# Understanding the Role of Geospatial Technologies in the Development of High School Students' Spatial Thinking Skills

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## Introduction

Students' use of geospatial technologies, from GoogleEarth to full-fledged geographic information systems (GIS) software, is increasing across a variety of grade levels in schools around the world. In addition to the experience gained from utilizing this sophisticated software, students are using these technologies to learn in a variety of different content areas. This research attempts to analyze the affordances of these technologies to spatial cognition and reasoning.

The Geospatial Semester is a unique project that allows us to see the impact working with GIS can have for actual students in the classroom. For almost six years, and across 22 different school districts around Virginia, students have had the opportunity to take a semester or year-long course focused on geospatial technologies. Students learn the basics of the software, and then have the opportunity to apply what they have learned in an individualized project to be presented at the end of the semester. Working with sophisticated software can provide multiple benefits to students, and allows a window into how students learn and solve challenging problems.

The central idea of GIS is layering different kinds of geographic data. Imagine a map analyzing water pollution in a watershed; different point sources of pollution could be one layer, streams another, and developed land a third overlay. The spatial nature of the platform allows the researcher to compare these different layers of information on the same display and visualize the interactions. Because terabytes of data are available to the students in this course, GIS provides almost limitless options for students to find a personally intriguing project. However, along with the plethora of options, students must gain the ability to sift through the unimportant information and seek out the right data that are integral and beneficial to their projects. In this way, the technological capabilities teach self-discipline, while the spatially promoted thinking fosters an interdisciplinary approach towards tackling research projects.

## Role of gesture and language in Spatial Thinking

Due to the inherently spatial nature of GIS, we believe an analysis of the gestures that are exhibited by students learning the software will be a rich area of research. We know that sometimes people learning a new concept can demonstrate through their hands more knowledge than simply what they say (Iverson & Goldin-Meadow, 2005) and we hope to apply that to these students learning the intricacies of GIS.

Perhaps their gestures will give insight into their readiness to learn a new feature (Larson et. al., under review) or another dataset potentially relevant to the project at hand. In this way, our research leverages SILC themes in both spatial problem solving and the possible role of gesture to provide diagnostic information as to whether students are acquiring the intended meaning and problem-solving procedures.

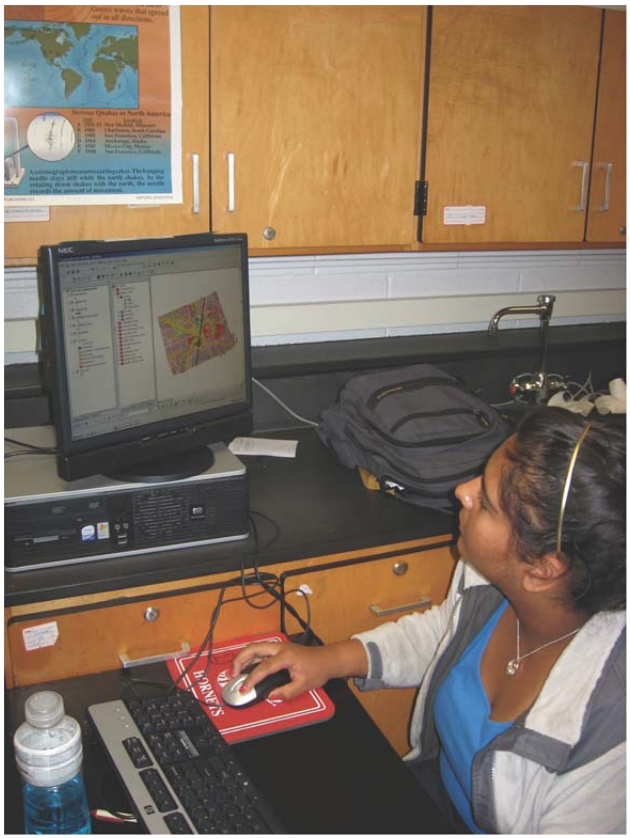

*Figure 1*

Study Design

The Geospatial Semester offers a testbed to explore how in-depth work with geospatial technologies impacts students' spatial thinking skills. We chose one of the Geospatial Semester high schools in Virginia and regularly visited to videotape short interviews with students. These interviews began roughly midway through the year when students had some exposure to the GIS software, but had not yet begun to work on their projects. We visited and videotaped on four occasions from December to May and then coded the videos for the use of spatial language and gesture.

