Learning Sciences

Contributors: Jeremy Roschelle, Shuchi Grover, Janet Kolodner
Questions, or want to add to this topic or to a new topic? Contact CIRCL.

Overview

The Learning Sciences is a field of scientific research that developed in the 1980s, from influences which include cognitive science, computer science, information processing psychology, child development, anthropology, and linguistics. The International Society of the Learning Sciences (ISLS) hosts conferences, organizes journals and provide ongoing forums which bring learning scientists together, worldwide. The two ISLS journals, Journal of the Learning Sciences and the International Journal of Computer-Supported Collaborative Learning, consistently rank among the top 10 educational research journals. The number of university-based Learning Sciences programs has expanded greatly since 2000, signifying institutional recognition of the importance of this field of inquiry.

Whereas traditional educational research sometimes determines what to study by looking at education as an institution (e.g. with policies, practices, organizational structures, etc.), learning science research more often starts with a **focus on learning**: how do people learn, what resources and supports enable learning, and how do features of settings and contexts interact with the learning process. Also, whereas traditional educational research focuses primarily on students' test scores or attainment of credentials, learning scientists are often concerned with knowledge, skills, and abilities that are not yet measured well by commonplace test scores nor yet signified by established credentials — for example, their knowledge of an emerging scientific topic like nanoscience, their skills in participating in a scientific discussion, or their ability to work with others to build knowledge. Learning science is willing to be future-directed, imaginative and risky — to explore how learners could develop in ways that are clearly valuable, but presently hard to learn. Learning scientists also investigate how people develop identity, as well as other social and emotional outcomes. Overall, learning scientists focus on learners and their needs.

Although learning scientists actively use a wide range of methods in order to conduct rigorous investigations of learning in these and other areas, two particular methods are much more common in learning sciences than in related fields. First, learning scientists often engage in ***design*** of new ways to facilitate learning in order to study whether issues in learning are constrained by existing resources or pedagogies and whether new technologies or approaches might overcome these limits and advance learning. Learning scientists tend to believe that technology can promote learning, but only if carefully designed and integrated into the life of the learner in a learning environment. Often, design is pursued by teams with multiple sources of authority and expertise, which can include teachers and other participants.

The need for contextual inquiry and the focus on design in the learning sciences prompted the birth of the design-based research (DBR). Second, learning scientists almost always seek to **capture details of how learning processes unfold** over time in interaction with people and materials and a setting — not just inputs and outputs, and not just discrete snapshots of learning at particular times. Methods to capture these interactions are therefore prominent, such as use of video and audio records, system log data, and observation. Presentations, reports, and journal articles often show examples of new designs and also display transcribed conversations and other interactions which would allow the reader to closely follow the process of learning as it unfolded over time.

Learning scientists study learning in specific ways. Learning scientists study learning in natural environments or in designed environments which could fit into realistic settings — and engage with the messiness of learning in realistic settings, rather than controlling variation precisely. For example, the learning sciences is strongly focused on studying human learning (rather than learning of other animals or machine learning). Most learning sciences work is deeply concerned with subject matter, such as mathematics, science, or history. When learning scientist study learning in a subject matter, they examine constructs and process which are important to the specific subject, and not just issues of memory and attention which apply similarly to all subjects. Topics can include how students can learn to engage in scientific inquiry, to understand fundamental but difficult math concepts, can participate in disciplinary practices of argumentation and explanations, and how students can learn subjects which are not ordinarily taught in schools in authentic ways, such as data science, nanoscience, or robotics. Learning scientists are also deeply engaged in how to measure and assess student learning, particularly when the target knowledge or skill is important to measure and not easily captured by conventional tests. Learning Scientists most often conduct studies in naturalistic settings (schools, museums, homes, community centers, etc.) rather than in highly controlled laboratories.

