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Title	Journeys in the learning sciences: The Singapore experience
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Source	<i>Educational Technology</i> , 48(4), 36-40
Published by	Educational Technology Publications

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# Journeys in the Learning Sciences: The Singapore Experience

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This article provides an overview of research in the Learning Sciences from a Design Research perspective, as it has been framed in Singapore by the National Institute of Education (NIE). The initial research agenda is considered in the light of challenges and the subsequent re-casting of objectives, based on the working out of a tripartite relationship between the NIE, the Ministry of Education, and local schools. A conceptual model is proposed as an attempt to provide structure for new research interventions going forward.

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## Introduction

The Learning Sciences (Sawyer, 2006) journey in Singapore, particularly at the National Institute of Education (NIE) and in local schools, began three years ago when the NIE received funding of S\$12 million to engage in Learning Sciences research. The NIE then initiated a research center known as the Learning Sciences Lab (LSL) (Looi et al., 2004). The LSL was tasked to foster deep student learning with technology-enabled pedagogical practices for cultivating 21st century knowledge and skills through Learning Sciences research in Singapore schools.

At that time, it was envisaged that the institutional structure between the Singapore Ministry of Education (MOE) and the local schools, together with the close relationship between the NIE and the MOE, would permit the LSL to explore and develop a niche in school-based Learning Sciences research. In particular, it was hoped that this close relationship would play a

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critical role in distinguishing educational research in Singapore, as—more often than not—the perception globally is that the pursuit of disciplinary research is generally best undertaken within the boundaries of a university campus.

With three years of school-based Learning Sciences research using the Design-Based approach (TDBR Collective, 2003), the LSL is beginning to develop so-called ‘point-at-able’ models which demonstrate the power of applying the Learning Sciences to teaching and learning practices in schools. For example, the National Education (citizenship education) videogame developed by the LSL enables students to negotiate meanings with concrete experiences in an immersive learning environment. The game and the pedagogical approach together foster the development of students’ identity as Singaporeans (Lim & Chee, 2007).

With new funding to be committed to the LSL by the MOE over the next five years, we are about to embark on a new round of research with three focus areas, namely, Practice-Based Research, Strategic Research, and so-called Interest-Driven Research (Baker, 2003; McKee, 2004). With Practice-Based Research, we aim to improve upon the good practices in the classrooms, and to build and improve Learning Sciences theories from such practices. Strategic Research refers to collaborative design and development research work with school teachers according to a research agenda that transfers and advances the theoretical frameworks of the Learning Sciences into point-at-able learning environments and their respective pedagogical approaches. With Interest-Driven Research, we hope to shape possible next-generation learning by working over either a longer timeline with which to impact school practices, or in areas that may not have been anticipated by policy planners.

This article aims to discuss some reflections on our journey in Learning Sciences research, and to reframe our overarching goals in this endeavor from a Design Research (DR) perspective. We have chosen the DR lens because its inherently iterative research-design process has the potential to be the very mechanism through which researchers, policy-makers, and practitioners can be drawn together in closer dialogue (Tan & Koh, 2006).

### About Research in the Learning Sciences

Research in the Learning Sciences embraces an intercommunity field that is dedicated to furthering scientific understanding of learning in classroom and real-world contexts, by engaging in the design and implementation of learning innovations that foster student-centered learning (Sandoval & Bell, 2004; Sawyer, 2006). With its interdisciplinary research orientation, such research spans fields as diverse as education, linguistics, anthropology, psychology, computer science, and neuroscience (Kafai, 2004; Sawyer,

2006). Research in the Learning Sciences values the social contexts of study, which include schools, museums, and homes (Jonassen & Land, 2000).

The beliefs that underpin research in the Learning Sciences include: that learning occurs in communities (Barab & Duffy, 2000); that learning is about active participation and construction of knowledge (Weinberger, 2003); that technology can help promote learning in meaningful ways (Bransford, Brophy, & Williams, 2000); and that research into learning ought to be where “the real learning happens” (Jonassen & Land, 2000).

