Applying Cognitive Principles to Improve Science and Math Curricula

Chair: Steve Schneider, WestEd
Discussant: Phil Kellman, University of California, Los Angeles

1. Using research on analogical reasoning, diagrammatic reasoning, and prior knowledge to improve middle school science outcomes.
Presenter: Nora Newcombe, Temple University

There have often been complaints about the lack of implementation of basic research findings from cognitive science into curricula. We are conducting a large research study to examine whether systematic modification of middle school science curricula using general cognitive science principles can significantly improve student learning in large urban school districts. A team of cognitive scientists is collaborating to systematically modify 3 curriculum units in common textbook for teaching science and 3 curriculum units in a common hands-on science curriculum. The modifications are based primarily on four main principles derived from cognitive science research: contrasting cases setup instruction, visualization conventions and challenges need to be explicitly addressed in instruction, instruction must build upon and address student prior knowledge, and spaced testing improves retention. We describe the foundations of these principles and provide examples of how these principles were used to modify the science curricula. This study presents an opportunity to test the cumulative benefit of basic cognitive science research applied to science education rather than just laboratory demonstrations.

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2. Applying principles of worked examples, visual mapping, formative assessment, and spacing to improve middle school math outcomes
Presenter: Jim Pellegrino, University of Illinois, Chicago

Basic research in cognitive science has identified design principles for effective instruction and practice. However, as classroom settings and curricula are very different from the typical research laboratory settings and materials, this substantial knowledge base has had only a limited influence in shaping the design of most K-12 instructional materials and practices. The National Research and Development Center on Cognition and Mathematics Instruction has the goal of redesigning components of a widely used middle school mathematics curriculum – Connected Mathematics Project (CMP) using four primary design principles from the IES Practice Guide (Pashler et al., 2007). These principles include: (1) combining