# Developing a Spatial Thinking Skills Taxonomy: Are There Important Lessons to Learn from Bloom?

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## Introduction

The importance of spatial thinking reached a level of prominence with the publication of the National Research Council (NRC) Report *Learning to Think Spatially* (2006). In the report, an interdisciplinary group of contributors detail the significant role that spatial thinking plays in the sciences, in everyday life and in the workforce. The report notes, "skill in spatial thinking is presumed throughout the K-12 curriculum, but is formally and systematically taught nowhere" (p. 131). Many STEM disciplines (science, technology, engineering, mathematics), even at the university level, fail to facilitate critical thinking skills. (Fox & Hackerman, 2003). In a recent volume of this journal (Gersmehl & Gersmehl, 2006), the Gersmehls articulate the need for classifying geographically-scaled spatial thinking skills into a taxonomy as a way to begin addressing this void in the K-12 curriculum. The authors suggest that for geography to return from the margins of K-12 education in the United States a "concise but comprehensive list of spatial thinking skills" is needed. I found their arguments and proposed list of spatial thinking skills stimulating. As I read their proposal, a question kept coming to mind: What can we learn from the development of Bloom's taxonomy that would apply to the development of a taxonomy of spatial thinking skills? In the paragraphs which follow, I begin with a short discussion of what we mean by spatial thinking skills, and then briefly identify some parallels between Bloom's taxonomy and the Gersmehl's proposal for spatial thinking skills.

I think it is reasonable to begin by considering what we mean when we use the term spatial thinking. As outlined by the NRC Report (2006), spatial thinking incorporates concepts of space, tools of representation, and processes of reasoning in order to structure problems, discover solutions, and articulate answers. Clearly, this broadly defined approach to spatial

thinking encompasses disciplines beyond geography and applies equally to academic and daily pursuits; spatial thinking is endemic to life. The Gersmehls' interest is in defining a taxonomy of geographically-scaled spatial thinking skills—skills that can be explored within an educational setting but can also be extrapolated to daily life. As geography educators I do think we need to clarify that the spatial thinking skills which are of importance to us should be in the K-12 curriculum. These spatial thinking skills would include, among other abilities:

- spatial relationships
- connections
- patterns
- relative location
- absolute location
- estimation of distance
- interpretation of scale
- visualization.

Many of these skills, but not all, are included on the Gersmehls' list. These skills, which are consistently identified as relevant to our discipline, occur both within map space as well as within the world. The authors clarify their intent to present a taxonomy of spatial thinking skills that students may use in map analysis. I would argue that we should support spatial thinking skills that apply to both map situations as well as real world applications.

*Bloom's Taxonomy*

The Gersmehls' proposal for geographers to engage in a discussion of a taxonomy of spatial thinking skills mirrors the approach taken over 50 years ago by a group of scholars in developing what became known as Bloom's Taxonomy (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). That group met and communicated for more than four years (1949-1953) about better ways to assess learning. Early in their discussion, they realized the need to begin with instructional objectives with which to plan learning experiences and design evaluation instruments. Most would agree that *The Taxonomy of Educational Objectives* is one of the most influential works in education today. The hierarchy from knowledge, comprehension, and application to higher order thinking skills of analysis, synthesis, and evaluation has been a mainstay of educational practice in the U.S. for nearly 40 years.

There are other parts of the history of Bloom, *et al.*, that may be less well known but particularly relevant to this discussion. The committee that collaborated on what has become known as Bloom's Taxonomy was concerned as to whether their work should be considered a "taxonomy" at all; they feared that a taxonomy "might lead to fragmentation and atomization of educational purposes" (Bloom, *et al.*, 1956, p.5). I think this is a valid concern as we move forward with thinking about a taxonomy of spatial thinking skills. The Gersmehls clearly, have given this some thought in that they note in caveat number one, "spatial thinking is an important part of geography, but it is not all of geography!" and in caveat number four "...this list is not a sequence of skills that should be taught in the order listed..." (p. 31). I would hate to see the rigor and diversity of the discipline of geography distilled to a testable list of spatial thinking skills.

