Symposium: Internationalizing the Learning Sciences from Formal to Informal Learning Environments

Co-Chairs:
Carolyn Penstein Rosé & Matthew Kam, Carnegie Mellon University, 5000 Forbes Avenue,
Pittsburgh, PA 15213, {cprose,mattkam}@cs.cmu.edu

Discussant:
Christopher Hoadley, New York University, 239 Greene St. Suite 300, New York City, NY 10003,
tophe@nyu.edu

Abstract: This symposium brings together researchers at the frontier of an emerging subcommunity of the learning sciences that looks toward developing methodologies and infrastructures with the potential to lead towards an integrated agenda of global research in the learning sciences, spanning both the developed and the developing world, in both formal and informal learning environments. It explores how emerging technologies and methodologies could be further developed to this important end, building on work already in progress.

Overview

In recent years there has been a growing awareness that research in the Learning Sciences community could be significantly strengthened by intensifying the extent to which it draws in researchers from underrepresented regions. While the methodologies we have developed and applied in our own backyards and the yards of our close colleagues have served to build up a substantial body of knowledge that we can be proud of, we understand as a community that we stand to gain tremendous insights from diversifying our target student populations from those that are primarily in Europe and North America to regions such as East Asia, South Asia (including India), as well as Africa.

Currently, and unfortunately, there is surprisingly little exchange between the educational research communities of the US and Western Europe and other parts of the world such as Asia where substantial bodies of educational research are conducted but not well known in the West. Other countries such as India have less well developed traditions of formal research in education, but nevertheless have much to add to this international exchange. In India, for example, achievement in mathematics ranks among the top worldwide, which suggests that they have something to teach us while learning about areas where they rank less well in comparison to the West, such as innovation (Steinbock, 2008; de Haan & Narayan, 2008). We hypothesize that systemic differences in the educational systems between countries (Ma, 1999) introduce unknown random factors that interact with key independent variables and thus make it unclear the extent to which results from experimental studies within Asia, for example, generalize to the West, and vice versa. Recent evaluations of Western teaching practices within Asia cast doubt that findings can be transported wholesale from one community to the other without an understanding of what these variables are and how they interact with key educational interventions (Chang et al., 2006; Chang & Tsai, 2005; Chang, 2001).

While we fully appreciate that the concerns of the Learning Sciences community are much broader than international comparisons of standardized tests, it cannot be denied that large scale international comparison studies such as TIMSS (http://nces.ed.gov/timss/) and PISA (http://www.pisa.oecd.org/) have revealed significant differences in achievement between countries that raise questions we much consider. Despite the well known limitations of such standardized measures of achievement, differences between national educational systems undoubtedly exist and raise questions for learning science researchers to address in order to understand these differences. Corresponding large-scale comparisons of teaching practices, such as the well-known TIMSS video study (Stigler & Hiebert, 1999), reveal systematic differences in teaching style across countries. Nevertheless, due to the impracticality in controlling for differences in these comparisons in past studies, work to date investigating the reasons for these differences may be considered limited. Thus, while differences in teaching practices between countries are known to exist, what is not known is how these differences in individual teaching practices interact with systemic differences between countries that lay the foundations for learning within individual countries. And thus, policy makers who would seek to raise scores on standardized tests within their home countries are left with more questions than answers. Culture and its implications for learning is one example of a concern that is orthogonal to what is captured by typical international comparison studies based on standardized tests. Thus, we benefit from acknowledging that controlled cross-cultural studies within the Learning Sciences (e.g. Vatrapu, 2008) help us identify gaps in our current understanding of cognition, learning, and the use of technology in service of learning and instruction. Deeper understanding arising from this kind of work holds the potential to help us reach towards insightful ways to appropriate lessons learned from international comparison studies.

In some regions, such as India, research in the learning sciences as we know it within our international Society is less well developed, and thus an effort to build up collaborations and infrastructure will require a lengthier, concerted effort. The field of Information Communication Technology for Development (ICT4D) has already made strides towards developing technologies and methodologies for technology-supported education and education research within these contexts, which was featured in a CSCL 2009 symposium (Evans et al., 2009), although the focus of this work has been distinct from that of the core Learning Sciences community. We see this earlier symposium as a welcome and synergistic effort to build a bridge from the ICT4D community into the Learning Sciences community. In this proposal, we respond by continuing the conversation by inviting both Learning Sciences researchers and ICT4D researchers to discuss together how to build effective bridges between communities and learn from one another. We believe that this conversation will extend Learning Sciences research to address the challenges of education in the developing world, and in turn identify new research challenges in this space while providing valuable opportunities to challenge our thinking about learning in the developed world at the same time.

