

Using Geographic Information Systems to Improve Elementary Student Learning & Motivation in Social Studies

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Abstract

A worldwide focus on improving success in Science, Technology, Engineering, and Mathematics (STEM) has led many educators and researchers to consider new ways of teaching that might impact student motivation and learning, allowing students not only to solve the problems presented, but also to more accurately explain why. Research indicates that Geographic Information System (GIS) can be helpful for student learning (Keiper, 1999). Many teachers initially are unfamiliar with the program itself but receive training in which they learn how to use GIS programs and how to teach subject matter using GIS. Even after teachers are exposed to the program, however, many find it difficult to implement in their classrooms (Lemberg & Stoltman, 1999). Moreover, most prior research has focused on high school students (Kerski, 2003) and college students (Hall-Wallace & McAuliffe, 2002). Our goal was to develop teacher training methods and curriculum to test the effectiveness of GIS learning for elementary students, particularly 4th and 5th grade social studies classes. The focus of our study was Quantum Geographic Information Systems (QGIS) and its effects on spatial thinking and social studies learning. Two teachers participated in intensive workshops during the summer to learn the curriculum, GIS mechanics, and pedagogy. Four classes were randomly assigned to experimental and control groups. Students in the experimental classes completed six modules that contained a set of GIS projects via computers and packets. Using the GIS program, students learned to manipulate maps (layers) using geo-processing tools that allowed them to use quantitative and relational thinking. The control classes completed their standard social studies curriculum. All students completed pre-and post-test measures of spatial thinking, social studies knowledge, and interest. We predict that students who completed the GIS curriculum will show larger gains in spatial thinking, social studies knowledge, and interest in science and technology relative to students in the control group. These findings will provide important details about effective teacher training and learning from GIS during the elementary years.

Introduction

- Improving success in STEM is important
- Geographic Information Systems (GIS)** may provide improved learning and motivation
- Most previous research with GIS has focused on high school and college students (Hall-Wallace & McAuliffe, 2002; Kerski, 2003)
- Our focus was using GIS with **4th and 5th grade students**
- Previous work also identified **technological resources** and **teacher training** as key factors for success (Demirci, 2009; McClurg & Buss, 2007; Shin, 2006)
- Our project included extensive teacher training, GIS modules, and technology support for **students working in pairs with laptops** and teachers using their school laptops.
- We predicted that students using GIS curriculum would show more growth in social studies knowledge and interest than would students using traditional social studies curriculum**
- We also predicted growth in spatial thinking (understanding space and its concepts, means of representing space, and processes of reasoning about space), which may be related to social studies learning



Objective

To test growth in social studies knowledge and interest as a function of GIS curriculum vs. standard social studies curriculum among 4th and 5th grade students

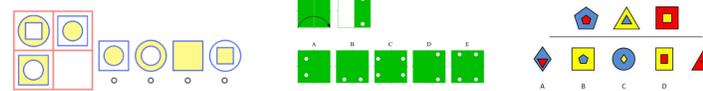
Method

Participants

• 78 4th & 5th grade students and 2 teachers from 4 classes in two elementary schools

Design and Procedure

- IRB approval
- Teacher consent, student assent, and parent permission
- Two classes at each school participated
 - **Experimental classes: GIS curriculum**
 - **Control classes: standard social studies curriculum**
- **Pre/Post Design**
 - **NAEP (National Assessment of Educational Progress) Geography Test:** Tested social studies knowledge using 14 items (20 minutes timed)
 - **Interest questionnaire:** Measured level of interest in social studies and school in general
 - **CogAT (Cognitive Ability Test) Nonverbal Scales:** Measured spatial thinking using Figure Matrices (22 items), Paper Folding (16 items), and Figure Classification (22 items) subscales (10 minutes timed for each subscale)
 - **GIS Modules Using QGIS:** Students learned to manipulate maps (layers) using geo-processing tools (buffer, intersect, union, and difference) to facilitate higher-level thinking
 - Module 0- Sun
 - Module 1- Map
 - Module 2- Venn
 - Module 3- History
 - Module 4- IL Capitol
 - Module 5- Box Turtle
 - Module 6- Bighorn Sheep



Results

- The study is still underway. The majority of data has been collected for this year of implementation, but analysis is ongoing
- We predict that growth in social studies knowledge (NAEP scores) and interest in social studies and science (interest questionnaire scores) from pre- to post-test will be greater for students using GIS than for students using standard social studies curriculum
- We also predict growth in spatial thinking abilities (CogAT scores)



Conclusion

- Previous research has shown positive influences of GIS curriculum on social science learning
- Results from a pilot study used to design and test our GIS modules showed that the experimental group outperformed the control group with regard to systems thinking and argumentative reasoning, two higher-level reasoning dimensions (Jadallah et al., 2014)
- This work is part of a large-scale project that is still underway
- Thus far, we have observed that teachers and students enjoy interacting with GIS, so we hope it will promote spatial thinking and enhance interest in and knowledge of social science
- We will include classes at three additional elementary schools next year as we continue to test whether implementing GIS in 4th and 5th grade classrooms leads to lasting gains in social studies knowledge and motivation
- We hope that this work will lead to more GIS implementation in elementary schools, including strong teacher training and student outcomes



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