Chapter 19. The Science of Learning Strategic Research Theme at the University of Hong Kong

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This chapter introduces developments in the Science of Learning research at the University of Hong Kong (HKU) from 2008 to 2018 within the context of institutional priorities and international trends. The Strategic Research Theme on Sciences of Learning (SoL-SRT) was initially established at HKU and led by the Faculty of Education in 2008 to provide a platform that brings together researchers in diverse fields to foster interdisciplinary research focusing around pedagogical issues and practices related to learning. Based on experiences of the first five years, the university supported a second phase of funding for the SoL-SRT that is underpinned by a complex system model of human learning as multilevel phenomena (from neural to individual behaviour to institutional and social), and more connected with the global Science of Learning movement and networks.

Introduction

Learning Sciences was established as a Strategic Research Theme (SRT) at the University of Hong Kong (HKU) in 2008 as an institutional initiative, led by the Faculty of Education, to build cross-campus, interdisciplinary research teams and projects that would advance research, policy and practice in education. The first phase, which can be considered as an exploratory phase, ended in 2012. The university subsequently gave further funding support for a second phase of the SRT in 2013 upon approving a major change in the strategic approach and clearer focus of the SRT. The title of the SRT was later renamed to the Science of Learning Strategic Research Theme (SoL-SRT) in early 2015 to better reflect the vision and aspiration of the SRT. This chapter describes the rationale for the establishment of the SRT and the subsequent developments, with a focus on Phase 2 goals, strategies and outcomes. The final section reflects on the potential contributions and challenges that such a university-led Science of Learning initiative faces.

Need for educational policy and practice to be underpinned by interdisciplinary research beyond the educational sciences

Learning lies at the core of all aspects of human performance. Learning transcends educational institutions and underpins a large part of human activities, as individuals, in teams, organisations and communities. Therefore, a better understanding of how people learn would contribute to the improvement of all aspects of human lives. Education, by its nature, is systematic programmes of learning designed by human beings. By definition, learning should be the core business of education. However, even in the field of education, it is only in recent years that people have recognised the significance of learning as an area of research. Various efforts around research on learning have been integrated to form what has been referred to as the "learning sciences", which is an emerging field of scientific inquiry (Bransford, Brown and Cocking, 2000[1]; Sawyer, 2005[2]) building on the educational science disciplines such as psychology, cognitive science and instructional technology.

The SoL-SRT was initially established in 2008 to provide a platform to bring together the diverse research efforts into learning across the university to form a collaborative cross-disciplinary community of researchers, pooling their knowledge to advance the frontiers of our understanding about human learning. Town hall meetings were organised, attracting the voluntary participation of over 60 academics from different disciplines in all of the ten faculties in the university. It was the first time such a diverse gathering of scholars as practitioners of "teaching" come together to create a community to collaborate in the quest to improve our understanding and practices of learning through scientific research.

The SRT at that time was focused on research on understanding how different pedagogical approaches, such as problem-based learning, case-based approaches and project-based learning, advance students' learning. This phase stimulated the cross-fertilisation of ideas on how teaching practices were underpinned by learning theories. It fostered collaboration among colleagues working in different disciplinary areas to address existing learning problems in new ways. For example, Speech Science colleagues were inspired by Sport Science colleagues' sharing on the implicit motor learning paradigm to apply this theory to successfully address motor speech disorders. It also fostered collaboration in tackling new problems, such as developing a focus on oral health literacy. There were also efforts to study the teaching approaches of award-winning teachers, examples include observation in

geology and entrepreneurship in engineering. The studies extended to systemic efforts in assessments (e.g. evaluations of projects and group work).

The Faculty of Education, which initiated and hosted the SRT, also played an important role in supporting the systemic territory-wide school curriculum reform in Hong Kong, which started in 2000, by conceptually focusing the dissemination and discourse on learning. All in all, Phase 1 of the SRT has successfully placed learning at the centre stage of education, both within the university and influencing the larger community. It is also evident that the strong educational practice connection and commitment of the Faculty of Education, and its mission to serve and inform policies in diverse educational settings and beyond contributed much to the applied, pedagogical orientation in the SRT's Phase 1 contributions.

