I am excited about this conference and the possibility of attending. My research interests focus on the malleability of spatial skills and the role of maps and other representations in spatial thinking. Thus I think I would both contribute to and benefit from the conference. I've organized my application around two themes: My perception of the value of a spatially-oriented curriculum, and a foundational research question that I think must be explored as we embark on developing these spatially-oriented curricula.

**The Value of a Spatially-Oriented Curriculum.**
A spatially-oriented curriculum is one that stresses the need to think about relations among facts or locations. Students are confronted with great masses of information, covered in ever-expanding textbooks that now approach 1000 pages in length. Representing and thinking about information spatially can help students to see relations and patterns among facts, rather than simply memorizing burgeoning lists of them. With Bob Kolvoord, I am investigating how working with GIS promotes thinking about new science and engineering problems in spatial ways. At the conference, I would discuss the possibility that infusing GIS-based instruction into early science and engineering classes could promote spatial thinking across the STEM curriculum.

More specifically, I think that a spatially-oriented curriculum would allow students to transfer information and approaches to problem solving. Transfer of abstract ideas from one topic to another can be notoriously difficult, and consequently, students learn bodies of information in one class that have little, if any, connection to what they have learned before or what they will learn next. Bransford & Schwartz, 1999 argue that effective transfer often involves learning how to think about information in consistent ways, despite changes in the specific topics. Spatial representations may provide a foundation for transfer of information because they provide a common framework for approaching different kinds of problems and thus help to reduce the tendency to treat each course as a separate silo.

**Research Question.** To implement effective spatially-oriented curricula, we need careful and specific research on several important questions. Here I discuss one set of question that I think could be one potential topic for the conference.

**Spatial Practices and Spatial Abilities.** There is no doubt that cognitive ability profiles greatly influence who goes into STEM fields (e.g., Wai, Lubinski, & Benbow, 2009). However, we need to be careful about assuming that these ability profiles necessarily reflect what scientists actually do. As I have argued elsewhere (Uttal & Cohen, 2012), spatial abilities may be particularly
important early in learning, but their importance may actually decrease as students learn more and become experts. Science education will often involve the acquisition of a large number of distinct practices—methods and approaches for solving problems. This point is stressed in the most recent National Research Council (NRC) guidelines (2012) for science learning, which suggest that we should define scientific thinking more in terms of what scientists do, rather than in terms of either cognitive abilities or specific bodies of knowledge. Scientific practices will often involve spatial thinking, but this “thinking in practice” will not be easily characterized or captured by solely by spatial ability tests. For example, the acquisition of a spatial practice may involve learning different ways to represent information via computer, or when and how to sketch in different ways.

At the conference, I would like to discuss research on the relation between spatial abilities and the learning and development of spatial practices. This relation may not necessarily be simple and direct. For example, it seems possible, even likely, that students who approach mental rotation problems using strategies instead of holistic processing may end up preferring to solve a host of problems in different ways (e.g., Khozhhenikov, Kosslyn, & Shepard, 2005). To me, this is fundamentally a question of development; we are interested not only in the cognitive abilities that predict STEM achievement and attainment, but also in how these abilities influence choice and preferences, and, ultimately, patterns and practices of problem solving.

These questions are not easily answered in the course of a typical psychology experiment or even an academic year. They will require longitudinal studies, perhaps beginning in high school and following students for a year or more into college. These studies are challenging but not impossible, and I think one potential outcome of the conference in Santa Barbara would be the initial development of plans for large-scale studies. Bringing together spatial cognition researchers and natural science educators provides an opportunity to think systematically about the kinds of research that needs to be done. Moreover, it could engender a community that uses similar measure and thus supports the pooling of data across different institutions. I very much look forward to participating in this effort.

References


