

Effects of Giant Traveling Map Use on Student Spatial Thinking

Jory Fleming and Jerry Mitchell*
Department of Geography
University of South Carolina
Columbia, South Carolina 29208
*mitchejt@mailbox.sc.edu

ABSTRACT

Geographic education is crucial for preparing students to navigate the places and spaces they inhabit, and National Geographic's Giant Traveling Map program seeks to address this need by providing an immersive and kinesthetic learning experience with the use of a gym-sized floor map. In this study, a Giant Traveling Map was tested with sixth grade students to determine the effect of engaging with the map on improving spatial thinking skills. Questions were drawn from the Spatial Thinking Ability Test to assess students' skills pre- and post-experience. Our results show minimal improvement for a few very specific spatial thinking skills and raise questions concerning the testing of spatial concepts and tying in assessment to map activities and geographic learning. We conclude that more study is needed to accurately evaluate the Giant Traveling Map Program for its educational impact.

Key Words: Giant Traveling Map, Spatial Thinking, Map Skills

INTRODUCTION

"National Geographic Giant Traveling Maps are enormously entertaining and educationally powerful tools for introducing geography and map reading skills to students, grades K-8. What better way to teach young people the power of maps and the limitless depth of geography than a half court-sized map of a continent on which they can explore, travel from country to country, hop around, compete, collaborate and have lots of fun?" (National Geographic 2016).

The National Geographic Society has had success introducing thousands of students to geography through its Giant Traveling Map (GTM) program. These large vinyl floor maps (the smallest are 16 by 20 feet) come with a trunk of activities and materials. Currently available maps include Africa, Asia,



Europe, North America, South America, Pacific Ocean, and the Solar System (Fig. 1). Beginning in 2016, two State Giant Traveling Maps were given to each state geographic alliance.

As noted in the quote opening this article, students find the maps to be fun and “enormously entertaining.” Teachers and parents alike share this sentiment (National Geographic 2016). The quote, however, goes a step further by arguing that the maps are “educationally powerful tools.” The maps are certainly powerful in creating awareness of geography, and the reaction by map users (how well did the learners like the learning process?) has been overwhelmingly positive. But what did they learn (e.g.: knowledge and skills), and what changes in performance resulted from the learning process?

This article highlights a project designed to assess GTM use and changes in student spatial thinking skill development. The use of interactive experiences in student education are an integral component of modern edu-

cational curricula, but in this case little data exists on student outcomes post map use. We begin with a literature discussion focused on spatial thinking and kinesthetic learning in geography. The project design follows and we conclude with analysis and recommendations for future work.

LITERATURE

Educators endeavor to find best-practice methods for teaching across all subject areas. This is true for geography education, and a number of efforts have been made to bring “fun” into the learning process. This includes using computer games for urban geography (Kim and Shin 2016), “capture the flag” GPS activities (Hupy 2011), and even treasure hunts (Gaillard and McSherry 2014). It is this quality – enjoyment – that the Giant Traveling Map program seeks to engage as a mechanism for enhancing student learning.

Learners at all levels require, and sometimes prefer, different types of engagement.



Figure 1. National Geographic’s Giant Traveling Map of Europe in use at a teacher professional development conference.

Fleming and Mills (1992) suggest that four modalities are used for learning information. These are described as VARK: Visual, Aural, Read/Write, and Kinesthetic. In geography education, there is a rich tradition in the Visual (maps), Aural (lectures, group discussion), and Read/Write (texts). Kinesthetic refers to experience and practice, usually in the form of demonstrations or simulations. Here we view the GTMs as embodying the Visual and the Kinesthetic by representing spatial information visually (on a giant map) while learning takes place through students movement and physical activity on the map. Consider the difference, for example, of a student listening to a description of mountains versus simulating one by laying down on a floor map. Compared to their typical desk work many students find this engagement to be fun, but does this translate into better content and skills development than traditional instruction?

Geography content includes facts (spatial information) about places, their interrelationships, the processes (both physical and human) that create them, as well as models to explain patterns and change. Also important is “how the human brain learns, stores, processes, and retrieves [this] spatial information” (Gersmehl 2014, 148). There is evidence that age (developmental level) demands different curricular recommendations.

For example, in their review of over 80 works on spatial thinking, Mohan and Mohan (2013, 4) note that “children in early elementary [ages 3 to 6] learn through sensory experiences and do best with tactile, hands-on mapping activities..[and that]... maps should also be big in size to allow children to explore them with their whole bodies.” This would seem to be an opening for a GTM, however children at this age typically do not understand a birds-eye view of the world. As students progressively get older and obtain more real-world experience, spatial concepts such as location, distance, and direction take on more meaning, as does an understanding of symbols and landmarks. The GTM program takes on a unique space

both cognitively and physically. It is larger than a traditional map and smaller than the real world, yet the features remain abstract much like a smaller paper or digital map. As such there is a tension at play – does this novel and alternate form of spatial expression lend itself to affecting spatial thinking in a non-traditional way for learners in a formative stage of conceptual development?

METHOD

This project was funded by a Magellan grant under the Office of Undergraduate Research at the University of South Carolina. Two factors constrain the method: the rental period of the GTM and the rental cost. In this case the map was shared in partnership with schools in North Carolina over a two-month period. South Carolina was allocated two weeks and paid a pro-rated share of the map cost from the grant. This study attempted to make use of that short instructional period. At this writing a two-week rental costs \$610 and is the shortest rental period available. With additional monetary resources, a GTM can be requested for longer periods of time and, as we show here, should be considered to maximize student map exposure to further this type of investigation. Unfortunately, a number of external factors during the rental period required substantive alterations to the original research design; these are described below.

Study Location

Historic, 1000-year flooding in October 2015 closed the two public schools originally slated to participate in the study during the two week map rental period. With the map already in our possession, the tight map rental window (the map would soon be shipped to another state) necessitated quickly finding a school capable and willing to host the map and have their students take part in the study. Within two days we were able to identify a private school located near Summerville, South Carolina that was willing to participate. While we report here

on the experiences of fifty sixth grade social studies students, other students from foreign language classes also were able to use the map during the week.

Participants

The need to quickly find a participating school necessitated a convenience sample. Fifty-two students participated in the map activities. Two were removed from these results as one was in a different grade (eighth) and the second did not complete the post-test. Of the fifty remaining sixth grade students, 24 were male and 26 were female. No other demographic or distinguishing characteristics were collected (race, age, level of ability, etc.) nor was a control group established. The map activities were led by the students' regular teacher who has an extensive background in geography (he has been an active member of his state geographic alliance for twenty years).

Map Activities

The specific map used was the Europe GTM. Three class sections, each containing close to 20 students, participated in the map activities. The students each received one forty minute session on the GTM. This map exposure was far less than originally planned and, though not ideal, was necessary given the sudden location change. School officials and teachers were very generous in allowing this one class period intervention to take place during an already well-planned and paced curriculum.

While on the map, students began by simply walking around and exploring the GTM on their own. The first structured activity involved "TALDOGS". TALDOGS is an acronym for the map features of Title, Author, Legend, Date, Orientation, Grid, and Scale. Students were asked to identify these features and they also spent some time looking for European capital cities for an upcoming map quiz.

The students also discussed latitude and longitude, used the plastic chain that came in

the map kit for measuring distance and relating cardinal directions, and learned examples of absolute versus relative location. The activities primarily focused on human geography as opposed to any specific treatment of landforms. In the weeks leading up to the GTM activities, the students had learned the Five Themes of Geography, identified continents and major countries on desk-size maps, learned about TALDOGS, and had, in the teacher's words, a "limited discussion about scale."

Spatial Thinking Tool

The assessment tool chosen for this project was the Spatial Thinking Ability Test (STAT) developed by Lee and Bednarz (2012). Although originally constructed through testing with university-level students, the STAT has been successfully used in other work that has continued to include undergraduate students and also middle school grades (Verma 2015; Collins 2014). While the National Geographic Society also is interested in knowing more about the educational benefits of the GTM program, a separate geospatial reasoning instrument under their construction was not yet complete when this project began (Chung, Cannady, and Kremer 2015). The STAT, then, was chosen. Knowing that the map experience also would focus on coordinate systems, we added one latitude/longitude question from the Geospatial Thinking Scale (Huynh and Sharpe 2013).

The pre-test and post-test both consist of the same nine questions culled from the original two tests. The questions were arranged in a different order from the pre-test to the post-test. These nine questions were chosen as the ones that would most closely match the types of activities performed on the GTM, save for one on 2D/3D visualization. For example, one question has the students identify the latitude and longitude of a city while another has the student navigate a city block using cardinal directions. Some of these skills also match previous classroom instruction from earlier in the school year as

noted. The expectation was that an engagement with those topics on the GTM would lead to improvement on those areas from the pre-test to the post-test. The students were given the pre-test at the beginning of the week with GTM activities occurring mid-week as the three different class schedules would allow. The post-test was given early in the following week (approximately one week after the pre-test).

