Governing Board Symposium
Cognitive Science and the Learning Sciences

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Introduction

The focus of the symposium is on real world implementations of educational innovations based on cognitive and learning science principles and research. These real world implementations can be in physical classrooms, on-line courses, informal educational settings, as well as other learning environments. The innovations can include new ways of conceptualizing and presenting a domain, computer-based multimedia learning tools, and other innovations. The common thread though is that these innovations are beyond lab-testing and are guided by principles and research from the cognitive and learning sciences. The governing board symposium will bring to the conference educational innovation found in different parts of the world (US, Asia, Europe) from distinguished researchers representing a variety of theoretical orientations and focusing on different aspects of the learning process (e.g., cognitive, social, emotional/ motivational).

Can intelligent tutoring systems become even more effective than human tutors?
Kurt VanLehn

This talk will start by reviewing reasons why human tutoring should be more effective than computer tutoring. Studies indicate that human tutors do not actually use some of the techniques that they are assumed to use. Moreover, the techniques that they do use are also used by step-based tutoring systems, which are a type of intelligent tutoring system. Thus, it comes as no surprise that step-based tutoring systems and human tutoring are equally effective, as shown in a meta-analysis of content-controlled experiments. This raises the question: what if step-based tutoring systems started using some of the techniques that human tutors were supposed to use? Would they even become more effective than human tutors?

Social foundations of coordinated learning across environments
Roy Pea

A persistent challenge in the learning sciences is accounting for coordinated learning across the socio-cultural environments in which people participate. K-12 aged children have been a special focus of these inquiries, given the preponderance of their awake time for learning outside of school, the recalcitrant problems of transfer of school learning to life, the underuse of funds of knowledge children have from life in school learning, and persistent achievement gaps. Contemporary accounts of K-12 learning over environments, while still attentive to cognitive issues of learning and reasoning in the disciplines, have been making substantive progress on the coordinated learning challenge in their attention to associated learner developments in identity, interests, social networks (and affiliated social learning capital), and examining social learning mechanisms such as imitation, joint visual attention, formative feedback, positioning in discourse, and accountable reasoning and talk in communities of practice. Highlights of recent work on these issues are also imbued with significance for socio-technical design of engaging learning environments that can mediate learning using new social media and mobile technologies. Our NSF-funded LIFE Center (Learning in Informal and Formal Environments) has been pursuing these issues as it seeks to develop and test principles about the social foundations of human learning from infancy to adulthood. Select findings will illustrate these developments towards understanding and designing connected human learning.

Bridging cognitive and learning sciences by engineering constructive interaction in Asian classrooms

Naomi Miyake

Real-world learning situations provide us with test fields for our cognitive science theories of how people learn. In this presentation, I report a case where a fundamental framework about how people constructively interact to learn could guide some policy making and practices in classrooms, which could influence the course of change in Japanese school education. The framework is named "constructive interaction," (Miyake, 1986) which states that two person, when engaged in solving a shared problem, exchange roles of a task-doer who proposes possibilities for solutions and a monitor who reflects upon such proposals, and such role exchange potentially promote each participating individual's understanding of the problem.

Though group work has been common in Japanese classrooms, such practice has not been guided nor assessed via lenses of cognitive and learning sciences. In the pursuit of acquiring the 21st century skills, current classrooms have been trying to shift their practice from teacher-centric, fact-oriented training to learner-centric, knowledge-building learning. In such classes the learners' activities are often socially interactive, or collaborative. There are many different ways to make a classroom collaborative, sometimes with confusion about which leads to which outcome. In my recent research in promoting collaborative classrooms based on the above framework, I have identified three research questions related to such confusion, created a testable classroom design to answer the questions. The three questions are to confirm that (1) outcomes of constructive interaction are individualistic, not easily shared by other members of the same group (or class), (2) a learner who mostly listens and monitors can still learn as much as more active learners, and (3) for a constructive interaction to lead productive learning, there is no need to socially organize the group, but it is essential for the members to share the desire to solve an apparently shared problem, or understand it. During 2010 and 2011, one hundred and four teachers from elementary to high school devised and delivered such classes in major subject areas, which resulted in higher performance than regular classes, with higher motivation to learn more after the class (http://coref.u-tokyo.ac.jp/en). The findings so far show that the answers to the above three questions are positive, as predicted by the basic framework of constructive interaction, making it possible to crease design principles for designing more productive collaborative classes around cognitive science frameworks. It has also been shown that this type of cognitive-science-based design principles could guide real learning in real classrooms, and when some basic cognitive science is shared by the practitioners, the outcomes of such classrooms can lead them to develop better practices on their own.

Emotions are important for students' learning and achievement

Reinhard Pekrun

Emotions are ubiquitous in academic settings. Students frequently experience emotions such as enjoyment, hope, pride, anger, anxiety, shame, hopelessness, and boredom in these settings. Moreover, these emotions are likely to influence students' learning, achievement, and health. Traditionally, they have not received much attention by empirical research, test anxiety studies and attributional research being notable exceptions. During the past ten years, however, there has been growing recognition that emotions are central to students' learning. In this presentation, I will address the functional relevance of emotions for student learning. Subsequently, I will discuss the origins of these emotions and related educational intervention aiming to promote adaptive emotions that facilitate academic learning. Pekrun's (2006) control-value theory of achievement emotions will be used as a conceptual framework.

Test anxiety research has shown that anxiety can exert profound effects on academic performance; is this true for other emotions as well? I will discuss five cognitive and motivational mechanisms that can mediate effects on learning: (1) availability of working memory resources; (2) long-term storage of information in terms of retrieval-induced forgetting and facilitation; (3) intrinsic and extrinsic motivation to learn; (4) use of learning strategies; and (5) self- versus external regulation of learning. As a consequence of effects on these processes, emotions can profoundly influence students' competence development. I will present experimental evidence and findings from two longitudinal studies on upper elementary and university students' emotions documenting these effects.

Given that students' emotions are functionally important, their origins and related educational tools to modify these emotions should be considered. Using the control-value theory, I will argue that appraisals of control over achievement activities and outcomes, and of the value of these activities and outcomes, are fundamentally important for emotion arousal in academic settings. By implication, teachers, tasks, and learning environments influence students' emotions by shaping their perceived control and values, and ways to influence these emotions can be developed by considering these appraisals. One especially important variable shaping students' appraisals and emotions likely is the cognitive quality of tasks. I will present exemplary evidence from an intervention study which examined the impact of cognitively activating tasks involving mental modeling on students' emotions in mathematics. The findings suggest that it is possible to promote students' appraisals and adaptive emotions by shaping tasks and learning environments in cognitively and emotionally activating ways.

References

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