Symposium Themes

Recent research in the Learning Sciences community and the ICTD community works towards reaching beyond past limitations, in a wide spectrum of learning contexts, from the "traditional" classroom context, all the way to informal learning environments. This symposium brings together researchers who are working towards internationalizing the Learning Sciences across this spectrum, from formal learning contexts (Rosé and Kam; Laferriere and Law) to informal learning (Moraveji; Kam), or spanning the gap in between (Vatrapu). Each talk argues in a different way that sharing of educational tools and resources internationally would provide an infrastructure that could be used to broaden our understanding of cognition and learning.

One crosscutting theme throughout this symposium is the potential role of educational technology in raising new questions about cognition and learning, adding new insights to our storehouse of knowledge about international education. The presenters have been chosen from a range of backgrounds, such that the symposium will explore the tensions between the cognitivist and sociocultural traditions of learning, design research vs. controlled studies, and local relativisms vs. global universals, as they pertain to the internationalization of the Learning Sciences. The diversity of perspectives is intended to facilitate a lively discussion that re-examines the ideological assumptions behind our methods and theoretical constructs, as well as the historical and cultural processes that shaped them. Finally, presenters will articulate their conceptualizations of culture and its relation to learning.

We have included 5 talk abstracts for this panel style discussion. Each presenter will have 10 minutes to present an overview of their work. The discussant will then conduct an extended panel discussion, which will include questions from the audience.

LearnLab India: Towards "In Vivo" International Comparative Education Research

Carolyn Penstein Rosé & Matthew Kam, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, {cprose,mattkam}@cs.cmu.edu

LearnLab India is a recent effort in the Pittsburgh Science of Learning Center (PSLC, http://www.learnlab.org), which is devoted to studying human learning in realistic contexts using state-of-the-art technology. This effort represents one endpoint on the formal learning to informal learning spectrum in that it is specifically focused on highly controlled classroom studies, which have been termed "in vivo" studies because they occur within "live" classrooms rather than laboratories, with a strong emphasis on balancing high internal validity with high external validity.

The PSLC LearnLab model has been successful in over 50 schools in the United States. It brings state-of-the-art intelligent tutoring technology such as Cognitive Tutors (Koedinger et al., 1997) and Collaborative Learning environments that trigger context sensitive support into realistic contexts (Kumar et al., 2007; Chaudhuri et al., 2009). Furthermore, it brings the ability to study human learning in a rigorous way through analysis of logged data related to student interactions with and through the technology on a moment by moment basis through application of datamining, text mining, and speech mining technology (Prata et al., 2009; Gweon et al., 2009; Rosé et al., 2008). LearnLab India is a partnership between PSLC and the larger School of Computer Science community at Carnegie Mellon University with the Indian Institute for Information Technologies in Hyderabad (IIIT-H). LearnLab India will be housed at the three campuses of Rajiv Gandhi University of Knowledge Technologies (RGUKT, http://www.rgukt.in), which is an educational outreach by IIIT-H to the rural youth of Andhra Pradesh, India. The goal of LearnLab India is to help RGUKT students, most of whom attended non-English-medium schools prior to college, to succeed in English-medium university coursework at RGUKT.

As planned outreach in connection with this effort, the PSLC is sponsoring an Internship Program in Technology Supported Education (http://www.cs.cmu.edu/~cprose/winterschool/index.html), with the goal of building bridges between institutions of higher learning in India and top ranking universities in the United States, beginning with but not limited to Carnegie Mellon University. This program will begin in December 2009 with a Winter School in which 130 undergraduates from around India will come together for an intensive two-week program to learn about research in the Learning Sciences and participate in short-term projects related to the LearnLab India effort.

As an example of planned research, drawing both from cognitivist and socioculturalist learning traditions, we propose to use language technologies to study the learning process itself as well as important social processes connected with that, which play a key role in second language learning, identity formation and commitment to a lifelong learning path. We will build on our prior work, where text mining and speech processing technologies are developed and used to track key patterns in the interaction between students in learning groups (Gweon et al., 2009; Joshi & Rosé, 2007). We will target patterns that are predictive of how much students are learning from the interaction or how well or poorly project teams are functioning together. The research will also draw on earlier research on how videogames can create more engaging learning experiences. Currently an effort is in progress to deploy a collaborative vocabulary building game built on top of the Basilica framework (Kumar et al., 2009).

