# Sketch mapping and Geographic Knowledge: What Role for Drawing Ability?

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## Abstract

Sketch mapping, a traditional technique for evaluating geographic knowledge, relies in different amounts on drawing ability, spatial ability, spatial memory, and geographic and spatial knowledge. Past research has shown little concern for how non-geographic knowledge and abilities influence the sketch mapping process. For instance, sketch mapping is potentially confounded by drawing ability and non-spatial recall ability. The proposed research employs an experimental design that combines geographic (free-sketch world map, world map labeling from memory and from list) and non-geographic (Rey-Osterrieth complex figures, paper folding, object location memory, and mental rotation) tasks to determine the validity of sketch mapping in world geographic literacy. We also hope to provide some insight into the role of drawing ability in the map creation process. By comparing the three maps with other non-geographic tasks, the relationships among geographic knowledge, drawing ability and spatial memory can be assessed.

## Background and Relevance

The primary focus of this research is the influence that spatial ability, spatial memory and drawing ability have on sketch mapping. Sketch mapping is a traditional method for evaluating geographic knowledge of the world (Blades, 1990; Pinheiro, 1998; Taketa, 1996; Saarinen, 1999). It has proven reliable (Blades, 1990), has helped to improve global geographic literacy (Saarinen, 1999), and has been successfully applied in education and science (Golledge, 1985; Kitchin, 1997; Pinheiro, 1998). This research will elucidate the role of drawing or artistic ability in the expression of geographic and spatial knowledge on hand-drawn sketch maps. Unfortunately, very few studies specify the possible impact of non-geographic abilities, such as drawing, on the outcomes of sketch mapping. Sketch mapping involves varying degrees of drawing or artistic skill, and in fact may not rely on drawing at all (Montello, Freundschuh, Gopal, & Hirtle, 1998; UCGIS, 2002; Montello et al., 2003). Although map-like representations, including model building with blocks (Jacobson, 1998), verbal representations (Bell & Saucier, 2004), stated preference (Gould & White, 1974), and multi-dimensional scaling (Golledge, Rivizzigno, & Spector, 1976), might not rely on drawing, they do have some connection to spatial ability, spatial memory, and artistic ability; in addition they have the common goal of communicating spatial and geographic knowledge (cognitive map).

In the past, sketch map evaluation has been split into the subjective or qualitative assessment and metric measurements of, between, and among objects (Montello, Lovelace, Golledge, & Self, 1999). Billinghurst and Weghorst (1995) employ a "map goodness" score as a subjective evaluation, an "object classes" score as a metric count of objects, and a "relative object positioning" score for map assessment. Many researchers advise caution when using metric measurements as a direct expression of the accuracy of cognitive map, while others argue that sketch maps are as accurate as other indirect cognitive techniques (Newcombe, 1985). More recently, the examination of the topological or non-metric representations has also emerged (Rovine & Weisman, 1989; Haq & Girotto, 2003). This approach is beneficial as task completion might not rely on a level of accuracy commensurate with a person's knowledge. It is a combination of accurate and less accurate information rather than the accurate representation of the cognitive map (Kaplan & Kaplan, 1982). Researchers can evaluate sketch maps based on the subjective or qualitative representation, categorical count of information, and varyingly precise measurement techniques.

Sketch maps are used to better understand what is known or how that knowledge is stored, processed, and used (Blades, 1990). Sketch mapping has been applied in geographic education as early as 1973 (Wood, 1973). The Geography Education Standards Project's "Geography for Life" explicitly identifies sketch mapping as one of its six essential elements of geographic literacy, defining the process as "…how to use mental maps to organize information about people, places, and environments in a spatial context…" (Geography Education Standards Project (U.S.), American Geographical Society of New York, Association of American Geographers, National Council for Geographic Education, & National Geographic Society (U.S.), 1994, 34).

## Methods and Data

Participants completed a test packet consisting of 8 tasks. They were instructed to work individually, to not look forward or backward through the test packet (except where indicated and only during the completion of an individual task), and to proceed to the next task only when instructed. Each task will be timed and will be accompanied by written and verbal instructions to ensure that the participants understand each component of the experiment. The total time to complete this test packet is approximately 41 minutes.

Task 1 is complex figure drawing. It is used as an index of non-geographic drawing ability. Participants are told to copy the Ray-Osterrieth Complex Figure within 3 minutes. A perfect score is 36, based on the individual elements identical to the original figure.