Coming from this orientation, researchers seek to improve theories of learning through:

- the development of strategies which promote deep/engaged learning of skills, practices, and knowledge;
- the identification of contextual factors that affect how people learn;
- the design of activity structures, curriculum resources, and environments; and
- the design of methodologies for studying learning.

### Status of Significant Existing Projects Originating from the LSL

The LSL is responsible for several projects which are well underway in local schools. Due to the initial two-year ‘prototype development’ phase associated with most projects, data collection with regard to the effects on students’ cognition and learning has only recently gathered some pace. There is now an urgent need to analyze the data that has been collected and to formulate theories that can either inform practice and/or advance the field of the Learning Sciences. Research undertaken by the LSL must improve current understandings in learning. In particular, we need to make advancements in our understandings relating to:

- how we design research in schools;
- how we develop capacity to sustain innovative pedagogies and practices;
- advancements in theories in the Learning Sciences;
- efficacies (or lack thereof) of instructional methods and scaffolds;
- the development and formation of professional identities;
- efficacies in the use of learning technologies vis-à-vis traditional modes of teaching and learning; and
- influencing learning and instruction from a multi-level systems perspective.

Going forward, the emphasis on research project proposals highlights the need for theory-building and advancement. As such, we have formed a team to engage in such efforts. The team will delve into the various research projects, identify meta-trends, and propose new directions to address the gaps which are uncovered.

From the projects which were undertaken over the past three years, we identify three main research

orientations (Baker, 2003; McKee, 2004):

- Practice-Based Research, with a view to theory development, e.g., in cooperation with Marlene Scardamalia and the Ontario Institute for Studies in Education, the LSL has a Knowledge Building project integrated into a local school with the potential to develop theories on how cultural shifts may be catalyzed and sustained in local schools (the research findings on this initiative were reported in Bielaczyc, 2006);
- Strategic Research, with a view to theory development, e.g., productive failure as an idea, questioning the fundamental assumptions of scaffolding; and
- Interest-Driven Research, with a view to informing the design of practice, e.g., interactive & digital media (IDM) projects, in consultation with John Seely Brown, John Bransford, and Roy Pea, among others.

We postulate a simplified conceptual model framed by the extent to which projects are explicitly informed by theory, and by the extent to which they are easy to put into practice, to replicate, and to scale. We make the assumption that the extent to which a given project is explicitly informed by theory will have a direct impact on the potential of the project to make a significant contribution to extend understandings of learning theory.

### Practice-Based Research

Practice-Based Research refers to projects initiated primarily from the practitioners in the schools themselves. By definition, they operate in the timeframe of the present. However, they tend to be characterized by relatively low explicit grounding in theoretical understanding, as many have been designed to address immediate and locally-perceived areas of need. It is important to recognize that this is a key area in which academic and research staff at the LSL can help such projects level-up in the medium-term. Specifically, research in these grassroots initiatives should focus on grounding them within a theoretical base from which they can grow, evolve, and impact local school cultures.

### Strategic Research

With regard to Strategic Research programs, these can be thought of as having likely impacts within a five- to ten-year timeframe. Such projects are informed by sound established educational theory, and both the MOE and the NIE have a strategic interest in furthering these programs (e.g., Early Childhood Education). Further, the scalability of these projects is as yet indeterminate, as a direct consequence of their somewhat experimental nature.

In terms of the strands at the LSL, projects in this category would include Science as Systems, Math Problem-Solving, Productive Failure, and work in Knowledge Building.

The common research issue that underpins this research orientation is the effort to understand the effects enacted from the MOE/NIE strategic programs on (1) teacher beliefs; (2) student learning gains and outcomes; (3) cultural changes in schools, such as that facilitated by improving socio-technological infrastructure; and (4) the role of leadership. The goal that such projects work toward is the design of curricular resources, assessment, professional development, and pedagogically and technologically rich environments, with a view to sustaining these innovations.