A current comparative effort in progress is focused on an information literacy unit that will be shared by students at RGUKT and students at Carnegie Mellon University. Two initial pilot studies, one with 10 students and the other with 300 have already begun to reveal differences in information seeking behaviors between students from highly developed areas in India and those of the target user population that suggest principles for needed scaffolding support, which differ from those previously proposed within the mainstream information retrieval literature.

The RGUKT campuses have an annual intake of 6,000 students. The magnitude of the size of the student population available in the research partnership with RGUKT would provide invaluable insights to inform continued research on the effective use of language technologies to support instruction. This partnership would not only greatly accelerate the effort to develop highly effective computer supported instruction because of that magnitude. It would also allow fine grained and finely controlled international comparison studies such as has never before been possible, which holds the potential to transform the field of international comparative education research.

Knowledge Building International Project (KBIP): a Nested Network of Learning and Knowledge Creation

Therese Laferriere, Laval University, 2325 rue de l'Université, Quebec, G1V 0A6, Canada, tlaf@fse.ulaval.ca
Nancy Law, University of Hong Kong, Pokfulam Road, Hong Kong, nlaw@hku.hk

The Knowledge Building International Project (KBIP 2007-2009) operates on the basis of locally based networks of innovation distributed around the globe. Catalunya (Comconèixer), Hong Kong (KBTN), Quebec (RNS), and Toronto (IKIT) are currently the four main sites. Similar to the Rosé and Kam abstract above, this work represents work primarily within a formal, classroom learning context. Nevertheless, while this work is connected with classroom learning, this work is unique in that it reaches beyond activity within individual classrooms or campus communities to build digital bridges between classrooms in different countries.

Pedagogical and research activities within this international effort are conducted within local university-school-government partnerships connected to one another. Much autonomy is left to the participants (students, teachers, graduate students, and researchers) for the designs of what works within their respective socio-cultural contexts, but they come together as they share a common understanding of knowledge building, and use the suite of tools available (knowledge building principles, Knowledge Forum® software, applets for specific analysis measures to be taken on the fly by researchers, teachers, and students).

As part of the applied cognitive sciences, Knowledge Building (KB) has its own epistemology, and it has become a pedagogical approach focusing on developing classrooms as communities for progressive problem solving and knowledge creation (Scardamalia & Bereiter, 2006). Unlike learning organized in traditional classrooms, the KB process is necessarily an intentional community effort, and is simply not possible as an individual enterprise. Learning takes place as a "by-product" of the knowledge creation process as learners tackle significant problems of understanding. Designing curriculum units for implementation as knowledge building experiences for school age children that can, at the same time, satisfy mandatory curriculum requirements is a challenge that has to be tackled to realize the vision of Education for Knowledge Creation in schools.

Agents (students, teachers, school principals, school district personnel, ministry personnel, university teacher educators and researchers) use Knowledge Forum as a "collaboration space" (asynchronous online

discourse). For synchronous discourse, a multi-user web-based videoconferencing system is used. The focus of the students' KB activities in KBIP has been on understanding and tackling issues related to climate change, energy and sustainable development. Typically collaboration at the classroom level is organized in clusters of 2 to 3 classes of students from different countries. Students from these classes engage in KB around a common theme and identify questions and problems. Working on them over a period of several months they contribute hundreds of notes on Knowledge Forum®. In 2008-2009, over twenty videoconferences were held among collaborating classrooms. Additional videoconferences for professional development among teachers from the different sites are also organized throughout the year. School personnel and ministry officers provided guidance and encouragement regarding curricular requirements, university teacher educators and researchers conducted onsite and online professional development workshops. One highlight of the year was the three-day onsite summer institute conducted in Mallorca (Spain), which provided an opportunity for the 30+ participating teachers, teacher educators and researchers to collaborate on designing, facilitating, analyzing and reflecting on the KB work of the 45 primary and secondary students who attended to work on the problem of the sustainability of caves (e.g. tourism effect, cave ecology, installing light in the caves and its impact) as well as visited two famous Mallorcan limestone caves.