RESULTS

Overall Test Results

Fifty students took both the pre- and post-tests. Both instruments were approved for use by our university's Institutional Review Board.

The lowest and highest scores on the pre-test were 0/9 and 8/9; the results for the post-test were 1/9 and 8/9. The average number of questions correct on the pre-test was 4.10;

the average on the post-test was 4.36. A t-test confirms that there are no significant differences between the mean test scores before or after the GTM lesson intervention for the group as a whole. Score declines were seen by 17 students (1.71 fewer questions correct), no change by 6 students, and improvement by 27 (1.56 more questions correct). While male students slightly outperformed females students from the pre-test to the post-test (.38 mean score change improvement to .15 mean score change improvement), a t-test confirms that the observed difference between the sample means do not differ significantly.

Individual Question Test Results

The results were likewise mixed for individual questions (Table 1). The table shows the number and percent of students correctly answering the question Pre- and Post, as well as the overall change.

Table 1. Pre- and Post-test Results

Question	Question Type	Pre-test		Post-test		Change % Correct Pre to Post
		# Correct	% Correct	# Correct	% Correct	
1	Comprehending Orientation and Direction	25	50	32	64	+ 14
2	Comprehending Orientation and Direction	27	54	24	48	- 6
3	Discerning Spatial Patterns/ Graphing a Spatial Transition	35	70	36	72	+ 2
4	Mentally visualize 3D image based on 2D information	11	22	16	32	+ 10
5	Comprehending Spatial Shapes and Patterns	20	40	25	50	+ 10
6	Comprehending Spatial Shapes and Patterns	21	42	21	42	0
7	Comprehending Spatial Shapes and Patterns	26	52	35	70	+ 18
8	Comprehending Spatial Shapes and Patterns	22	44	11	22	- 22
9	Coordinates, Latitude, Longitude	18	36	18	36	0

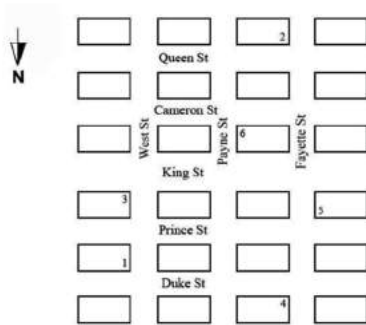
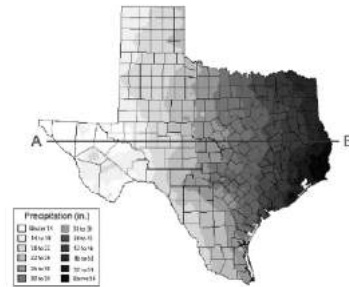


Figure 2. Comprehending orientation and direction question. Question 1 asks: If you are located at point 1 and travel north one block, then turn west and travel three blocks, and then turn south and travel two blocks, you will be closest to point ...” Question 2 asks: If you are located at point 1 and travel west one block, then turn left and travel three, then turn west and travel one block, and then turn right and travel four blocks, you will be closest to point ...” See Lee, J., and Bednarz, R. 2012. Components of spatial thinking: Evidence from a Spatial Thinking Ability Test. *Journal of Geography*, 111(1): 15-26.

Questions 1 and 2

These students had classroom instruction on cardinal directions prior to GTM use, and also worked out direction problems while using the GTM. These two STAT questions utilize a generic city-grid to examine navigation using cardinal directions and would seem to be directly aligned to the treatment (Fig. 2). Overall Question 1 yielded a +7 correct answer improvement from pre- to post-test, while a very similar Question 2 yielded a -3 correct answer decline. We hypothesize that students performed more poorly on the second question because, although it used the same map, students had to make four direction turns as opposed to only three in the previous question. This extra step may have been confusing. Two points of interest matter here: 1) was there sufficient time

DIRECTIONS: The map below shows annual precipitation of Texas.



