Designing Better Methods of Instruction in Spatial Domains

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My work has grown out of a background in behavioral research in spatial cognition and has been guided by the observation that instruction in many spatial domains can be significantly improved. My intention is to use my background to help provide improvements in instruction where they are needed. As I pursue this work, I find that I often emphasize different options from many of my colleagues in psychology. I think my own views arise from working in an area, instruction of basic neuroanatomy and neuroscience, that is a complex topic learned as part of relatively advanced disciplines. I will take these few paragraphs to try to express how my recent work has begun to define for me an approach to empirical work in instruction.

I am constantly reminded these days of the familiar tension between basic science on the one hand and ecologically valid research on the other. For my own part, I have grown rather impatient with the traditional model of hypothesis testing. I think that the many people encouraging Design-Based Research are pointing to contrasts that are important for the work I wish to do. A critical part of the contrast, in my view, is that science generally takes the world as it is and tries to analyze why it is that way. The approach leads to manipulating one variable at a time. Design-based approaches arise in the context of making new things. The first order of business is to measure how well the new systems work and to strive to make them better. Once best practices are established, we can move to analyzing precisely how and why the new systems work as well as they do. Whether you find this approach attractive will probably depend on your practical experience. In my experience, you cannot build an effective instructional system one variable at a time in a bottom-up fashion. The world has too many higher order interactions. You need to build the best system you can and compare it to realistic alternatives. Precisely why one system is better than another may not be immediately decided from the point of view of analytical theory.

My recent work has involved interactive computer-based systems with high quality computer graphics. Most recently, my colleagues and I have been developing systems for learning basic neuroanatomy. This work illustrates concrete aspects of my approach to instruction in several ways. First of all, I think that computer-based graphical systems will fundamentally change instruction in an area such as neuroanatomy. I am well aware of the research that suggests that such systems are not effective. The simple fact, however, is that well designed systems have not in general been constructed, and they certainly have not been tested. I believe that instruction in spatial domains will soon be transformed by new digital technologies informed by cognitive science and the long tradition of research on learning.
Interactive computer graphics in computational instructional systems will permit exploration, thoughtful experience, testing, and feedback that was unimaginable until recently.

Another part of the approach that we have been taking is that the best way to develop skill in a complex domain such as neuroanatomy is to teach people the material in that domain. I am sure that there are many cases where it is a good idea to develop basic spatial skills, much as children learn basic mathematical skills. For complex material such as neuroanatomy, however, I think it is likely that we need to find the best ways of teaching that material. Each discipline will have its own tasks, its own complexities, and its own best solutions. The methods and solutions that are found to work well will generalize in many ways to instruction in other domains. But the development process must dive into the content of the domain in order to build those methods and solutions in the first place.

We have also been taking the approach that methods of instruction that work well for the typical person will work well for people who have low spatial ability. People who have low spatial ability may take longer to learn, but the methods that help them will be the same as the methods that help everyone else. This is not intended to overlook variations in spatial ability or to say that they are unimportant. Rather, it is a belief that a major source of variance in the effectiveness of learning follows from the structure of the domain. Finding a better way to make that domain accessible will benefit everyone.

Finally, I doubt that domains of spatial learning are homogeneous in terms of the kinds of knowledge and skill that they require. People learning to read microscope slides are not necessarily doing the same thing as people learning to read MRI images. Microscopes are applied to microanatomy, and this can only be seen through microscopes. MRI images concern gross anatomy, and most of the people who read them have had experience with dissection. Spatial localization is almost never important in microscopy, while it is often of particular importance for someone reading an MRI image. My guess is that the geosciences require knowledge and skills that are different from both of these biomedical cases. In this context, I am skeptical about whether the standard tasks from experimental psychology, such as the typical mental rotation task, are good models for the kinds of learning required in real world spatial reasoning. It may be useful to remember that before the advent of these “mental imagery” tasks, there was almost no scientific study of spatial cognition at all. After the advent of these tasks, many psychologists studied only these tasks. As psychology moves into areas of real spatial reasoning, I believe there will be a great deal to learn.