Despite the challenges of differences in language, culture and time zone, there have been high levels of motivation shown by teachers and students to participate in KBIP. Implementing KB as a pedagogical approach is an innovation and a challenge, both for teachers and learners. Curricula and facilitation design, as well as classroom practices and culture are necessarily different in the different sites. KBIP forces teachers, learners as well as teacher educators and researchers to make explicit their ideas and assumptions and to learn from each other during the process of collaboration and knowledge building. We will report on specific research results obtained in Hong Kong and Quebec regarding student motivation, online discourse patterns, and students' depth of understanding of critical questions facing our world today.

Supporting and Measuring Global Information Literacy Through Cross-cultural Studies of Web Search

Neema Moraveji, Stanford University, Stanford, CA, USA, neema@moraveji.org

In contrast to the earlier two abstracts, this work takes us into an informal learning environment within the developing world. Nevertheless, it is connected with the work in progress discussed in connection with Rosé and Kam's abstract above in its focus on information literacy skills. It connects also with the work discussed in the Laferriere and Law abstract in its focus on the internet as an environment to support knowledge sharing and knowledge construction.

Web search is a timely and imperative skill for citizens in information economies or those who participate in interconnected knowledge work regardless of their country. Moving beyond the traversal of digital libraries and into general knowledge acquisition it is a skill that crosses the boundaries between formal and informal learning environments and the developed and developing worlds. While we tend to think of web search as information retrieval rather than learning, much of lifelong learning in modern societies takes place during information seeking on the web, and increasingly internet penetration, and web based technologies, are growing into less developed regions.

Unlike many traditional school disciplines, the topic of web search (part of the broader topic of information literacy) does not belong to any one country or tradition. The technologies involved are culture-agnostic and there is little historical precedence of curricula, learning mechanisms, or best practices. We argue that these factors conspire to make web search an ideal topic to study as a means of integrating global perspectives and expertise in the learning sciences.

Among the sub-skills involved in being information and media literate (i.e. as discussed in Jenkins et al., 2006; Enochsson 2005), the ability to effectively and efficiently find, assess, and synthesize credible and authoritative information on the Internet combine to transcend cultural boundaries. We discuss reasons why Web search (herein referred to as 'search') is an ideal topic of study and alongside planned and ongoing research in a global context.

Academics, instructors, and policy makers have worked to study how search practices are learned in recent years, but much remains unknown. Computer experience, developmental stage, exposure to experts, formal instruction, accurate mental models of search engines and the Internet, and peer interaction each play a role. We plan to focus on *social* factors in particular and study them across cultures as they emerge in distributed and collocated environments.

We have designed and developed tools to support search learning and plan on giving them to schools in different areas in exchange for anonymous usage data that will provide us with the ability to take the global 'pulse' on global information literacy expertise.

To deploy such technologies in classrooms within different countries, we plan to build upon the existing base of dozens of schools worldwide using the Mouse Mischief platform by the authors (Moraveji et al., 2008). Complemented with interviews and classroom observations, this work will illustrate the distribution of expertise in search across the world and how such skills spread socially. These findings will inform the redesign of the tools and design guidelines for systems and curricula aimed at improving information literacy. We anticipate that search expertise may follow a distribution quite different from those in traditional school topics and performance on standardized tests, revealing trends on expertise in the global information economy, helping all countries prepare accordingly.

Information-processing theory posits that the formal mental operations required to conduct purposeful and effective searches (e.g. as required to define abstract keywords) emerge at the corresponding developmental stage. We view the logical steps in search as a partial and abstracted representation of the user's cognitive process. Used as such, the data collected from our systems (or through large-scale studies done using Mechanical Turk) will help us conduct comparisons between users and aggregate them to make comparisons across cultures regarding expertise in Web search. By representing such processes we allow them to be transferred between participants via *cognitive apprenticeship*, a process by which learners can model accurate problem-solving skills by inspecting the transparent processes of instructors (Collins 1987).

At this symposium, we will present results from work on studying the social factors involved in the learning of search and information literacy skills on the Internet. The results will incorporate or have implications for learning across cultural boundaries. We advance that studying search is an ideal platform for a global agenda on research in the learning sciences.

