



Digital Mapping Technology in Elementary Grades: Effects on Spatial Ability, Map Skills, Interest and Motivation

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CADRE PI Meeting | Washington, D.C. | June 1-3, 2016

Context

Fifth grade students learned the use of a Geographic Information Systems (GIS) software to solve spatial challenges embedded in a multi-disciplinary unit. During a six-week period, students learned basic set theory functions (interest, union, and difference) and a geoprocessing tool (buffer) and used these functions and tools to solve problems that increased in difficulty. The GIS modules started with only two layers of data using abstract shapes (Venn diagrams) and ended with more than ten data layers that showed areas required to relocate a box turtle in Illinois and bighorn sheep in Utah. Teachers scaffolded students heavily at the beginning but gradually faded their assistance as students depended more on their peers.

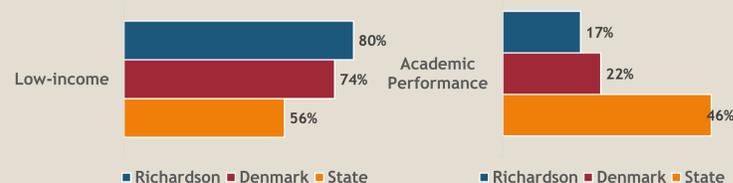
Research Questions

Will engaging in GIS activities significantly:

1. Affect students' spatial abilities?
2. Show the impact of students' digital game behavior?
3. Influence students' map reading skills?
4. Impact students' motivation and interest?

Participants

- 160 fifth grade students, 7 classrooms, 6 teachers, 3 schools (pseudonym: Richardson, Denmark, State) serving diverse population in an urban city.
- Average Demographics: 51% White; 36% Black; 3% Hispanic.



Analyses and Findings

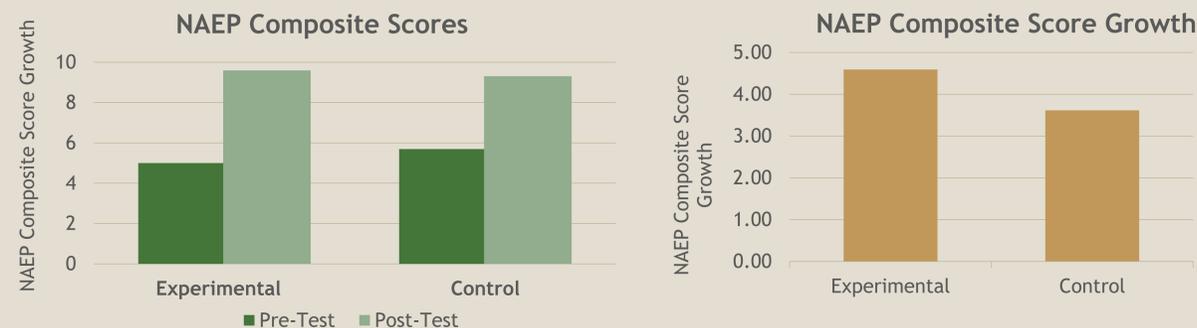
Spatial Abilities and Digital Game Behavior

- **Cognitive Ability Test (CogAT) - Nonverbal items** measured students' spatial ability using abstract questions including paper folding among other subscales. The results indicated that experimental and control groups experienced significant growth from pre to post test ($F[1,141]=77.92, p=.000$). However, the experimental group, compared to the control, experienced a stronger and significant growth ($F[1,141]=4.03, p=.047$) which can possibly be attributed to GIS exposure. Resent studies indicated that cognitive ability tests administered to GIS-trained students did not yield significant results; this finding suggested that GIS does not impact spatial ability. Instead, GIS was found to impact advanced spatial cognition that cannot be detected through cognitive ability tests.
- **Digital Game Behavior.** The CogAT results were obtained after controlling for the impact of digital games that were hypothesized to impact spatial abilities of adult populations. In our study, digital games and duration of play had no impact to students' CogAT scores indicating that the growth observed in the experimental group are likely explained by GIS training.



Map-reading and Map-analysis Skills

- **NAEP Geography items.** Public domain geography items selected from a map-focused pool of questions of the National Assessment for Educational Progress were used to measure students map-reading and map-analysis skills. Similar to the CogAT results, the NAEP results indicated that both groups did significantly better in the post test ($F[1,162]=291.43, p=.000$); however, the experimental group showed a more significant growth pattern ($F[1,162]=26.51, p=.019$). Similar to CogAT; NAEP as a paper-pencil test is not a good transfer measure that can accurately asses the skills and processes learned by students using GIS.



Interest in GIS

- **Exchange Help.** An interest questionnaire was administered both pre and post the intervention. The experimental group indicated a higher preference to giving and receiving help than the control group in the post survey.
- **Computer Use.** The experimental group showed higher comfort level using computers to solve problems and a higher inclination to share computers with peers.
- **Perspective towards GIS.** The items in the box below are items that students rated as either strongly agree or agree.

Post-Test Experimental GIS Interest Questions

I am more interested in solving problems because of the GIS activities	I feel more comfortable with computers now than I did before the GIS activities	I learned a lot from the GIS activities we did in class	I liked the GIS activities we did in class
I am more interested in technology because of the GIS activities	I understand how to solve problems using GIS	I understand how to use GIS	

Conclusion & Future Directions

- The CogAT results we obtained from our studies align with resent literature indicating that the impact of GIS is far beyond what can be measured by abstract figure-based spatial ability tests.
- Our study did not improve students map reading skills, but there may well be other types of GIS training that would.
- The GIS curriculum encouraged students to interact more positively with classmates. It also encouraged students to consider the use of technology for real problem-solving.
- There is a need for developing instruments that can more accurately measure the impact of GIS on student learning.