In reviewing the Phase 1 outcomes of the SRT, it is clear that we could go further than creating a platform for interaction and collaboration, if our goal is for the cross-disciplinary collaboration to achieve more significant contributions. There needs to be a clear research focus for interdisciplinary collaboration that addresses locally and internationally significant educational concerns that excites and leverages the network of learning-related research expertise emerging from the Phase 1 efforts.

Another strategic direction in formulating the Phase 2 work plan was to establish the role of HKU as the leading national and regional hub for learning-sciences research with broad international connections and recognition. To achieve this, the SRT should serve to facilitate the sharing of information and academic dialogue; initiate and undertake substantial and significant collaborative research; respond to issues of learning locally, nationally and internationally; and explore the implications of the collaborative activity for advancing learning in a wide range of educational contexts and beyond.

## A complex system model of learning as multilevel and interconnected

The vision and mission for Phase 2 of the SRT is underpinned by a complex system model of human learning as multilevel phenomena involving interactions across hierarchically nested levels of learning, including:

- the neural level of learning in different functional areas related to learning

- cognitive and metacognitive aspects of learning at the individual level

- socio-cognitive, socio-metacognitive, socio-cultural, interactional and behavioural aspects of learning at the group level

- learning at organisational and community levels for more effective functioning and change leadership

- sociological, cultural and anthropological studies as studies of learning at the system and societal levels.

As represented in Figure 19.1, the learning taking place at each of these different levels of human learning from neural to societal has been studied using different disciplinary paradigms and research methods. The learning processes at each level takes place within different time spans, from milliseconds at the neural level to centuries at the societal level. Different disciplinary paradigms and methods have contributed to different ways of studying and influencing learning at these different levels, from clinical intervention, to policy advice. While these different disciplinary approaches have advanced our understanding of learning, a major challenge lies in the fact that learning at the different

levels are not independent of each other. On the contrary, learning at each of these levels influence and feeds back on each other.

Figure 19.1. A diagrammatic representation of the multilevel hierarchically nested sites of learning and the disciplines that study them at each of these levels
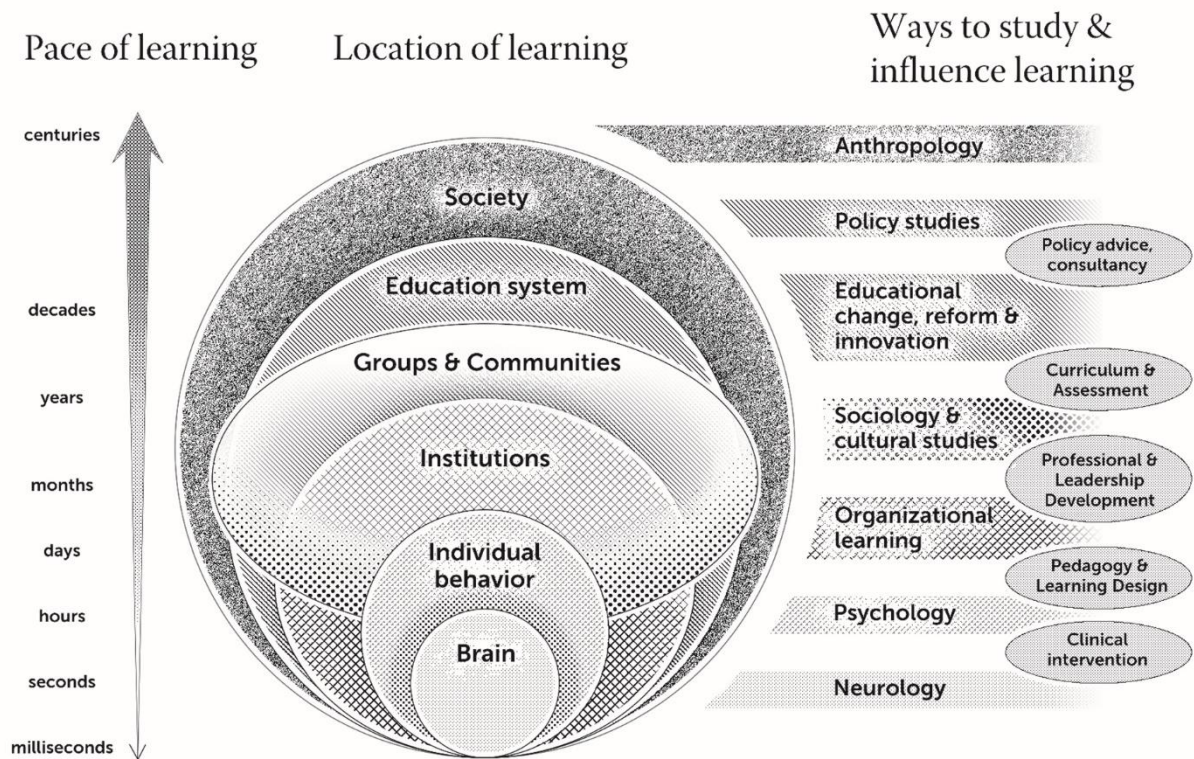
By building interdisciplinary research that spans multi-levels of human learning, we have the opportunity to build explanatory models of learning that are more consilient and powerful. The overall goal for Phase 2 of the SRT is to contribute to theory building and evidence-based policies and practices related to learning through:

> *Developing focused, multilevel, multidisciplinary research programmes to support theory building and evidence-based policy and practice related to learning, building on our strengths in learning research across the University.*

This goal is to be achieved by bringing together researchers across the university from areas such as psychology, cognitive science, neuroscience, language, medicine, engineering, computer science and education.

Research subthemes building on strengths in the faculty and university

Based on the existing strength of the Faculty of Education, three subthemes have been identified as focal areas for developing research programmes and infrastructures:

Subtheme 1:

Integrating neural, cognitive and pedagogical approaches to learning research and educational intervention. This subtheme seeks to stimulate research that could focus on and advance theory, practice and policy in language learning, and building on our established strengths in research that are directly or indirectly linked to learning within a multilingual context.

Subtheme 2:

Learning and assessment. This subtheme has three inter-related foci: 1) enhancing human learning through pedagogical and technological designs that are enacted in authentic, complex learning environments; 2) developing more nuanced understanding of how people learn under different settings through the collection, analysis and visualisation of multi-faceted data of learning processes and outcomes data; and 3) developing better tools and theories of assessment on the basis of research under the above two foci that can benefit learners, parents, education practitioners, policy makers and the wider community.

Subtheme 3:

Building tools and theory for learning across levels. This emerging theme in Learning Sciences research recognises the nature of education and learning as nested, interdependent and multilevel complex phenomena, and that unless research on learning takes account of and addresses the ecological complexities involved, the impact of our research on learning, and indeed our understanding of learning, would be severely limited. Two dimensions of work in this subtheme are relatively promising given our existing strengths: 1) building hierarchical, complex system models of learning in a specific domain of learning; and 2) building models of successful strategic and policy interventions for large-scale learning improvement.

Strategies to leverage international, national and local opportunities

The university and the hosting faculty provide seed funding for research themes recognised as strategic at the university level. With the Phase 2 funding, the SoL-SRT embarked on a number of strategies to realise its vision and mission. The following are the key strategies and their implementation over the past few years.