Comparative Informatics: Investigating Cultural and Linguistic Influences in Computer Supported Collaborative Learning

Ravi Vatrapu, Center for Applied ICT, Copenhagen Business School, Frederiksberg, Denmark, vatrapu@cbs.dk

Similar to the previous two abstracts, this work focuses on technology enhanced learning. However, this work takes its point of departure in the human computer interactional (HCI) aspects of informal and formal learning settings. Currently, the Internet is undergoing a profound shift towards social interaction, participation and collaboration. Many, if not all, of the informal and formal learning settings are situated within this transforming socio-technical landscape. Within this context, the Comparative Informatics (CI) research program studies how participants interact with technology enhanced learning environments in systematically varied experimental contexts of group composition (intra- vs. inter- cultural; same vs. mixed gender) and linguistic mediums (e.g., Danish, Chinese, English). The rest of this abstract is organized into two parts. The first part presents the design of and findings from a laboratory study of an intra- and inter-cultural CSCL system. The second part discusses conceptual and methodological challenges in conducting controlled studies of technology enhanced learning.

Technology enhanced informal and formal learning environments are characterized by socio-technical interactions. Socio-technical interactions involve individuals interacting with (a) technologies, and (b) other individuals through technologies. These two interactional aspects are theoretically conceived as (a) perception and appropriation of socio-technical affordances and (b) structures and functions of technological intersubjectivity (Vatrapu, 2009). Affordances are action-taking possibilities and meaning-making opportunities in an actor-technology system relative to the competencies of the actor and the capabilities of the system. Technological intersubjectivity (TI) refers to how participants interact with, relate to, form impressions of, and have empathetic experiences with each other in technology enhanced settings. The basic premise of the Comparative Informatics research program is that the perception and appropriation of affordances as well as the structures and functions of technological intersubjectivity vary across cultures and languages.

The CulturalReps research project investigated two specific research questions related to the effects of culture on appropriation of affordances and on technological intersubjectivity in a computer supported collaborative learning environment with external representations. The experimental study design consisted of three independent groups of dyads from similar or different cultures (American-American, American-Chinese, Chinese-Chinese) doing collaborative problem-solving in a knowledge-mapping learning environment. Participants interacted through an asynchronous computer interface providing multiple tools for interaction (diagrammatic workspace, embedded notes, threaded discussion) as they worked on an intellectually challenging problem of identifying the cause of a disease outbreak. Based on empirical findings documenting cross-cultural variations in behavior, communication and cognition, several research hypotheses were advanced. Empirical data were collected using demographic, culture and usability instruments; participants' self-perception and collaborative peer-perception instruments; screen recordings and software logs of experimental sessions.

Statistical results showed that members of different cultures appropriated the resources of the interface differently in their interaction, and formed differential impressions of each other. For example, on average,

American participants of the experimental study created more evidential relation links, made more individual contributions and were more likely to explicitly discuss information sharing and knowledge organization strategies than their Chinese counterparts. Despite statistically significant differences between the three experimental groups on (a) how they used the tools and resources of the learning environment and (b) how they related to each other during and after their collaborative learning interactions, individual learning outcomes analysis of the essays indicated no significant differences (Vatrapu, 2008).

One interpretation of the individual learning outcomes result is that participants utilized the "alternates for action" incorporated into the learning environment effectively and appropriately from their own cultural standpoints. The results of the experimental study indicate the existence of multiple interactional pathways to learning outcomes in intra- and inter-cultural CSCL. However, more systematic empirical work is needed to (a) establish the existence of and (b) evaluate the efficacy of multiple cultural interactional pathways.

Several theoretical and methodological challenges remain in the design and analysis of controlled studies of cross-cultural and cross-lingual technology enhanced learning systems. Interacting through technology is not unproblematic. First, it makes interaction more difficult. Second, it may not mean, feel, and afford same thing to everyone. With respect to computer supported collaboration, there is a productive tension between the future possibilities envisioned and the present realities documented by empirical research. Information and communication technologies (ICT) are often designed under the implicit assumption that members of different cultures using different languages equally view a given functionality as appropriate for carrying out a given, or that another member observing a given act in an ICT environment interprets it as originally intended by the actor. Given that culture, language, cognition, and action (Aydede, 2004; Gibson, 1979; Gumperz & Levinson, 1996; Kramsch, 1998; Nisbett & Norenzayan, 2002; Noë, 2004; Vatrapu & Suthers, 2007) are intricately intertwined, in a technology driven multi-cultural and multi-lingual world, it is an open empirical research problem that the human computer interaction (HCI) design and development aspects of ICT and collaboration systems still permeate with unexamined assumptions. As can be seen from this symposium submission, learning sciences researchers have begun to critically engage with these issues by employing a rich mix of theories and methods across a diverse set of informal and formal learning settings.