Results

Data collection will be completed in May, 2011. We have already established baselines for comparisons as the remaining interviews are completed. Discussing the projects with the students from inception through presentation will give us an insight into which aspects of the students' problem solving techniques significantly improved due to interactions with the technology and the data and which were unaffected. Additionally, because we have interviews of the students, we will be able to measure qualitatively their enthusiasm for their project, along with which aspects of the course were most inspiring and which aspects had little impact. One quantitative result we will be able to analyze is simply the number of gestures produced by the students while discussing their projects throughout the semester. It is our hypothesis that as they become more knowledgeable regarding their materials their gesture will not only provide insight, as discussed above, but simply that there will be more of it, mirroring the students' gain in understanding regarding their topic.

## Discussion

We are eager to review the results of this work and extend it to continue to unravel the impact of geospatial technologies on students' spatial problem solving skills. We would like to extend this research to compare students in a Geospatial Semester class with a group of students with no experience with these technologies. However because of the voluntary participation in the Geospatial Semester, selecting a control group is challenging. We are also hoping to extend this study to younger students using geospatial technologies in different content classes.

In a parallel project, we are developing a rubric to asses the evidence for advanced spatial analysis in student projects and correlating that with the 21st Century Skills (2009) framework.

As we begin to develop an understanding of the affordances of these technologies, we anticipate being able to offer advice to curriculum and professional development designers to help maximize the benefit of using these tools to master different content.

## References


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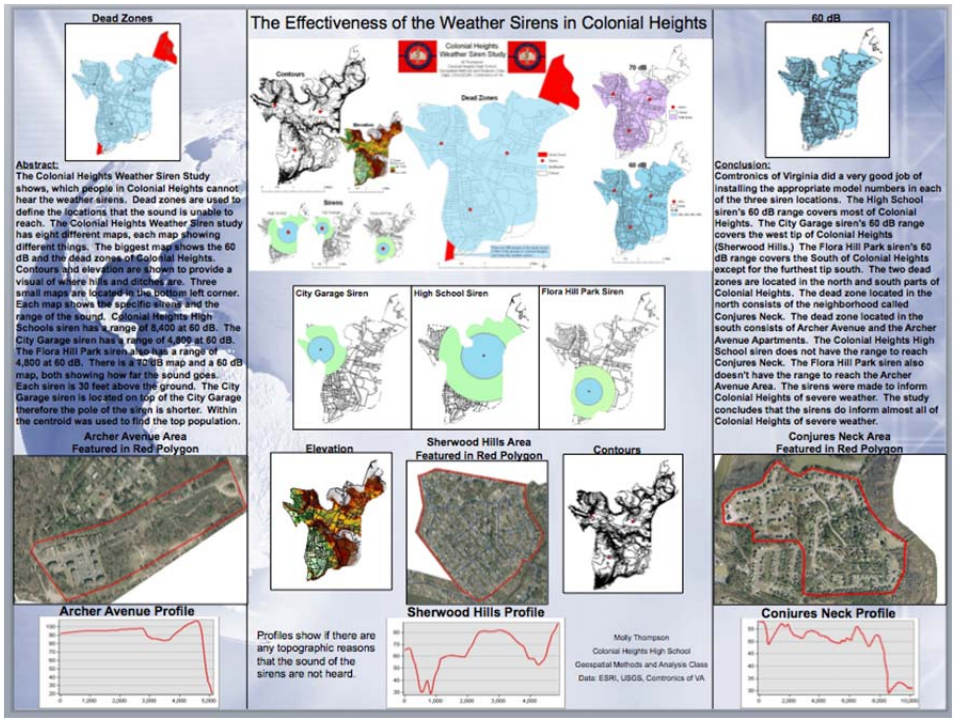


*Figure 2.* Example of a student project. Students from Colonial Heights High School explored the reach of the weather siren in their small city.

