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Author(s)	Looi Chee Kit and David Hung
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# ***Introduction to Special Issue on the Learning Sciences: Capacity Building, Critical Areas, and Concerted Impact***

**Chee-Kit Looi  
David Hung**

*National Institute of Education, Singapore*

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## **Emergence of the Field**

Since the conception of the term "Learning Sciences" some 15 years ago, this field has seen the emergence of many young researchers with a passion for understanding how learning occurs. Prior to this evolving conception, there were many researchers who were working in other disciplines, such as educational psychology, cognitive science, and anthropology, who had studied learning in both experimental and naturalistic settings.

Researchers in the field have examined in depth various issues related to conceptual change, transfer, metacognition, cognition, motivation, activity systems, scaffolding, reflection, and many other processes leading to learning. The structure of representations, the nature of problem-solving, how expertise develops, and how technology mediates learning have become key concerns in the field.

The basic aim of those in this field is to improve theories of learning, and in particular to transform content from superficial learning to deeper learning among all participants involved. Learning Sciences researchers generally prefer an approach to research in which learning is studied in the messiness of contexts where it really occurs and not in contrived laboratory situations. They collect both qualitative and quantitative data from multiple perspectives, and they follow a developmental and historical approach to data observation. Learning Sciences researchers are not satisfied simply with data and interpretations, but are concerned with deriving design principles and the success conditions through which change and innovation occur.

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## **This and Other Special Issues**

*Educational Technology* has already published two special issues on this emerging interdisciplinary field: (1) an issue dedicated to how dialogue and convergence can be fostered between the domains of Instructional Systems Design and the Learning Sciences; and (2) an issue on Design-Based Research—a methodology which has increasing importance, not just in the Learning Sciences.

This special issue, then, is the third of its kind. We wanted to view macro issues within the discipline, and to highlight efforts in the Learning Sciences beyond North America and Europe. From the Learning Sciences work in the USA, we have recognized that much of the research did not make inroads into the public schools. Indeed, many successful studies have resulted from after-school contexts, such as the work of Zhao, Mishra, and Girod (2000) and Barab, Kling, and Gray (2004). Thus, we were concerned with issues of scaling-up and sustaining research in practice. Many of the articles in this issue stress this point and attempt to illustrate possibilities and principles as to how scaling-up is possible, albeit in incremental steps.

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## **The Learning Sciences Internationally**

We have recognized that Learning Sciences research arose in USA graduate schools, such as at Northwestern University, and now at similar programs, found at Indiana University and elsewhere.

We wish to communicate in this issue that there is a place for the Learning Sciences in the Asia-Pacific region as well. There are indeed researchers and young academics (perhaps not so young now) "hidden" in various other parts of the world, who are concerned with similar issues. One possible advantage they have is that educational systems in the Asia-Pacific part of the world are more centralized. Because there is a need to reform pedagogy and learning towards more constructivist and social-constructivist orientations, which is supported by policies that are congruent to such epistemologies, we believe we have a good chance at scaling up Learning Sciences work. We invite our colleagues in the West to participate in our school settings.

In Singapore, we have set up a Learning Sciences lab to explore how learning occurs through technology in Singapore schools. We desire to understand how deeper forms of learning in terms of cognition, metacognition, and epistemology occur. We have recognized also that the conditions of our local system differ from other contexts, and hence, research findings need to be re-enacted anew in this part of the world. While Singapore students score highly in many international assessments at the school level, the education ministry is keen to support research that can



inform models of how to better prepare our students to obtain 21st century competencies in cognitive, meta-cognitive, social, and affective areas.

### Overarching Issues Facing the Learning Sciences

Any strategy for how the Learning Sciences can have an impact on schools must include the following overarching issues:

- *How does engaged or deep learning occur in this sociocultural context through technology?*
- *What are the conditions leading to this learning process?*
- *How do we design for such learning, having understood the conditions?*

To study "how engaged or deep learning occurs," we make two assumptions: (a) that such learning exists in our school system, and (b) that it occurs in international contexts (as we have determined from literature and study trips abroad). If certain forms of engaged or deep learning are non-existent, but have occurred in other contexts internationally, we need to *create* these possibilities in our local schools through Design-Based Research (DBR) methodologies. Through DBR, researchers working with teachers and students attempt to create situations (which did not exist previously) that foster the conditions necessary for deep learning. Through this process, design principles are evolved and refined. Supporting the entire Learning Sciences effort is an understanding of the socio-technological infrastructure that supports deep learning. By this we mean the policies, pedagogies, assessment practices, student-teacher interactions, and other crucial factors which enable deep learning to occur through technology.

Extending the work in the Learning Sciences to the international context, this special issue attempts to discuss issues which we believe are important and emerging in the field of the Learning Sciences. It is an attempt to consolidate common themes; to discuss important aspects in the field which need attention; to identify gaps; and importantly to discuss how research can be translated into practice—and innovations sustained. Several initiatives have aspired to build the capacity of those in the field of the Learning Sciences by addressing members of disparate communities:

- Learning Sciences, educational research, science, and technology research;
- informal, formal, and implicit learning;
- brain sciences, educational research, and educational technology; and
- researchers, policy-makers, and school practitioners.