3. If you draw a graph showing change of Texas annual precipitation between A and B, the graph will be ___

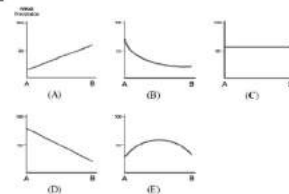


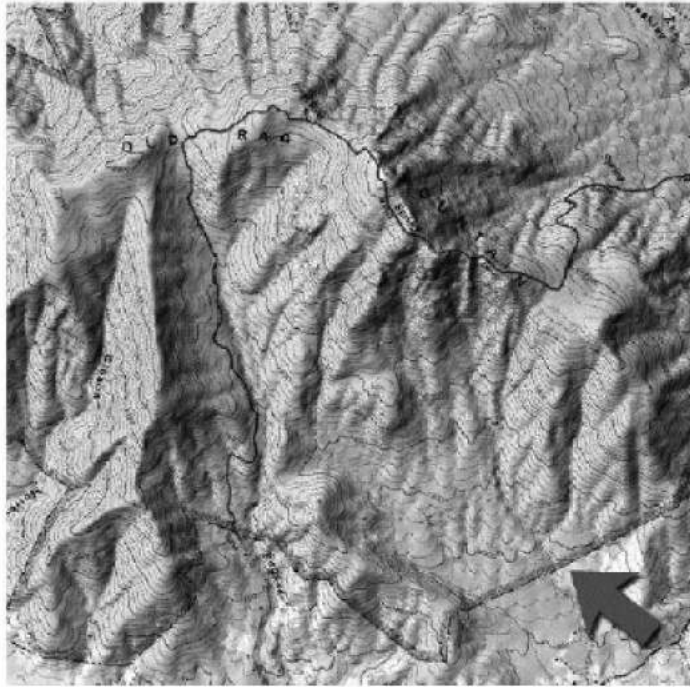
Figure 3. Graphing a spatial transition question. See Lee, J., and Bednarz, R. 2012. Components of spatial thinking: Evidence from a Spatial Thinking Ability Test. *Journal of Geography*, 111(1): 15-26.

spent on the GTM activity to really make a difference, and 2) does a direction activity on a GTM (moving about space on a comparatively small scale map) translate to a direction activity on a hand-held, large scale paper map?

Questions 3 and 4

Question 3 involved relating a graph to a map depicting a rainfall gradient (Fig. 3) and resulted in an overall +1 correct answer improvement. This question had the highest initial success (70% answering correctly the first time). This accords well with the university students in the original STAT study (Lee and Bednarz 2012, 22) where “students could identify patterns on a map and choose a correct graphical display of a spatial pattern.” Our students even outperformed the

DIRECTIONS: Place yourself in the map where the arrow is pointing.



4. If you look at the area above in the direction of the arrow, which terrain view (A-E) most closely represents what you would see?

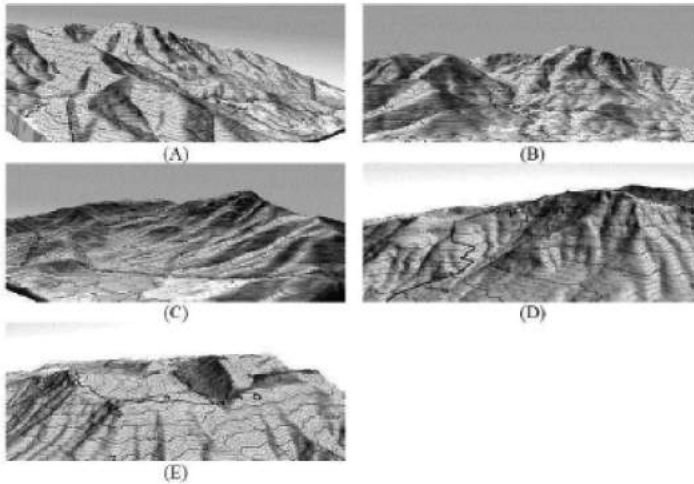


Figure 4. Terrain representation question. See Lee, J., and Bednarz, R. 2012. Components of spatial thinking: Evidence from a Spatial Thinking Ability Test. *Journal of Geography*, 111(1): 15-26.

DIRECTIONS: Real world objects can be represented by point, line (arc), and area (polygon). Based on the examples below, classify the following spatial data.

Example

<p>Point</p> <p style="text-align: center;">•</p> <p>Ex. trees, road intersections, poles in distribution networks.</p>	<p>Line Arc</p> <p style="text-align: center;">~~~~~</p> <p>Ex. roads, rivers.</p>	<p>Area</p> <p style="text-align: center;">◊</p> <p>Ex. the areal extent of a city, an area of a continent.</p>
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5. Locations of weather stations in Washington County _____

(A) Points and Lines
(B) Lines
(C) Area
(D) Points and Areas

6. Mississippi River channels and their basins _____

(A) Points and Lines
(B) Lines
(C) Area
(D) Lines and Area

7. Shuttle bus route of the Lincoln Elementary School _____

(A) Points
(B) Points and Lines
(C) Area
(D) Points and Area

8. Places that can be reached by Franklin County fire engines in 5 minutes or less _____

(A) Points
(B) Lines
(C) Area
(D) Points and Lines

Figure 5. Point, line, and polygon questions. See Lee, J., and Bednarz, R. 2012. Components of spatial thinking: Evidence from a Spatial Thinking Ability Test. *Journal of Geography*, 111(1): 15-26.

junior high students in the STAT study (70% to 46%).