1. Connecting to and supporting pivotal high-profile international networks and events:

   One prime example of this strategy is the co-organisation of the International Convention on the Science of Learning[1] held on March 1-6, 2014 in Shanghai, in collaboration with the US National Science Foundation, OECD, UNESCO, East China Normal University and Shanghai Normal University. The first four days were an invitation only set of activities involving more than 120 participants, comprising prominent scholars, leaders of international agencies, policy makers and practitioners. We were able to solicit support from the Hong Kong SAR Government to provide funding support for a 15-member delegation to participate in the convention, which included education policy makers, scholars, principals and teacher leaders. The highlight of the convention was a two-day dialogue on "Science of Learning – How can it make a difference?" This event brought our SRT members in contact with a wide network of international and national researchers in the science of learning as well as agencies and institutions that see the

contributions and potentials of science of learning research in formal and informal education. It also brought media and public attention to Science of Learning as an area of importance for national development[2]. It is also through organising this convention that the SRT decides to change the name of the SRT to Science of Learning to recognise consilience (Wilson, 1999[3]) as a strength in the multi- and interdisciplinary study of learning.

Another high-profile international event that the SRT leveraged was the opportunity to hold local versions of the Learning Analytics Summer Institutes (LASI) in conjunction with the LASI organised by the Society for Learning Analytics and Knowledge.[3] The SRT collaborated with the Centre for Information Technology in Education (CITE) in the Faculty of Education to host the 2013[4] and 2014[5] LASI-HK. These events provided important opportunities for colleagues in the Faculty of Education to connect with researchers within and outside of the university, as well as colleagues in the IT industry, working in areas related to e-learning and learning analytics.

2. Introducing important advances in research and methodologies in Science of Learning for research capacity building and knowledge exchange:

During Phase 2, The SRT organises a major Science of Learning event every half-year: Winter Institutes (in January) and Summerfests (in June/July), during which we bring in international scholars to give keynotes, public lectures and conduct methodology workshops. These half-yearly events bring a cross-campus and community-wide focus to research on science of learning, and help to connect us with researchers and practitioners interested in the area. In addition, we take advantage of the availability of the invited scholars to facilitate "incubation workshops" around thematic research topics during which groups of colleagues across campus present their work and research ideas. These events bring together colleagues with similar research focus but may not have been connected to each other due to different disciplinary affiliations.

Brown bag seminars and meeting of the minds series

3. The brown bag seminars, later formalised in the meeting of the mind series, were held monthly to provide opportunities for informal sharing and exploration. It serves as a platform for colleagues to exchange ideas about their completed, ongoing and/or future research, and to explore common interests and opportunities for collaboration within the faculty and across faculties. Typically, each session will have 2 to 3 colleagues speaking for 10-15 minutes about their research, which may share a common theme, phenomenon of interest or methodology. These presentations then serve as stimulations for discussions among speakers and participants, which sometimes result in ideas for further collaboration.

Engaging and soliciting faculty and university leadership support to build crucial research infrastructures and human resource expertise

Given that the SoL-SRT is underpinned by a complex system conceptual framework of learning as happening in hierarchically nested multiple levels, and the aspiration to contribute towards a consilient understanding of learning, we are acutely aware that we lack theoretical and methodological expertise and infrastructure in neuroscientific methods in learning research. Our first step was to build awareness and interest within and beyond the faculty. We were fortunate to

receive further funding from the university and the Faculty of Education to invite two prominent scholars from the United States to contribute to our science of learning strategic developments: Professor Laura-Ann Petitto, co-principal investigator and science director of the NSF Gallaudet University Science of Learning Center for Visual Language and Visual Learning (VL2), under the Sin Wai Kin Distinguished Visiting Professor Scheme and Professor Kevin Dunbar, Professor of Human Development and Quantitative Methodology at the University of Maryland under the University Visiting Research Professor Scheme. Both of them came for half-yearly visits from December 2014 to July 2016, each lasting about a month. These recurring visits built sustained rapport with colleagues and provided research mentoring which would not be easily achieved through one-off academic visitors.