*Capacity building* can leverage new technologies to develop newer understandings of theories of learning; facilitate cross-boundary discourse and ideas via an interdisciplinary focus; draw in high-quality researchers; and encourage the diversity of ideas to

promote innovation. As much as we need to build up capacity in research, we also need to build up capacity in various stakeholders and their institutions. Schools that are on the receiving end of successful research endeavors may have a clear need for an implementation plan, formulated through design-based experimentation. Professional development models also need to be developed with the Design-Based experimentation approach, and the principles derived should be scalable.

### Articles in This Issue

To begin this issue, we deal with *critical areas* which we feel have insufficient emphasis in the literature—the work of Learning Sciences among teachers. **Bielaczyc and Collins** examine the idea of developing "implementation paths" to support teachers in implementing technology-based learning environments in the classroom. These paths are trajectories that teachers move through with their students to progress from initial to effective use of a technology-based tool. Bielaczyc and Collins argue that Design-Based Research must pay attention to articulating the implementation path of the design; otherwise, much useful information is lost.

**Tan and Koh** explore bridging the gap between research and practice by proposing a communities-of-practice approach that brings together three different communities—researchers, policy-makers, and school practitioners. They argue for a co-evolutionary approach, wherein all members begin this journey of research-to-practice translation together.

**Looi, Hung, and Tan** explore implications of how Learning Sciences can inform teacher education from the perspective of shifting teachers' beliefs and professional development, with a view towards sustainability.

**Clarke, Dede, Ketelhut, and Nelson** continue the dialogue on scalability with their implementation of the *River City* MUVE curriculum in different educational contexts, their approach of fusing automation and individualization to achieve scalability, and their plan to develop a "scalability index" to assess the scalability of an educational innovation across different contexts.

Following these articles, we bring readers to macro issues with which the field is grappling. **Chan, Ko, Tzeng, and Chou** postulate a Grand Challenge Problem for the Learning Sciences, the solution of which would require integrating perspectives from neurosciences, educational research, and educational technology.

Concluding the special issue is an area of crucial importance in this field—inter- and multi-disciplinary collaborations for *concerted impact* (Hung, Looi, & Tan, 2005). The field of the Learning Sciences needs to provide strategies and exemplars as to how research centers and individual researchers can better make sense of and engage in such practices. **Bell and Sabelli**



discuss the usefulness of looking at the overlapping boundaries and conflicting views among the many disciplines that look at learning through different theoretical and methodological lenses. They suggest the need for close coupling between Learning Sciences, educational researchers, and the science and technology research communities. They predict a decade of theoretical synthesis in which there will be much progress galvanized through conceptual collisions and syntheses.

The final article, by **Linn, Husic, Slotta, and Tinker**, describes the Technology Enhanced Learning in Science (TELS) center, which builds capacity for Learning Sciences investigations of educational technologies. Through a partnership of multiple universities, school districts, and research organizations, the TELS research program focuses on how scientific visualizations embedded in inquiry projects enable students to develop integrated understanding of complex science topics. It is a program aimed at making concerted impact through their four research themes of science curriculum design: TELS technologies, professional development, leadership development, and informed assessment.

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### Conclusion: Beyond This Issue

This special issue is an attempt to continue the important dialogue on Learning Sciences and educational technologies. We hope to persuade researchers and practitioners from multiple disciplines who read this magazine that this new and emerging field of the Learning Sciences concerns us all. In essence, the Learning Sciences requires its researchers to be agile mediators between communities, engaged in boundary crossing (Engeström, 2005).

There are a few areas that we believe need to be considered beyond this issue. First, researchers in this field need to consolidate the invaluable research work in learning and cognition from cognitive psychology, educational psychology, cognitive science, and the many other, more traditional fields of learning. From this work, the Learning Sciences can identify gaps and questions yet to be answered. If Learning Sciences indeed embraces an inter-disciplinary perspective, it needs to engage researchers from domains not officially deemed to be "learning sciences" and engage them to create conceptual syntheses.

Second, much more research and thought are needed to address the situated nature of learning and its implications for research. If all work is bound intimately to context, and only small generalizations are possible, to what extent is research valuable to inform practice? What is generalizable may be predominantly *principles* of learning that inform practice. These principles have yet to be contextualized and re-applied to new situations and contexts. What

implications do these kinds of research have for educational policy issues (including funding)?

Third, there is at present still a lot of resistance to methodologies such as Design-Based Research. Is this methodology ideal? How do we balance researchers' observations and interpretations with those of the participants in context? How do we ensure rigor and accurate interpretations of data? Stretching DBR further, should we try to develop research capacity in school participants (similar to action research) and expand their capability for improving theory, which then leads back to better-informed practice?

This field is exciting. We have come a long way from behaviorist conceptions of learning and are now poised to understand learning from multiple integrated perspectives. Sociocultural orientations and constructivist epistemologies seem to be here to stay. Findings from neuroscience research will probably feature more prominently in the future, with work coming from some of the science-of-learning centers in the USA. The legacy of learning research needs to be passed on from our predecessors, some of whom are now in their 60s and 70s and still contributing. We believe this field is here to stay, not only in the West but now in East-Asia.

Lawrence Lipsitz, the Editor of *Educational Technology*, mentioned in an e-mail to us some weeks back that Englewood Cliffs is fast becoming Englewood Cliffs-East; we believe Learning Sciences will soon feel an impact from Learning Sciences-East! □

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