Learning sciences research is often concerned with designing environments, tools, materials and practices for optimal learning and tends to accumulate around design principles which interlink with empirical findings. Four exemplary areas include:

1. **Modeling learning progressions** and adapting learning experiences, resources and feedback to support learners' progress. Design principles in this area relate to how to to design learning environments, sequence instruction and optimize feedback both to learners and to teachers. These have been realized in intelligent tutoring systems, for example.
2. **Collaborative learning** and scaffolding, scripting, and orchestrating social interaction. Design principles in this area relate to how to organize social learning (often in small groups) to overcome known challenges and to increase the opportunities to learn deeply and may include designing particular structures, conversational supports, or ways for teachers to modulate the setting.
3. **Simulations, visualization, modeling, and representation**. Design principles in this area link new possibilities for displaying information to cognitive processes involved in making sense of scientific models or phenomena and/or mathematical constructs and notations — often with an emphasis on real-time, dynamic presentations which could not be easily portrayed on paper or in books, and with an emphasis on engaging students in an inquiry or investigative stance.
4. **Opportunities to engage in hands-on constructive activities**, when carefully designed to include well-designed materials, challenges, and allow for playful interactions, interest-driven learning, and sufficient mentoring or guidance, as a way to developing students' identity as a participant in challenging domains of expertise.

Learning scientists tend to be less enthusiastic about black box experiments, in which only inputs and outcomes are reported, with little empirical documentation of how the inputs contributed to the outcomes. Learning scientists want to go beyond only studying users' perceptions of how much they enjoyed a particular learning experiences or found it useful, unless this data is triangulated with other data that tracks the quality of the learning process. Learning scientists also tend to be less involved in large-scale survey methods or secondary analysis of existing data sets, as these methods tend to only have snapshots in time. While learning scientists value self-reflections about a learning experience, they work to move from insights to empirical accounts, which can be more easily verified by others.

Learning Sciences research is particularly important as a key vector of cyberlearning investigations. The presence of a potentially transformative learning technology, alone, is not sufficient for a cyberlearning investigation. Rather, cyberlearning is realized through the interweaving of technology with learning science and other methods that illuminate processes of learning with theoretical depth and empirical precision. This interweaving requires research in computation, STEM or other fields to intersect with principles of how people learn as informed by the learning sciences.

Issues

Learning scientists are looking for ways to add rigor both to the theoretical basis of design and the empirical claims about efficacy, especially as educational technology surges in the marketplace but often lacks depth in theory and rigor in empirical evidence.

Learning sciences intersects with other emerging fields, such as learning analytics. As an example, see Roy Pea's address at the ELI 2013 annual meeting – Learning Sciences and Learning Analytics: Time for a Marriage).

Historically, learning sciences research has examined smaller populations of learners in great depth, often revealing insights that would not be apparent in larger populations and aggregate data. However, to maintain relevance, learning sciences has to evolve to interpolate between larger-scale and smaller-scale studies, and slower and more agile research methods.

Learning sciences has had a healthy mix of public and policy engagement along with the mechanisms for growing a strong internal research community through a society, journals, conferences, and other efforts. Continued effort to address broad, important policy issues while conducting high quality research is important to the health of the field.

Readings

Key readings documenting the thinking behind the concept, important milestones in the work, foundational examples to build from, and summaries along the way.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (1999). How people learn: Brain, mind, experience, and school. National Academy Press.

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. The Journal of the Learning Sciences, 2(2), 141-178.

Collins, A. (1992). Toward a design science of education (pp. 15-22). Springer Berlin Heidelberg.

Hoadley, C. & Van Haneghan, J. (2011). The Learning Sciences: Where they came from and what it means for instructional designers. In Reiser, R.A., & Dempsey, J.V. (Eds.) Trends and Issues in Instructional Design and Technology (3rd ed., pp. 53-63). New York: Pearson.

Lavigne, N. C., & Mouza, C. (2013). Emerging technologies for the classroom: A learning sciences perspective. New York ; London: Springer.

Sawyer, R. K. (2006). Introduction: The New Science of Learning. In R.K. Sawyer (Ed.), The Cambridge handbook of the learning sciences (1-16). Cambridge: Cambridge University Press.

Kelly, A. & Lesh, R. (2000). Handbook of research design in mathematics and science education. Dordrecht, Netherlands: Kluwer.

Resources

To learn more about the learning sciences visit The International Society of the Learning Sciences (ISLS) web site, as well as the Journal of the Learning Sciences (JLS) and the International Journal of Computer-Supported Collaborative Learning (ijCSCL).

The International Society of the Learning Sciences Network of Academic Programs in the Learning Sciences (ISLS Naples).

A brief history of the learning sciences by Chris Hoadley (ISLS Naples webinar recording).