At this symposium, an outline of the conceptual and methodological framework for comparative informatics will be presented. Comparative informatics is the application of the comparative method to the study of information and communication technologies across a diverse set of contexts. According to Ragin (1987, p. x), the comparative method is "especially well suited for addressing questions about outcomes resulting from multiple and conjectural causes where different conditions combine in different and sometimes contradictory ways to produce the same or similar outcomes." Prior and emerging findings from experimental studies will be presented. Implications for design and evaluation of technology enhanced learning will be discussed.

Language and Literacy Learning in Developing Communities via Cellphones

Matthew Kam, Carnegie Mellon University, 5000 Forbes Avenue, Pittsburgh, PA 15213, mattkam@cs.cmu.edu

This final abstract builds on the earlier four by studying mobile learning across multiple cultural contexts in the developing world. Now in its 6th year, the Mobile and Immersive Learning for Literacy in Emerging Economies (MILLEE, http://www.millee.org) research project aims to leverage the increasing ubiquity of the cellphone – the fastest growing technology in developing regions such as South Asia and Africa – to make language and literacy learning more accessible to children in rural areas and the urban slums. The educational intervention involves the design of educational game software that runs on the cellphone. The e-learning games target global languages such as English as a Second Language and Mandarin, so as to empower low-income children from minority-language backgrounds to integrate into the mainstream, global economy.

In the last five years, we have performed 10 rounds of fieldwork in India spanning about 12 months on the ground. We observed that rural Indian children found our earlier game designs – which were subconsciously influenced by our prior experiences with Western videogames – to be non-intuitive. This observation forced us to examine the traditional village games that rural Indian children play everyday, and to perform a cross-cultural analysis of the systematic differences between these games and contemporary Western videogames (Kam et al., 2009a). The results from this analysis have been used to inform subsequent game designs. A semester-long evaluation of the games in an after-school program at a village school site in Northern India demonstrated significant learning gains on spelling skills (Kam et al, 2009b). We are making preparations to conduct a larger-scale evaluation in the form of a controlled experiment with 800 rural children in 40 schools in India. While the project in India targets ESL, we are working with new partners to expand the project into backward regions in Africa (ESL literacy) and China (Mandarin literacy). The longer-term goal is to build a research infrastructure that will collect data for us to engage in cross-cultural comparative studies, so as to explore how we can more effectively perform cross-cultural design and reuse/localize learning objects across multiple cultural settings.

In spite of the above (early) successes so far, the greatest opportunity for mobile learning is to put language and literacy learning within reach of the low-income children who cannot attend school regularly due to child labor challenges such as the need to work for the family in the agricultural fields or households. This informal learning approach calls for the cellphone-based games to be embedded within the social fabric of the children's everyday lives, to be used in times and places such as their homes and fields that are far more convenient than schools. This new phase of the project calls for methodological and conceptual innovations. We have conducted participation-observations to uncover the scenarios in the everyday lives of rural Indian children that are promising for mobile learning, and have ran a semester-long in-situ study in which children in the same village used the games under naturalistic conditions. We will continue to refine our data logging procedures to allow us to study how participants play and learn with the mobile games when researchers are not present.

The challenges with designing technology-supported learning interventions for out-of-school settings are not only logistical, but also theoretical. Our results suggest that our current instructional designs are more effective for improving learning among children who have more years of schooling, vis-à-vis children with less schooling. This implication is hardly surprising; drawing on sociocultural theories of learning which posit that the development of higher-order mental functions occurs through social interaction mediated by signs including language, a landmark study by Scribner and Cole (1981) found that the social practices associated with the institution of schooling led to new ways of deploying their cognitive resources. While most published research in education and the Learning Sciences has centered around learners with access to schooling, if we are indeed to design technologies that truly promote learning among out-of-school children, it follows that more research is needed to understand and account for the cognitive processes employed by the latter.

In this symposium, we will present an overview of our results and an initial conceptual framework on instructional design for out-of-school children. This framework will not only aim to help us design educational applications that improve lives for child laborers, but also inform the design of "bridge programs" that help out-of-school children reintegrate into formal schooling as well as better design adult literacy programs. By working with out-of-school learners in multiple cultural settings that include sub-Saharan Africa to South Asia – two regions on the lowest end of most human development indices, our long-term vision is to establish a research agenda whose intellectual merit is to arrive at a more holistic understanding of human learning and cognition – which will fill the gaps in existing research that is largely rooted in Western traditions and societies.

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