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The Cambridge Handbook of the Learning Sciences

Learning sciences is an interdisciplinary field that studies teaching and learning. The sciences of learning include cognitive science, educational psychology, computer science, anthropology, sociology, neuroscience, and other fields. *The Cambridge Handbook of the Learning Sciences* shows how educators can use the learning sciences to design more effective learning environments, including school classrooms and informal settings such as science centers or after-school clubs, online distance learning, and computer-based tutoring software. The chapters in this handbook describe exciting new classroom environments, based on the latest science about how children learn. *CHLS* is a true handbook: readers can use it to design the schools of the future – schools that will prepare graduates to participate in a global society that is increasingly based on knowledge and innovation.

R. Keith Sawyer is Associate Professor of Education at Washington University in St. Louis. He received his Ph.D. in Psychology at the University of Chicago and his S.B. in Computer Science at the Massachusetts Institute of Technology. He studies creativity, collaboration, and learning. Dr. Sawyer has written or edited eight books. His most recent book is *Explaining Creativity*: *The Science of Human Innovation* (2006).

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The Cambridge Handbook of the Learning Sciences

Edited by

R. Keith Sawyer

Washington University

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In memory of three learning sciences pioneers:
Ann Brown, Robbie Case, and Jan Hawkins

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Preface

R. Keith Sawyer

Learning sciences is an interdisciplinary field that studies teaching and learning. Learning scientists study learning in a variety of settings, including not only the more formal learning of school classrooms but also the informal learning that takes place at home, on the job, and among peers. The goal of the learning sciences is to better understand the cognitive and social processes that result in the most effective learning, and to use this knowledge to redesign classrooms and other learning environments so that people learn more deeply and more effectively. The sciences of learning include cognitive science, educational psychology, computer science, anthropology, sociology, information sciences, neurosciences, education, design studies, instructional design, and other fields. In the late 1980s, researchers in these fields who were studying learning realized that they needed to develop new scientific approaches that went beyond what their own individual disciplines could offer, and they began to collaborate with other disciplines. Learning sciences was born in 1991, when the first international conference was held, and the *Journal of the Learning Sciences* was first published.

Learning sciences researchers have generated an impressive body of scholarship since 1991, and it's time to share the research with the rest of the world – education researchers, teachers, administrators, policy makers, consultants, and software designers. This handbook is your introduction to an exciting new approach to reforming education and schools, an approach that builds on the learning sciences to design new learning environments that help people learn more deeply and more effectively.

Learning sciences researchers often refer to themselves as a community because sometimes it seems like everybody knows everybody else; only a few hundred scholars attend the professional meetings that are held each year. This is a relatively small group in the context of education research; the American Educational Research Association claims more than ten thousand members. But the learning sciences community is growing, and it is beginning to have an impact on education far beyond its size. Between 2003 and 2006, the National

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Science Foundation funded nearly $100 million in grants to accelerate the development of the learning sciences. More and more people are realizing that the approaches emerging from the learning sciences community have great potential to contribute to improving education.

The National Research Council report *How People Learn* (Bransford, Brown, & Cocking, 2000) was the first overview of the new sciences of learning. That book provided an accessible introduction to the learning sciences for a broad audience. The *Cambridge Handbook of the Learning Sciences* (*CHLS*) picks up where this NRC report left off: *CHLS* shows how educators can use the learning sciences to design more effective learning environments, including school classrooms, and informal settings such as science centers or after-school clubs, online distance learning, and computer-based tutoring software. The chapters in *CHLS* describe exciting new classroom environments, based on the latest science about how children learn. These classroom environments combine new curricular materials, new collaborative activities, support for teachers, and innovative educational software, often using the unique advantages of the Internet to extend learning beyond the walls of the school. *CHLS* is a true handbook in that readers can use it to design the schools of the future – schools that are based on learning sciences research and that draw on the full potential of computer and Internet technology to improve our students' experiences. The learning sciences are supporting deep links between formal schooling and the many other learning institutions available to students – libraries, science centers and history museums, after-school clubs, online activities that can be accessed from home, and even collaborations between students and working professionals.