Question 4 required the student to look at a shaded relief map from above and then identify a view that most likely represented what terrain you would see at ground level (Fig. 4). This resulted in a +5 correct answer improvement. This question had the lowest initial success (only 22% correct), a similarly poor outcome as in the Lee and Bednarz (2012) study. Those authors believe that this question may represent more than one – or rather a suite of – spatial thinking skills. It may not be possible to devise any one activity that would improve this ability on a GTM.

It is important to note that there were no activities performed by the students that related to these two particular questions. We added these questions hypothesizing

that there might be some “geographic osmosis” by simply “doing geography” on the GTM – a type of gateway effect. Potentially hindering success as well: the majority of non-map literacy activities (i.e.: TALDOGS) focused on human geography while these two questions involve physical geography. The lack of a focused treatment and this topic change may be adding to these inconclusive results.

Questions 5, 6, 7, and 8

Real-world objects are often represented on maps with points, lines, and polygons. Questions 5-8 asked students to identify these features (Fig. 5). Save for Question 8, there was no to only modest improvement on this group of questions despite GTM activities to find point features (cities), line features (rivers), and polygons (countries).

Two questions in this set allow an opportunity to discuss an important issue – question presentation. For example, Question 7 asked students about a shuttle bus route. An obvious spatial feature is a line (the route), but this was not a stand-alone answer. A shuttle bus route has two spatial features (stops = points; route = line), thus the correct answer was (B) Points and Lines. We surmise that had the answer bank included a Lines only answer, students would have missed this question and the finer point about the two spatial features.

Question 8 was especially problematic as it had the largest decline from the pre- to post-test. We also attribute this largely to confusion with the question wording. “Places that can be reached by Franklin County fire engines in 5 minutes or less...” refers to an *area*, however “places” might have been considered as points by the students. This is a matter of scale. On a GTM, a place such as a city covers more territory and may be considered an area, while on a large scale map it is thought of as a point. This potential language confusion deserves inspection and redress.

Select the coordinate pair that best locates the ‘City’ in Figure 11 below.

- a) $51^{\circ} 50' E, 36^{\circ} 10' N$ b) $36^{\circ} 10' N, 51^{\circ} 50' E$
c) $35^{\circ} 0' N, 50^{\circ} 0' E$ d) $51^{\circ} 50' W, 36^{\circ} 10' S$
e) $36^{\circ} 10' S, 51^{\circ} 50' W$