For many decades, Bloom's Taxonomy has been a primary method of classifying educational objectives and learning experiences, and has been used extensively in educational assessment. As geographers we can all recognize the dangers that may be lurking in the event that we develop a taxonomy to serve as a foundation of assessment of spatial thinking skills that is misunderstood and/or misused. Thinking about this has reminded me of the practice of many well-intentioned teachers requiring memorization but little application of the *Five Themes of Geography*. I think it is important to note that the committee that formulated Bloom's list put forth the cognitive taxonomy as an impetus for discussion on learning rather than a concrete list of cognitive skills; a flexible tool rather than a rigid hierarchy. These are critical characteristics for us to consider as we move forward in this discussion.

*Organization of Spatial Thinking Skills*

Bloom and his colleagues paid particular attention to the precise definition of terms as they articulated their taxonomy. This is another lesson, I believe, we can bring to this discussion. The Gersmehls propose a list from 0-10 plus three spatio-temporal modes of thinking, and two strategies for organizing other forms of spatial thinking; these differentiated skills are based on years of their own research and a thorough review of related research in human cognition and neuroscience. They adopted an approach to develop a sound taxonomy based on the criteria of priority, exclusivity, logical sequence, and exhaustiveness. This is a comprehensive position from which to begin this discussion. I would argue that it is equally important to consider consistently how we can make our understanding and our organization of

spatial thinking skills accessible to both teachers and learners. As experts in geography we are able to understand the implications of research in neuroscience, cognition, education, and human development for the discipline of geography but we often define our concepts in ways that are impenetrable to outsiders. We must communicate these implications in terms that have meaning and can be easily understood by educators at all levels. As Mosely, Elliott, Gregson, and Higgins (2005) write, "it is important to have a comprehensive set of terms when thinking about thinking and learning...those terms need to be jargon-free and meaningful to learners as well as teachers" (p. 370). These concerns, I think, resonate with our current discussion. At present, I do not have specific suggestions for terminology. However, I found some of the terms, such as "aura," to be awkward.

The proposed taxonomy proceeds from specific and local to abstract and global; this is a logical framework. However, would it be possible to create an organization of skills that proceeds from lower order to higher order skills? Or, perhaps, can we apply the recent revision of Bloom to a taxonomy of spatial thinking skills? The revision, in the 1990's, expanded the original, one dimensional framework into two dimensions—cognitive processes and knowledge (Anderson & Krathwohl, 2001). The cognitive processes (Figure 1):

- remember
- understand
- apply
- analyze
- evaluate
- create

appear as columns on a table, with the knowledge dimensions:

- factual
- conceptual
- procedural
- metacognitive

constituting the rows. This change from one dimension to two integrates a hierarchy in cognitive skills along with a complexity of knowledge. Perhaps we can reconceptualize the linear structure proposed (a list from 0-10). This seems particularly relevant in that specific spatial thinking skills can range in complexity (for example different types of regions or the use of scale in

Table 1

*Revision of Bloom's Taxonomy to reflect two dimensions (Anderson and Krathwohl, 2001)*

| **Knowledge Dimension** | **Cognitive Process Dimension** Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| Factual | | | | | | |
| Conceptual | | | | | | |
| Procedural | | | | | | |
| Metacognitive | | | | | | |

analysis) and so much of what is involved with spatial thinking is non-linear and interconnected.

## Conclusion

According to Anderson and Krathwohl (2001), Bloom suggested, in a memorandum that was circulated in the early 1970's, that each major field should have its own taxonomy of objectives in its own language. Although spatial thinking links us to many disciplines, we should work to articulate those skills that are discipline specific and define those skills in terms that are accessible. I applaud the Gersmehl's proposal. They clearly recognize the challenge of building consensus, but did not hesitate to initiate the discussion. I hope that all of those interested in spatial thinking and more broadly the role of geography education in the United States will engage in this discussion; at meetings, in forums like this one, and on collaborative projects. I think we can learn some valuable lessons from the development of Bloom's taxonomy that, I hope, will further this dialog. Specifically, the taxonomy should be flexible; include jargon-free terminology with precise definitions; and be structured in a way that captures the hierarchy and complexity as well as the interconnected nature of spatial thinking.

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