Learning (IFL), founded and directed by Lauren B. Resnick, is a primary vehicle for this work; Nancy Israel serves as executive director. Since 1995, IFL has worked in more than 50 urban districts throughout the country, bridging research and practice to improve the quality of teaching and learning for all students. IFL work focuses on building knowledge and skills in teachers—human capital for education. To do this, IFL works with districts to develop rich instructional materials and tools for teaching and learning. IFL also assists in building social capital—the networks in which teachers learn and practice high-level classroom implementation of these materials.

Other work in this area includes the PEER (Process Engineering for Educational Results) collaboration, a team of education researchers, school system experts, and systems engineers that supports school districts in measuring the quality of their work to improve leadership and teaching by building a districtwide assessment system. The work of Margaret Smith is part of LRDC’s research to reform school practice as well. She is studying how teachers support student learning through the use of rich mathematical tasks. Richard Correnti’s work attempts to understand how changes in teacher practice underlie changes in student learning. His work focuses on reform implementation and how reforms can influence changes in teacher practice.

Another effort in LRDC’s reform of school practice strand—in collaboration with the University’s School of Education—involves Louis Gomez in a program to engineer an urban secondary school around systems of education improvement. This school, Pittsburgh Milliones 6–12, University Preparatory School, represents an attempt to create the kinds of supportive learning environments found in some of the country’s best-performing schools. The goal is to create a school that is very effective for students who have been historically underserved by public education.
SOCIAL AND MOTIVATIONAL FACTORS IN LEARNING

Educational researchers and practitioners have long believed that learning is heavily influenced by the motivational consequences of social interactions inside and outside the classroom. Relevant work has focused on such diverse phenomena as teacher-student interactions, instructional grouping, teacher expectations, and peer tutoring.

LRDC researchers are currently engaged in several lines of work designed to clarify the impact of social and motivational factors on learning and performance. These social and motivational factors are important at the individual level but also drive team-based dynamics and organizational strategies. John Levine is examining a potentially important determinant of group learning, the conditions under which newcomers can produce innovation (defined as changes in work practices) in teams that they enter. Levine and Timothy Nokes are investigating the cognitive consequences of dialectical interaction, in which two or more people with roughly equal status but alternative viewpoints solve a problem or perform a task.

This laboratory research is complemented by survey and quasi-experimental field research examining the relationships between social and motivational factors on the one hand and learning on the other hand. Within the education context, for example, Janet Schofield is exploring how sense of belonging influences the college retention of White and African American students. Another study examines how the average ability of one’s classmates affects one’s achievement. Related issues also are being investigated with populations other than students. For example, Frits Pil has undertaken a large-scale field study of how social relations influence teacher knowledge use and development.

Faculty
John Levine
Sharon Nelson-Le Gall
Timothy Nokes
Frits Pil
Janet Schofield
CONNECTIONS ACROSS THE UNIVERSITY

In addition to participating in the collaborative work that takes place within the center, LRDC scientists are part of other multidisciplinary organizations at the University of Pittsburgh, including the following:

- The Pittsburgh Science of Learning Center brings together researchers from the University of Pittsburgh and Carnegie Mellon University to study robust learning—learning that is retained and transfers to new situations—in the areas of science (physics and chemistry), mathematics (algebra and geometry), and language learning.

- The Center for the Neural Basis of Cognition, housed in Pitt’s Department of Psychology, is a joint project of Pitt and Carnegie Mellon dedicated to the investigation of the neural mechanisms that give rise to human cognitive abilities.

- The Intelligent Systems Program is a multidisciplinary graduate program dedicated to the study of applied artificial intelligence.

LRDC researchers also connect with many other schools and departments across the University of Pittsburgh through joint appointments and collaborative research. These connections currently include the Joseph M. Katz Graduate School of Business, School of Arts and Sciences (Departments of Computer Science, English, Linguistics, Physics and Astronomy, and Psychology), School of Education, School of Law, and Swanson School of Engineering.

Another way that LRDC promotes connections across disciplines is through appointments of University of Pittsburgh faculty as LRDC associates. These currently include the following faculty members:

Mary Besterfield-Sacre, Swanson School of Engineering
James Greeno, School of Education
Lindsay Clare Matsumura, School of Education
Anthony Petrosky, School of Education
Chandralekha Singh, School of Arts and Sciences
The University of Pittsburgh was founded in 1787, making it one of the oldest institutions of higher learning west of the Allegheny Mountains. One of the leading public research universities in the United States, it is a member of the prestigious Association of American Universities. The campus in the Oakland neighborhood of Pittsburgh is a 132-acre site adjacent to the renowned University of Pittsburgh Medical Center, Carnegie Mellon University, the Carnegie Museums of Pittsburgh, and Schenley Park. The on-campus John M. and Gertrude E. Petersen Events Center hosts many sporting events and concerts as well as other special activities.

Pittsburgh has all the charms of a larger city but lacks many of the usual disadvantages. Crime is low, as is the cost of living, and it’s easy to find a neighborhood that perfectly fits one’s needs. Friendly and diverse, the city is the University of Pittsburgh’s campus—a great place to live, work, and play.

To learn more about Pittsburgh, visit www.pitt.edu/pittsburgh or www.coolpgh.pitt.edu.

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