Given the heightened awareness of the relevance and importance of neuroscientific understanding of learning to education, the faculty was keen to establish a research lab with neuroimaging equipment to support the study of learning. This was particularly opportune when the Faculty was given the opportunity to redesign and strengthen its physical infrastructure when it was relocated to new spaces as part of a campus development initiative. The Dean was successful in soliciting strategic funding support from the university to set up a neuroscience lab in 2015. Professor Petitto played a key role in providing advice to the formulation of the application, and in the subsequent design of the lab. The university's funding support included not only the construction of the physical laboratory spaces and associated neuroimaging equipment, but also the initial funding for a full professor and supporting staff to set up the Neuroscience for Education Laboratory.

What has been achieved so far

Since the launch of Phase 2 of the SoL-SRT, there have been some significant achievements, the most prominent ones include:

1. Establishment of the Neuroscience for Education Laboratory, which was described in the previous section.

2. Success in researchers in the Faculty of Education being a collaborating research partner on a tri-institutional learning design and learning analytics research and development project funded by the Innovative Technology Fund of the Hong Kong SAR Government, led by a principal investigator in the Computer Science Department of the HK University of Science and Technology, and further collaborators in the Massachusetts Institute of Technology.

3. Success in bidding for a theme-based research project on Learning and Assessment of Digital Citizenship,[6] which is the largest education related research grant ever awarded by the Hong Kong Research Grants Council. The project is an interdisciplinary research project involving researchers from the HKU and the HK University of Science and Technology, in the fields of developmental psychology, e-learning and learning technologies, journalism, paediatrics, psychometrics, computer science and computer engineering, anthropology, history, and higher education.

Looking into the future

The major driving force for the establishment of Science of Learning as a field of research at the HKU was the leadership at the Faculty of Education. The SRT was able to achieve tangible and significant outcomes within a relatively short period of time due to the SRT's successes in taking advantage of the mechanisms and incentives available at the university level to support strategic research development, and the willingness of the faculty to invest additional resources to achieve impact. However, this model of development suffers from uncertainties in securing adequate sustained support for long-term scalable development. We have made a first step in raising awareness and interest among researchers and the community, established some core infrastructure for neuroscience in education research, as well as substantial funding for a five-year project on Learning and Assessment for Digital Citizenship that builds on our established research and development strengths on technology-enhanced learning. For these efforts to achieve substantial scientific research outcomes and to contribute to advances in policy and practice requires significant sustained support at the government and institutional policy and strategy levels.

The science of learning research developments to date have also benefitted in important ways from the opportunities we had to connect with and learn from high-profile international networks and events. These have extended the conceptual and methodological reach of the SRT leadership and members, which have been pivotal to the continuing evolution of the SRT. Looking forward, this is also one area of uncertainty that will affect our further development. To date, international networking events in the Science of Learning have relied heavily on the enthusiasm and support from national and international agencies and institutions. However, there is no standing organisational infrastructure and mechanisms for establishing an explicit vision and negotiating priorities and programme for international collaboration and networking to advance research, policy and practice in the Science of Learning. There is great potential for Science of Learning in Hong Kong to develop and contribute as a national, regional and international hub if given the appropriate support, as demonstrated by the achievements made over the past few years.

Notes

1 http://solconvention.cite.hku.hk/

2 http://solconvention.cite.hku.hk/news/

3 https://solaresearch.org/

4 http://www.cite.hku.hk/news.php?id=501&category=cite

5 http://www.cite.hku.hk/news.php?id=518&category=cite
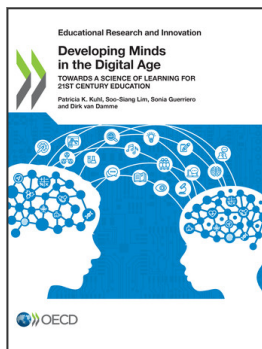
6 https://ecitizen.hk/

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Wilson, E. (1999), *Consilience: The Unity of Knowledge*, Vintage, New York, NY, http://www.wtf.tw/ref/wilson.pdf. [3]