Task 2 is freehand world sketch map. Participants are instructed to draw a world sketch map and label as many countries as possible in 8 minutes. This task measures individual knowledge of world geography by counting the number of countries labeled rather than evaluating the accuracy of countries drawn. Logically, one's ability to draw a well-proportioned map indicates better geographic knowledge.

Task 3 is world map labeling from memory. This task consists of 3 regional outline maps – the Americas, Europe and Africa, and Asia – of 221 countries in total. Participants are allowed 8 minutes to label the countries on a list and to move back and forth among the three maps. It is intended to measure the knowledge of world geography (as indicated by the number of countries correctly labeled) independent of drawing ability. Total number of correctly labeled countries, total number of incorrectly labeled countries, percent correct, and total number of countries labeled are scored separately.

Task 4 is world map labeling from list. Participants are given a list of country names in alphabetical order number 1-221. 10 minutes are allowed to write the corresponding number to the correct location on the map. It is intended to measure the knowledge of world geography independent of drawing ability. Scoring method is same as in task 3.

Task 5 is object location memory task, from Silverman and Eals, 1992. Participants are instructed to study the first picture and circle the objects that have changed location on the second picture without looking back. This task intends to test the participant's spatial memory.

Task 6 is paper folding task (VZ-2) by the College Board. Participants are given 3 minutes to circle one correct answer out of the 5 figures on the right that represents the holes being punched when the paper is folded as the figure on the left. The score is a formula of correct answers minus a fraction of incorrect answers. This task intends to test the participant's spatial visualization ability.

Task 7 is Vandenberg mental rotation task. Participants are given 3 minutes to determine 2 correct 3D objects out of 4 that are identical to the one on the far left after being rotated at different angles. Score is given only when both objects are correct. It is another spatial ability test in this experiment.

Task 8 is complex figure drawing from memory. Participants are given 3 minutes to recall the complex figure that they copied in task 1. This task is used to measure spatial memory and as a second drawing ability index.

Data is divided into two categories – those independent of drawing ability (total number of correctly labeled countries, total number of incorrectly labeled countries, percent correct, and total number of countries labeled) and those related to drawing ability – along with descriptive statistics including sense of direction, drawing ability, group, and sex. Non-spatial analysis includes the coding of the labeled countries (correct and incorrect) for examination using descriptive statistics for correlative analysis and analysis of variance. Data will also be digitized into GIS database for spatial analysis. By using ArcGIS, the presence or absence of clusters of correctly labeled countries for each participant will be established. These "knowledge clusters" will help to reveal group differences in world geographic knowledge. The data will further be exported to GeoDa for spatial analysis using spatial autocorrelation and cluster mapping to determine any statistically significant variation in these "knowledge clusters".

## Conclusions

Drawing or artistic ability may be correlated with the expression of geographic and spatial knowledge. In this experiment, the free sketch world map task is compared with the complex figure (copying and memory) tasks to evaluate the expression of geographic knowledge through drawing ability and spatial memory. The map labeling (from memory and from list) tasks are assumed to represent geographic knowledge independent of drawing ability.

The free sketch map task requires both geographic knowledge and drawing ability. This task is compared to the two non-geographic tasks – complex figure copying and memory. A positive correlation between the free sketch world map and the two complex figure drawing tasks (copying and memory) indicates that those people who can draw a complex figure more accurately will include more countries on their sketch map of the world. This result supports the conclusion that one's artistic ability influences their ability to express geographic knowledge.

The map labeling (from memory and from list) tasks do not require any artistic skills, but do require accurate geographic knowledge. The map labeling from memory task requires participants to recall country names from memory (as in the free sketch map) while providing the spatial cue of world location and country shape (as in the map label from list). No correlation between the drawing tasks and these two labeling tasks would further support the hypothesis that the drawing component of sketch mapping is related to one's ability to communicate what is known about the world or an environment. Inasmuch as the free sketch map task includes both a drawing component and a geographic knowledge component, having it positively correlated with the drawing tasks and the labeling task but the labeling tasks NOT correlated with the drawing tasks would be a strong support for our hypothesis that drawing ability can confound or support one's ability to communicate what is known about the world on a sketch map (depending on whether they are drawn well or drawn poorly).

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