### Interest-Driven Research

Finally, so-called Interest-Driven Research is potentially high in emergent theory, such as educational theory relating to identity, values, and belief systems. This is because they often (but not always) arise from a strong *a priori* understanding, synthesis, and explicit explication of existing learning theory. By definition, such projects take many years before their true impact is felt on the education system as a whole. Such projects are often not within the immediate interests of policy planners but are nonetheless valuable in advancing understanding of learning possibilities. The essence of such projects is the identification, exploration, and charting of niches at the envelope of prevailing educational paradigms. When successful, Interest-Driven Research is therefore critical in catalyzing shifts in paradigmatic understandings of the nature of education and the art and science of learning.

Interest-Driven Research efforts almost invariably start out low in scalability, because of their long-term nature. An important point to note is that, with the passage of time, and as theoretical understandings and the state-of-the-art is advanced, successful 'blue-sky' projects can evolve into strategic programs/innovations, while new blue-sky projects are gradually postulated. In other words, the entire matrix of research is not a static construct, but it represents a snapshot at any given time of the situation of research projects within the prevailing paradigmatic understanding of Learning Science theory. Over time, the work shifts continually toward theory. This continual shift represents the advancement of theory, and the evolution of Interest-Driven Research into more mainstream Strategic Research.

It should also be noted that Interest-Driven Research is almost never high in scalability, at least, in terms of the initial phases of research. That part of the scope of work should be thought of as a chimera—a useful vision to work toward but never actually attainable in reality. An example of such a vision might be when digital epistemic game-based learning is welcomed by all major stakeholders in schools (not least of which by both parents and teachers), so that new understandings of formal and informal learning emerge, and thus significantly contribute to theory-building in the Learning Sciences. In fact,

research dedicated to this pursuit is actually the engine that drives the entire process toward theory building.

### Range of Research Areas

Given this conceptualization, research from Math Problem-Solving and Productive Failure, for example, is having high yield in schools currently because of the applicability of fit into the local system. The projects need not enact significant cultural shifts in schools. It is also acknowledged that present research efforts in New Literacies/Media operate on a longer-term time-scale, with respect to tangible results, ease of generalization and scalability, and point-at-able exemplars. This is not least because of the high degree of logistical support and structural change necessitated by these projects, such as timetabling, hardware support, and the persistent primacy of traditional paper-based curriculum materials.

To elaborate, for our first research orientation—practice-focused with a view to theory-development—we recognize that established pedagogies such as Knowledge Building have to be contextualized in local school settings. In order to achieve this, much effort needs to be applied toward professional development and the creation of supporting (policy) structures which form the substrate from which cultural shifts occur. To move this category of projects toward high innovation in theory, there is a need to professionally develop teachers, equip schools with the appropriate socio-technological infrastructure and resources, and establish adaptable curricula to support the innovation. In addition, nuances in contextualization of these innovations would hopefully provide us with more insights related to how students learn. Bielaczyc (2006) has detailed that such design issues extend beyond the tool itself to encompass a broader range of factors such as social structures in the classroom.

In terms of the second research orientation—strategic or idea-focused with a view to theory-development—small-scale, localized experiments can be set up with a view to exploring ideas which challenge established theoretical dogma. These experiments are worthy of funding only to the degree to which initial hypotheses supporting these efforts are sufficiently elaborate in their development and explication, and that local cultural conditions in the school are considered ripe for such experimental interventions. To move this category of projects toward a higher level of innovation in theory, while maintaining their relevance in practice, there is a need to understand the factors and conditions leading to successful implementations and determine ways through which they can be scaled and sustained in local school settings. Moreover, the project can ascertain whether supporting tools and environments can further enhance learning and cognition.