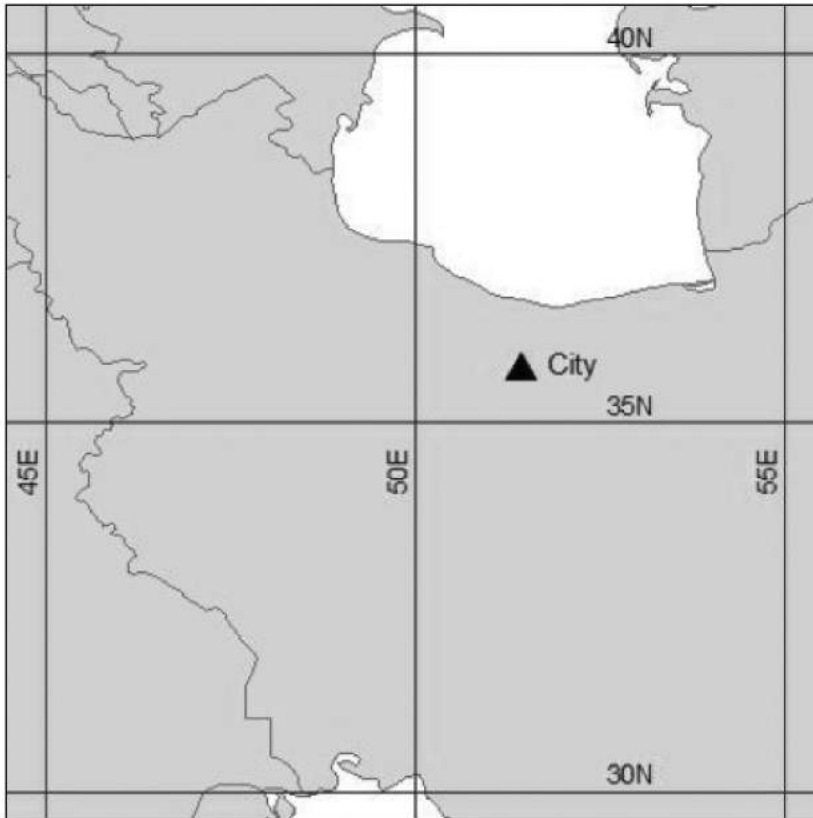


Figure 6. Latitude/longitude question. See Huynh, N. and Sharpe, B. 2013. An Assessment Instrument to Measure Geospatial Thinking Expertise. *Journal of Geography*, 112(1): 3-17.

Question 9

The final question (#9) asked the student to select a latitude/longitude coordinate pair that most closely match a point on a map (Fig. 6); this was the question added from the Geospatial Thinking Scale (Huynh and Sharpe 2013). The result was a 0 correct answer increase. While the students did receive latitude and longitude instruction on the GTM, the very short instructional period (already divided among several other topics) likely did not lead to any enduring understanding of the topic. Further, a single item may not have been sufficient to assess this often confusing concept.

DISCUSSION AND CONCLUSION

The testing results indicated no significant change overall after the GTM activities, and rather modest improvements, if any, for individual spatial thinking questions. We do not interpret these results to mean that GTM use cannot have an effect on spatial thinking skill improvement. Rather, we believe that this presents an opportunity to rethink issues related to how we assess and ultimately seek to develop spatial thinking.

First among these issues is the testing instrument. The Geospatial Thinking Scale (Huynh and Sharpe 2013) was tested primarily on high school, undergraduate, and graduate students. Although the STAT did include some junior high (middle level) students, "...the field tests in several different environments showed STAT was useful for testing both university and high school students" (Lee and Bednarz 2012). A claim for its usefulness for younger students, like the sixth grade students in this study, is not made. The new instrument under NGS development (Chung, Cannady, and Kremer 2015) may show more promise as they have modified their test items with middle school student input, although they do include STAT test items that may still prove difficult. Of interest here is whether the questions are 1) written in a non-confusing

manner; 2) developmentally appropriate for the tested audience; and 3) truly measuring a particular spatial skill. This is an area ripe for continued investigation. Furthermore, the STAT assesses spatial thinking, and though there are parallels, spatial thinking is not the same as *geographical thinking*. Geographical thinking involves a particular advantage, as Hanson (2004) suggests, toward approaching an issue. These include recognizing the relationships between people and the environment, the importance of spatial variability, understanding scale, and integrating spatial and temporal analysis. We have concerns that macro-scale map use (GTM) and the intervention activities that include geographical thinking are not fully captured by the STAT. For example, does using cardinal directions on the GTM to locate capital cities translate to better route-finding on a street grid (STAT question)? Clearly better alignment between treatment and instrument is necessary for future work.

A second issue relates to study design. This project was significantly impacted by factors that shortened the study period and removed the opportunity for a student control group. Two questions we raise here include what length of instructional time both before and during GTM use is appropriate for an enduring understanding of geography topics as taught on a GTM, and what should be the time period between pre- and post-testing to assess permanency and retention? Future work should likely encompass longer GTM exposure and narrow the spatial focus (e.g. only working on distance and direction as a start). We further believe that more time must be spent investigating the activities that come with the GTM kit¹ to make sure that they are designed to specifically have an impact on certain spatial thinking skills. It is not unreasonable to expect that learning geography can occur while "doing geography", but this shotgun approach is unlikely to result in measurable improvement in any one area.

In this work we have not shown that GTM use is superior or inferior to traditional geography instruction for developing spatial

thinking skills, but rather identify issues that can make a determination on that point much clearer. Other efforts, such as a similar project currently underway with the Colorado, Maine, and New Hampshire geographic alliances (NCGRE 2016), along with continuing research by National Geographic, should continue to inform our understanding of how Giant Traveling Maps can not only improve classroom engagement, but also improve spatial thinking development.

NOTES

1. Each map has a notebook containing a variety of activities specific to its map. The Europe map, for example, has a 34-page activity guide. Teachers may review these activities online prior to map arrival.

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