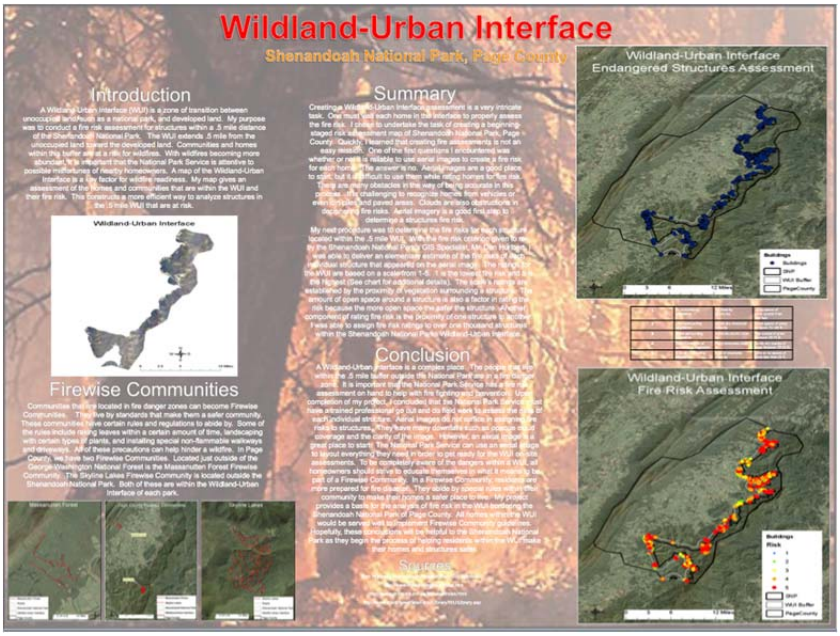


*Figure 3.* Example of a student project. In this project, a student from Luray High School collaborated with personnel at Shenandoah National Park (SNP) to develop a wildfire risk rating system for projects that abut SNP.

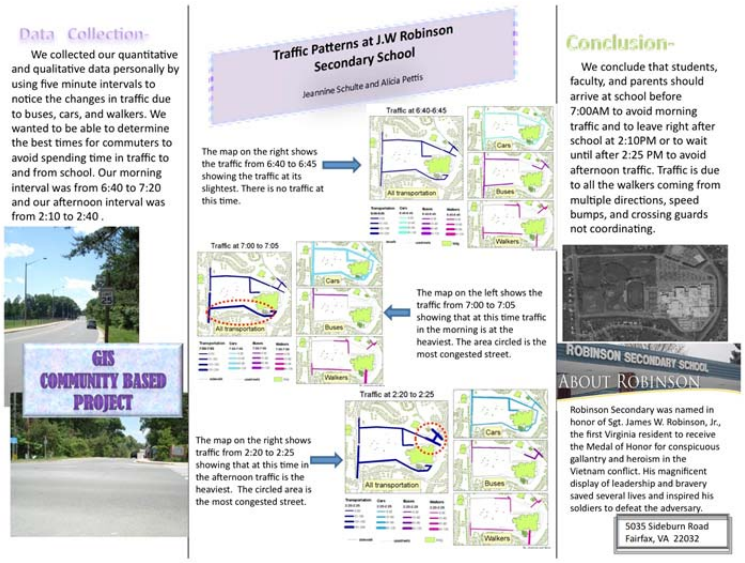


*Figure 4.* Example of a student project. Two students from Robinson Secondary School mapped traffic before and after school and developed alternative routing to improve traffic flow.