Projects relating to the third research orientation—theory-formation with a possible view to informing the

design of practice—are interest-driven projects, in which the gap between theory and implementation is large; however, funding agencies should recognize the potential of such efforts, provided logistical and operational constraints are successfully overcome. To move this category of projects toward high relevance and sustainability in practice, there is a need to develop strategies for practice-integration which furthers understandings of assessment, curriculum, resources, and professional development. Such strategies should also inform how sub-cultures for learning develop in local school settings.

In summary, it should be apparent that the range of potential research areas in the Learning Sciences is growing, and the space will continue to evolve in the medium to long term. This presents unique challenges to us to provide both oversight and a responsive and adaptive infrastructure in order to advance the research interests of the NIE as a whole.

### Strategies for Moving Ahead

We propose the following strategies:

- To identify emerging areas of strength and commonality between the various research projects of each strand, with the goal of making significant contributions to particular niches in theories of learning.
- To assist projects in terms of increasing their scalability and advancement of theories of learning. There is a need to conduct meta-studies in ways that may reduce the gaps that currently inhibit practice or innovation in theory building. This can be thought of as consolidating the research output in the Learning Sciences.

The need for such consolidation will only grow with the passage of time, and as more Learning Sciences research projects come on-stream. In retrospect, the close relationship engendered among the LSL, the MOE, and local schools has not translated into as straightforward an environment for enacting educational change as we had first envisaged. Schools are at various stages of their own, along the cultural trajectory from a traditional didactic view of teaching and learning, to a view informed by adopting a Learning Sciences perspective.

In terms of the conception of educational research with regard to theory and practice—as presented in this article—we identify a need to bridge the gap between ‘high theory’ and ‘high practice.’

If meaningful and impactful research affects practice—through the mediation of technology—we suggest that DR methodologies go some way toward addressing this gap. DR adopts an iterative research-design process which aims to create and change both cultural context and the participants themselves. In the process, design considerations and principles are developed and refined, thereby improving theory related to learning. Through DR, the researchers working with the teachers and stu-

**Table 1.** Theory-practice dimensionality from a Design Research perspective.

	Traditional Paradigm (Researcher-centric)	Design Research	Practitioner-centric
Relation to context	Detached	Interactional	Interwoven
Observational perspective	Third-person	Hybrid—both first- and third-person perspectives	First-person
Practitioner's ability to conduct research	Not essential	Literate	Competent
Researcher's ability to undertake practice	Not essential	Literate	Competent
Contribution to theory building	Intentional	Intentional	Potentially either a by-product or intentional, depending on practitioner-researcher
Contribution to practice	By-product	Intentional	Intentional

dents attempt to create the contexts and situations (which either did not exist, or, if they did, were not evident), which allow for deep and meaningful learning.

The popular conception of academic researchers as external to practice on the ground, instead of the more ideal notion that they are co-partners, can be addressed through the adoption of DR methodologies. This is because well executed DR interventions are characterized by the developmental transformation—by all stakeholders in the intervention—of the context in which learning occurs.

These understandings are summarized in Table 1, which describes the differences between traditional research paradigms, DR, and getting teacher-practitioners to be competent in doing research.

We recommend that, going ahead, there is a need to balance researcher- with practitioner-centric learning interventions. It should be self-evident that, generally speaking, the contributions to theory and practice made by researchers and practitioners differ. From the point-of-view of the researcher, contributions to theory are often, but not necessarily, intentional. This is contrasted with the populist notion that practice is often insufficiently informed by theory. We see the continual dialogue implicit in the DR approach as the key to bringing these two methodological ends closer together.

## Conclusions

Three years after its establishment, the Learning Sciences Lab continues to enjoy a rare and tight relationship with policy-makers in the Ministry of Education, as well as with practitioners in local schools in Singapore. What has evolved is a sharper appreciation that research interventions driven by theoretical understandings alone will not succeed—even given the close tripartite relationship—if cultural understandings about teaching and learning are not equally communicated, shared, and shaped by parties who perceive themselves as equal partners. We therefore see the iterative and development approach so characteristic of Design Research methodology as a key frame within which subsequent research projects can be formulated. □

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