Many of the cutting-edge classrooms described here make use of advanced computer technology – but not just for technology's sake. Learning scientists are well aware that computers have generally failed teachers and students; that they are, in Larry Cuban's (2001) famous words, "oversold and underused." Learning scientists have discovered that computers only benefit learning when they take into account what we know about how children learn, and when they are designed to be closely integrated with teacher and student interactions in the classroom. This handbook will introduce you to the best of this new educational software. But computer software is only one component of this handbook; various chapters propose new teaching strategies, alternative ways of bringing students together in collaborating groups, and new forms of curriculum that cross traditional grades and disciplines. Some chapters even propose radical new ways of thinking about schooling and learning.

The thirty-four chapters of the *CHLS* are organized into six parts.

In my own Introduction and Conclusion, I explain why the learning sciences are important not only to education but to our entire society. The major advanced nations and the entire global economy are rapidly changing. In these two chapters, I draw on a large body of recent scholarship that describes the mismatch between the schools we have today and the demands of the knowledge age. Because the learning sciences are discovering how to teach the deep knowledge, skills, and attitudes required in the knowledge society, they are positioned to provide the blueprint for the schools of the future.

Part I, Foundations, introduces the reader to many of the big ideas that have been most influential throughout the learning sciences.

Part II, Methodologies, describes the unique research approaches used by learning scientists to study and to design new learning environments. Experiments are an important research methodology, but they are typically not useful in designing and engineering classrooms, and learning scientists have developed a variety of new methodological tools.

Part III, The Nature of Knowledge, presents new research on the kinds of deep knowledge that support expert activity. Learning scientists are not simply trying to help students memorize textbook facts

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better, because memorizing isolated facts and step-by-step procedures is not enough in today's knowledge society. Instead, learning scientists study how to help students understand underlying explanations and causes and how to solve complex, real-world problems.

Part IV, Making Knowledge Visible, shows how learning scientists are using these new discoveries about the nature of knowledge to design classroom activities that help students learn by making visible the deep knowledge they need to learn – often with sophisticated computer displays.

Part V, Learning Together, emphasizes the important role of collaboration in learning. A wide range of educational research has found that collaboration contributes to learning. Unlike an older generation of educational software, where each student worked in isolation at his or her own computer, the advent of the Internet and of wireless handheld devices supports students in learning collaborations, so that computers bring students together instead of pulling them apart.

Part VI, Learning Environments, tackles the real-world problems that face any educational reform – teacher professional development, equity for all students, and scaling up innovations throughout school districts and ultimately, throughout the country.

A book like *CHLS* is a massive undertaking; more than sixty authors have contributed, and many other members of the learning sciences community have participated indirectly, by reading and commenting on chapter drafts. As with any professional community, the knowledge that emerges is collectively created by all of the participants. Many important scholars whose names do not appear as authors nonetheless have contributed to the collective endeavor of the learning sciences. While editing this handbook, I have discovered that the members of this professional community are deeply aware that they are each only one participant in a broad community of practice, and that the knowledge generated cannot be considered to be owned or possessed by any one researcher. By sharing openly and working collaboratively, learning sciences researchers have made great strides in less than two decades. I hope that *CHLS* functions as a resource that will allow a significant expansion of this community of practice, allowing everyone involved with education to tap into these new findings and begin the task of designing the schools of the future.

I have many people to thank for their contributions to this project. Philip Laughlin, my editor at Cambridge University Press, was the original visionary who saw that readers needed a book like this, and I thank him for his support throughout the project. I am particularly grateful to the four advisory board members. They have gone far beyond the call of duty, in devoting their time and energy, responding vigorously whenever I asked them for help concerning issues that arose during the project.

I am grateful for the support I received from Washington University. While working on the handbook, I was partially supported by the St. Louis Center for Inquiry in Science Teaching and Learning (CISTL) and by the Washington University Department of Education. This support was due to the efforts of Jere Confrey, project director at CISTL, and to Bill Tate, Chair of the Department of Education. During the spring 2005 semester, students in a doctoral seminar at Washington University read many of the early drafts of these chapters, and their suggestions were extremely helpful. During final editing in the summer of 2005, Stacy DeZutter provided invaluable editorial assistance, also with support from CISTL.

And of course, I am grateful to each of the authors for the hard work they invested. It was a true pleasure to work with such a deeply professional group of scholars, with everyone delivering their chapters "on time and under budget," as they say. I am particularly grateful that the authors were willing to respond to my suggestions – in many cases I offered detailed comments, and many authors invested a significant amount of time writing a second draft. Having worked so closely with these scholars, I have a deeper

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understanding of why the learning sciences is having such a significant impact on education.

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