With the publication of the National Research Council report *Learning to Think Spatially* and the funding of a Science of Learning Center on spatial intelligence, there is increasing interest in questions of how to teach spatial thinking. There is now good evidence that aspects of spatial thinking can be trained (Uttal et al., in press). But in educating spatial thinking, what exactly should we teach? If we are to be most effective in educating spatial thinking, we need to first identify what we mean by spatial thinking.

So far, I believe that we have not thought broadly enough in our characterization of spatial thinking. We tend to view spatial thinking with the lens of our own disciplines, so that individuals from different disciplines mean different things by “spatial thinking.” For example, in my own discipline, Psychology, most research on spatial thinking has focused on spatial imagery and related processes that are measured by common tests of spatial ability (mental rotation, paper folding etc.), and much research on spatial thinking in Geography has focused on spatial analysis and the use of spatial technologies such as geographic information systems (GIS). These are important aspects of spatial thinking, but spatial thinking is broader than either of these. Although there are dozens of tests of spatial ability (Eliot & Smith, 1983), in developing these tests, there was no systematic attempt to first develop a taxonomy of spatial thinking processes. As a result, current tests of spatial ability measure only a subset of ways we think about space or think spatially. Similarly, geographic information systems represent a powerful technology for facilitating spatial thinking, and have been applied broadly across the college curriculum, but there are other spatial technologies, such as interactive visualizations, virtual models and animations that are also central to spatial thinking.

In my own research I have studied spatial thinking by examining domains of expertise that demand spatial thinking, and analyzing the types of tasks that experts in these domains have to accomplish, and the spatial cognitive processes with which students in these domains struggle. To date, my colleagues and I have examined aspects of spatial thinking in medicine (surgery, radiology, and learning anatomy), in meteorology, mechanical reasoning, physics, and in organic chemistry. Based on my research on complex spatial thinking in these domains, I have identified two basic components of spatial intelligence (Hegarty, 2010). The first is *flexible strategy choice* between imagery or simulation-based thinking and more analytic forms of thinking. The second is *meta-representational competence* (di Sessa, 2004), which encompasses ability to choose the optimal spatial representation for a task, to use novel external representations productively, and to invent new representations as necessary.
My research has examined only a small subset of disciplines in which people think spatially. I welcome the opportunity that this meeting will give us to examine the nature of spatial thinking, across the whole college curriculum, in order to begin to develop a broad characterization of the nature of spatial thinking.

In working toward a curriculum for spatial thinking, it will be important to identify which spatial thinking processes and skills are applicable to several disciplines and which are specific to particular disciplines. Some aspects of spatial thinking, such as imagining spatial transformations and using spatial technologies are likely to be broadly applicable. Therefore, one possible strategy in developing a college curriculum is to identify aspects of spatial thinking that could be taught in foundational general education courses. On the other hand, there are important questions about whether spatial thinking can be taught in a domain-general way or whether it is best taught in the context of a discipline. For example, we now have good evidence that spatial thinking processes (e.g., mental rotation) can be trained (Uttal et al., in press), but there is limited evidence that this training transfers to performance in academic disciplines that involve spatial thinking.

I expect that one of the outcomes of this meeting will be a set of research priorities that need to be addressed in order to fill gaps in our knowledge about the nature of spatial thinking. However, there are already promising approaches to spatial education being implemented at several universities. In drawing on current best practices and a broad understanding of the nature of spatial thinking, I think we can move forward and consider how a curriculum in spatial thinking can best be implemented at the college level, while continuing to research the nature of spatial thinking and evaluate current approaches to spatial education.

References:


