Geographic Information Systems in the Social Studies Classroom

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Chapter I: Context

Town of Cromwell and Cromwell School District

Cromwell Middle School is a district with 479 students grades 6th through 8th. According to the Accountability matrix the school has earned an 80.8% score which is above the state average of 74.9%. The school's academic initiatives range from advancing scores in ELA and Math performance which are both low for high needs students. Specifically, the Math scores gap between high needs and all other students is significantly high at an 18.9 point difference. This is reflective of a greater state gap of 17.7 but is over emphasized at CMS.

Cromwell's district enrollment has been consistent throughout the past several decades dating back to 1946 with 479 students (252 males and 203 females). In the 6th grade there are 147 students (79 males and 68 females). 7th grade has 158 students (83 males and 75 females). 8th grade has 150 students (90 males and 60 females).

Technologically, the district is a 1:1 Chromebook initiative. Students are able to bring their devices home with them and return to school with them each day. This provides an amazing advantage when it comes to class management as the school also utilizes Google classroom for sharing and submitting assignments. All the grades are divided into two teams, meaning there are at least two teachers for every subject in each grade level. The only scenario in which that is not the case is in the 6th grade where there are no Social Studies Teachers--instead the STEM teachers divide the labor for Social Studies amongst themselves to teach.

Another building initiative for the 2019, 2020 school year is to implement a "Focus Block". Focus, as it is referred to, is separated based on the four quarters of the year into two rotating initiatives; "Enrichment", and "Remediation". For Enrichment, students with higher performance get an opportunity to be challenged in each discipline to reach content and skills beyond the regular classroom schedule. For Remedial blocks, students who may struggle with literacy skills in each discipline get more intensive and guided instruction to help scaffold the skills needed to succeed in the classroom. The model is not static, and students who do well in remedial settings can move up and out to different disciplines and different levels of Focus.

The school culture is positive and enriching and is based upon instilling a growth mindset in students. There is a strict no bullying policy and the school climate is heavily aimed at responsive emotional teaching. Each morning, the announcements are performed by the Principle of the school. The Pledge of Allegiance is said every morning followed by a moment of silence. There is also a quote of the day which is positive. The physical layout of the school is designed in a large square and all the hallways connect to one another on the same floor. The class sizes are small, no more than 20 students per class.

The Classroom

The 8th grade class where the study was conducted is an American History class which follows American History between the years 1763 to 1865--in the past 8th grade also covered the Reconstruction Era, but a couple years ago that was turned over to the high school American History curriculum. Each student in the classroom has their own assigned chromebook that they have access to 24/7. The classroom is run on Google Classroom, with documents and instruction

shared regularly with the students in real-time. The work is regularly posted after hours so students have access to it for class time the next day. The share function on Google Classroom and Google Drive have proven to be a real asset for students. Students are able to work on the same document from separate Chromebooks, they can edit the same presentation or slideshow, and they can also have the privacy granted from having their own device. There are only two major downsides regarding the chromebooks. First, students are required to have them charged before their class periods. If a student does not have his or hers charged, we do have two chargers available for students to use--but they have to share. In addition to the charging issue, some chromebooks occasionally break or run into technical difficulties (internet connection, hardware issues, etc.). The technology is relied on so heavily in the classroom, that when students don't have their chromebooks up and running--for whatever reason--then they are virtually unable to participate in the class that day. The alternative to having a chromebook for the student is to handwrite material on a piece of paper and enter it in at a later time.

Regarding more traditional resources, the class has hardcover textbooks available in the room which date back to 2011. The textbooks are rarely used, they have only been used on occasion for the maps available for students to reference.

The curriculum, in addition to covering the major events between 1763 and 1865, will stress media bias, civics, immigration, and civil rights as a major topic of study. Curriculum has been in flux over the previous years. A new curriculum director has been hired and an initiative for the 8th grade is to design a new curriculum which will be underway in the spring of 2020.

A typical day in the 8th grade Social Studies classroom begins with CNN10--a 10 minute daily news segment that covers international news. The program is updated daily and is produced specifically for a student audience. This serves as a daily routine for the students. The students know they are expected to take notes in their chromebooks. This helps them stay current, digest news, and develop notetaking skills, and also acts as a do now activity. Afterwards, the students end their notes by practicing inquiry and ask a question based on the topics discussed.

The Students-4th Block 8th Grade American History

There are students with IEPs and 504s in each class. There are paraprofessionals assigned to work one on one with students in the classes when necessary. In addition to IEPs and 504 plans, there is one English Learner in the 8th grade classes. The primary language of the classes is English, and there is little effort placed on English Learners. In Block 8 there are 19 students in the class, 4 females and 15 males in the class.

Research will be conducted with block 4 only. The classes consist of the following student demographics; in block 1 there are 21 students, 10 females and 11 males. All students in the class are between the ages 12 and 13. There are 3 African American students, 1 Asian student, 1 Hispanic student, and 16 white students. In block 4 there are 19 students, 6 females and 13 males. All students in the class are between 12 and 13 years of age. There are 5 African American students, 2 Hispanic students, 1 Middle Eastern student, and 10 white students. In block 5 there are 16 students, 7 females and 9 males. All students in the class are between the

ages 12 and 13 years old. There is 1 Hispanic student, 2 Asian students, and 14 white students in the class.

There are 10 students with an IEP divided up between the blocks. Of those students, 1 has dyslexia, 1 has autism, 3 have LD in Math, 4 have LD in Reading, 3 have ADD/ADHD, 1 has multiple disabilities, and 3 have a speech or language impairment. For accommodations, modifications and IEP goals, 8 have one on one speech coaching, 4 have one on one reading accommodations, 6 attend counselling, and 3 attend a writing class session. The IEP accommodations range from more time on assessments and assignments, to scheduled supports with a paraprofessional.

Ultimately, the greatest perceived challenge will be the fourth block as they are the most diverse set of learners. Block 4 has high functioning and low functioning students in the same classroom so differentiation will need to be utilized in order to maximize learning.

Chapter II - Literature Review

Inquiry and Social Studies

There has been a great shift in the social studies classroom toward inquiry and exploration based learning (Wineberg, 2001). The Common Core Initiative in 2010 geared the American public school systems toward Math and English. A large part of the initiative was to establish state standards to address the demands of the ever changing workforce of 21st century America (Buehl, 2009). While this initiative was a positive force in many ways, it failed to answer the question of other disciplinary roles in the curriculum. Social studies was not the primary focus for the Common Core framework and therefore was underrepresented.

Experts went to work to develop their own frameworks for social studies. Inquiry was placed at the forefront of social studies exploration. Multiple studies were able to confirm the value of questioning and self discovery as it relates to historical thinking (Thacker, Lee, Friedman, 2017). Historical thinking, as Wineberg stated, is an unnatural act for humans to perform--and if it is a challenge for adults, it is even more so a challenge for students (Wineberg, 2001). It requires a unique set of skills that are seen only in the discipline of history. Rather than approaching history in a traditional lecture sense, and aiming at the facts and dates of history, the new framework gears instruction in the same direction that professional historians conduct their work--with inquiry at the forefront.

Questions allow students to think more deeply about historical topics and issues than they have in the past. By creating questions and practicing inquiry based learning, students are exposed to critical thinking through disciplinary literacy (Buehl, 2009 & Wineberg, 2001) This new focus in social studies education places greater demand on educators to provide students

with a high caliber of instruction. While teaching social studies through the inquiry arch and the C3 frameworks has been the goal of social studies experts in recent years, surveys suggest that it is still rarely used by educators (Thacker, Lee, Friedman, 2017). Experienced teachers struggle to find ways to introduce deeper levels of inquiry into the classroom (Thacker, Lee, Fitchett & Journell, 2018).

The Importance of Geography in Social Studies Curriculum

The C3 Social Studies Framework placed particular emphasis on the four major disciplines within the social studies umbrella--history, economics, geography and civics (Thacker, Lee, Friedman, 2017). The goal of the framework is for each discipline to inform the other. The idea is centered around all four disciplines being taught in all social studies classrooms. The question becomes, is there a legitimate benefit to utilizing geography in a social studies classroom? It has been known for a while that geography and history offer a mutual *intellectual perspective* and that they should be taught together to emphasize the social studies (Fitchett & Good, 2012). However, many social studies teachers have developed a misperception of geography as a static and stagnant memorization of places (Kincheloe, 2001).

With an emphasis on the inquiry arc, studies suggest developing a fundamental understanding of the uses of geography for the historical and contemporary world (Fitchett & Good, 2012). This has proven to be difficult for educators to implement with traditional uni-dimensional maps (Linn, 1997). The question of how to implement maps in an interactive and effective way is paramount for 21st century expectations. With a student centered focus in social studies, educators have begun to look for ways to accommodate for this demand. Experts

say technology is a great way to meet the needs of 21st century students in the classroom (Hinde, 2015).

The question remains, how can educators transform their instruction to accommodate for the new technological demands in the classroom and also deliver high quality interactive maps to drive inquiry based learning? Researchers from a 2003 study have suggested using geographic information systems (GIS) as an interactive tool to solve the need for both. According to the study, students can visualize complex spatial relationships using GIS. Specifically, students are able to ask questions they could not access with traditional forms of instruction. Students can ask the "GIS questions" (Broda, 2003). Students are able to turn on or off layers of a map, focus in on specific data and overlay information to generate better queries that they could not otherwise access or perceive (Broda, 2003).

Slow Growth in GIS Pedagogy:

Despite the success of some research, the results from using mapping technology have yielded mixed results. Some limitations of the data might suggest these earlier studies took place too early with limited technology. Over the past 20 years GIS software has improved greatly. A study conducted in 1997 compared student performance between two sample groups, one using traditional maps and another using interactive maps. The results of this study suggested little to no difference in performance between students who used digital maps compared to traditional maps. Yet when surveyed for which technique students liked better, students overwhelmingly preferred the digital maps over traditional maps. (Linn, S., 1997)

Another study in 2005 indicated that performance did not differ between students who used paper copies versus digital versions of the maps (Pedersen, P., Farrell, P., & Mcphee, E.

(2005). This study was conducted to reveal the lack of pedagogy in interactive map use in school curriculum. The evidence revealed that students preferred the paper copy over the digital versions (Pedersen P., 2005). The results were in, more curriculum development and technological development was needed for classroom integration for GIS.

The Tide Turns--Technological Advances:

Despite these earlier examples, more recent studies have challenged the dated results. A study published by Clearing House: A Journal of Educational Strategies, Issues and Ideas in 2012 used GIS software--Google Earth, as well as GIS websites--to promote "critical thinking, decision-making (discussion), and action". These make up the three components of geographic education in the 21st century. They designed the study around the historical and contemporary context of investigating genocide around the world. Their results indicated that without the interactive maps, students would not have come to a real world plan of action as a result of the data they were able to explore (Fitchett & Good, 2012).

Newer studies suggest technology has developed greatly since the earlier studies had been conducted, and had they been performed more recently they may yield different results (Hall, 2017, Hinde, 2015 & Lo, 2009). This limitation exists in the question of what constitutes as an "interactive map"? Linn's 1997 study, defined an interactive map in a more basic way than the complex GIS tools used in Fitchett's 2012 study (Fitchett, 2012 & Linn, 1997). For this reason, the data from Linn's earlier study is severely dated compared to the newer GIS maps available in the modern classroom (Hall, 2017).

A study conducted in 2015 on conservation efforts of South American Rainforest sheds light on the complex demand of GIS. According to the study, students took on a real world role

in conservation and were told to analyze 4 different maps of the area. In this study, an "interactive map" was defined as having the following features; scrolling, zooming, highlighting, integrated geo-spacial data, the ability to toggle basemaps on or off, drop down menus equipped with infused data, and a side by side map comparison. The results indicate that students not only greatly preferred and enjoyed using the digital maps, but the level of analysis that was achieved could not have been reached using a more traditional format (Weisse, Omri, White, Roth & Naughton-Treves, 2015).

Cross Disciplinary Implications of GIS:

A recent look at the abilities of GIS suggests the tool has other uses than just social studies. GIS can connect students in the classroom to a variety of interdisciplinary applications. Hall's study suggests the skills required to analyze interactive maps are interdisciplinary in nature. (Hall, 2017). The ability for students to engage in environmental, political, historical, literary and mathematical queries and practices all at once is an invaluable asset for educators (Weisse, Omri, White, Roth & Naughton-Treves, 2015). In this particular study, students were asked to practice environmental conservation of the Peruvian Rainforests. The students were assigned a real world scenario as a real world actor. They would deal with real world zoning maps which promoted student conventionalism and decision making based on the inquiry of their explorations. Lastly, students were expected to draft a proposal from their character's perspective (Weisse, Omri, White, Roth & Naughton-Treves, 2015). Not only did the students get exposure to real world problems and scenarios, but all the students reported enjoying the use of the GIS software (Weisse, 2015).

Students with learning disabilities (LD) have also been shown to benefit from GIS systems and interactive map instruction (Brock, 2013 & Ducasse, Brock, & Jouffrais, 2018). The ability for students to interact with the layers and other features of GIS yields positive results from students with LD (Brock, 2013). Students with LD performed better when they could physically touch a 3 dimensional map with the digital representation as opposed to a traditional map.

Ultimately, GIS instruction has proved to endure the test of time. As interactive maps become technologically enhanced and more available in school systems, it is appropriate to find new ways to integrate GIS pedagogy into the classroom (Broda, & Baxter, 2003). Further studies are still needed to test the correlation between GIS instruction and inquiry based learning in the social studies classroom. This study will test whether or not GIS instruction in a social studies classroom will improve the quality of student inquiry.

Chapter III - Methodology

In this action research project, the researcher implemented a GIS intervention in a middle school classroom and studied the effects on the quality of student inquiry. The researcher examined this through a strategy called Question Formulation Technique (QFT) (Pease & Carpenter, 2012) from January 21st until February 1st of 2020. In order to record the results there were six points of data (in addition to a student survey) collected. These points include two Pre-Assessments for the quality of inquiry using a traditional map and the quality of inquiry using a written text. Two middle data points during the QFT lesson; first using a traditional map,

and second using a written text. And lastly, a Post-Assessment using GIS and again with a written text. This unit focused on the electoral college in an American Civics course. More on the data analysis will ensue in the following chapter.

Research Question

Will instruction using GIS and interactive maps in a social studies classroom improve the quality of student inquiry? The research question developed due to the limited use of interactive maps for geographic instruction. Students in the class were very used to using paper political maps to inform their understanding of early American History. However, the limitations of a paper map were very clear. Students had a difficult time drawing or visualizing topographical features when limited with a political territorial map. The students were able to draw and label certain topographical features (mountains, rivers, etc.) but the lines crossed over political boundaries and caused greater confusion than positive inquiry. With a digital GIS map, the students would be able to switch on and off basemap layers, different data points, and view complex variations of these maps all at once in a more digestible platform.

Participants

The participants for this study included four sections of the 8th grade social studies classes at Cromwell Middle School (CMS), located in Cromwell, Connecticut. The four blocks consisted of the following students. In block 1 there are 21 students, 10 females and 11 males. All students in the class are between the ages 12 and 13. There are 3 African American students, 1 Asian student, 1 Hispanic student, and 16 white students. In block 4 there are 19 students, 6 females and 13 males. All students in the class are between 12 and 13 years of age. There are 5 African American students, 2 Hispanic students, 1 Middle Eastern student, and 10 white

students. In block 5 there are 16 students, 7 females and 9 males. All students in the class are between the ages 12 and 13 years old. There is 1 Hispanic student, 2 Asian students, and 14 white students in the class. In block 8 there are 19 students in the class, 4 females and 15 males in the class.

There are 10 students with an IEP divided up between the blocks. Of those students, 1 has dyslexia, 1 has autism, 3 have LD in Math, 4 have LD in Reading, 3 have ADD/ADHD, 1 has multiple disabilities, and 3 have a speech or language impairment.

The Collaborative Intervention

At the beginning of the spring semester, the researcher introduced the Pre-Assessments using a traditional style map that the students were familiar with. The students had just finished lessons on the electoral college and had a strong foundational understanding of the content required for the intervention.

The intervention began on January 22nd, 2020 and lasted until February 1st, 2020 wrapping up the unit on the electoral college. The researcher then taught the lesson using the QFT method as a whole class. Students operated in small groups of four or five and practiced inquiry and question-making. The groups were created with different levelled learners in mind. Students were placed with peers of different skill levels for support.

During the QFT lesson, students stood at different parts of the room with poster paper and markers. The researcher put up a still image of three different maps, a population map of the United States from 2016, a map of the popular vote results from the 2016 election and a map of the electoral college results from the 2016 election. For each image, students were asked to ask

questions about the maps shown. Students were encouraged to ask compelling questions that were harder to answer and would inspire deeper thinking. The groups then selected their strongest question and shared it with the class.

The next lesson was a tutorial and familiarity lesson for the GIS software. Students were able to use their chromebooks and accessed the GIS site individually. They then mirrored the researcher's instruction on how to use the basic features of the site. Afterward, students were allowed to familiarize themselves with the program for the entire class at their own pace.

The final intervention was given in the form of GIS instruction. Students were asked to use a pre produced map in the GIS software which included the same data from the three maps used for the QFT but integrated into the advanced software. Students were given 15 minutes to interact freely with the maps and then ask questions, again with an encouragement to make their questions compelling.

Data Collection

Data Set #1 - Pre-Assessment with a Written Text. Students were provided with a short excerpt about the electoral college on the 2016 election on January 23rd, 2020. Students were asked to read the text and draft their own questions from the text. Students were asked to create two open questions and two closed questions.

Data Set #2 - Pre-Assessment with Traditional Maps. A set of traditional maps were distributed to the students on January 22nd, 2020. It was used to inspire student inquiry about the electoral college. Students were asked to create two open questions and two closed questions.

Data Set #3 - Question Formulation Technique. Students were divided into groups of three or four students on January 24th, 2020. Students were shown three traditional style maps on the projector and asked to create questions together. Students were asked to create at least two open questions and two closed questions.

Data Set #4 - Post-Assessment with GIS Interactive Maps. Students were given the GIS software with interactive versions of the previous 3 maps. Students were given 15 minutes to interact with GIS and then ask two open questions and two closed questions.

Data Set #5 - Post Intervention Survey. Students were given a survey to collect their feedback about the interventions of the lesson.

1) Which map did you prefer, the interactive GIS maps or the traditional maps?
2) Did you enjoy this lesson? Why or why not?
3) Which map did you find more interesting (traditional or GIS)?
4) Which maps helped you understand the 2016 election more?
5) Did you find it easier to ask questions about maps or about the text?
6) Did you find it easier to ask questions about traditional maps or GIS maps?
7) Any comments you would like to share?

Measuring the Data

Guiding Questions are questions that help students reach higher order thinking such as, "What states are swing states in the presidential election?" "Where do most people live in the United States? In urban or in rural areas?"

Compelling Questions are questions that inform inquiry and are signs of higher order thinking such as, “What is needed to create a successful government?” “What makes the U.S. Federal Election process so complex?”

These questions can be categorized into 4 numerical categories and produced in a rubric

1. Low level Guiding Questions
2. High level Guiding Questions
3. Low level Compelling Questions
4. High level Compelling Questions

Low level G.Q.s are answered with a single word answer and are one dimensional usually used for factual context ex. “How many electoral votes does a state get?”, or “How long is a Presidential term?”

High level G.Q.s are more open but are still answered with more specific answers ex. “What does the Constitution say about the Electoral College?”, or “Has the electoral college gone through changes in American history?”

Low level C.Q.’s are essential questions that lead to deeper inquiry and additional G.Q.’s but may not be focused ex. “What are other varieties of election processes in other countries?” “What thinking or compromise played out to form the electoral college to the way it is today?”

High level C.Q.s are essential questions that yield a deeper understanding and comprehension of the material ex. “What kind of changes could be made to the electoral college to compromise between those who want to get rid of it and those who want to keep it?”

In each intervention it was expected that each student ask two open and two closed questions. The definitions are as follows:

Open Questions are questions that require a more informed and complex answer. Often questions that are posed in the form of a research question. Often these questions begin with "why" or "how".

Closed Questions are questions that are satisfied with a single factoid or a yes or no answer. These questions often begin with "when", "did", or "where".

Chapter IV - Results

Introduction

The purpose of this study was to investigate the correlation between interactive maps and geography instruction on the ability for students to produce quality inquiry. Also to compare the impact of traditional maps versus interactive maps on student performance. The research question is; *will GIS and interactive map instruction in a social studies classroom improve the quality of student inquiry and question formulation?*

It was suspected that the interactive maps would improve the quality of student inquiry. Students would be able to manipulate the maps in ways traditional maps could not and therefore would offer students a greater insight into the data.

Each intervention varied slightly in information for students to practice inquiry from. Some interventions provided students with different types of maps, and others were simply forms of written sources for students to practice inquiry.

Dataset #1 - Intervention using an Article

The data was collected in the form of a graphic organizer formative assessment. Students were asked to create closed and open questions by reading the article on the electoral college. This form of data collection was done in order to establish a baseline performance for student inquiry as well as a chance to expose students to the content at hand. There are no maps in this dataset because the emphasis is on the dependent variable--the inquiry. Students were asked to read and create questions about the article.

Table 1

Student Inquiry When Given a Pre Assessment Without Maps

Quality of Questions	Total Sample	Percentage
Low Level Guiding Questions	**45**	**66.2%**
High Level Guiding Questions	**15**	**22.0%**
Low Level Compelling Questions	**8**	**11.8%**
High Level Compelling Questions	**0**	**0%**
Total Questions Collected	**68**	**100%**

Note. Guiding Questions are typically questions that can be answered using a yes or not answer or a researchable factual answer. Compelling questions are open ended questions that require an open ended answer.

The data was collected in the form of a graphic organizer formative assessment. Students were asked to create closed and open questions by reading the article on the electoral college. This form of data collection was done in order to establish a baseline performance for student inquiry as well as a chance to expose students to the content at hand. There are no maps in this dataset because the emphasis is on the dependent variable--the inquiry. Students were asked to read and create questions about the article.

This collection was done on January 28th, 2020. Students had just completed their lesson on the Constitution and were now beginning a lesson on the Electoral College and how the President is elected.

It was determined by the researcher to look at the entire class and quantify the number of compelling questions and the number of questions that were guiding questions. In this way it is possible to compare datasets over time and see if there was a difference between them as a whole class.

Out of 19 students in the class, 16 completed the assessment and performed inquiry from the assessment. These 16 students yielded a total of 68 questions. Out of these 68 questions 45 of them were classified as Low Level Guiding Questions. 15 of them were classified as High Level Guiding Questions. 8 of them were Low Level Compelling Questions and there were 0 High Level Compelling Questions.

From the total sample of 68 questions, it was also determined that 2 of these questions were Low Level Geography Questions. 1 question was politically opinionated, 4 questions directly addressed and challenged the electoral college, 3 questions generally questioned the electoral process of the U.S., and there was 1 question that was off topic from the provided material.

Dataset #2 - Impact of Traditional Maps on Inquiry

The data from the second intervention was pulled from quality questions students created after reviewing traditional maps. Again, a formative assessment graphic organizer was the form utilized by the researcher.

This form of data collection was done in order to establish a baseline performance for student inquiry while using traditional maps. In this way, it is possible to compare this data to the later set of data pulled using interactive maps.

Table 2

Student Inquiry When Given a Pre Assessment with Traditional Maps

Types of Questions	Total Sample	Percentage
Low Level Guiding Questions	**42**	**62.6%**
High Level Guiding Questions	**13**	**19.5%**
Low Level Compelling Questions	**11**	**16.5%**
High Level Compelling Questions	**1**	**1.4%**
Total Questions Collected	**67**	**100%**

Note. Guiding Questions are typically questions that can be answered using a yes or not answer or a researchable factual answer. Compelling questions are open ended questions that require an open ended answer.

The collection was done on January 29th, 2020. Students had just completed their lesson on the Constitution and were now beginning a lesson on the Electoral College and how the President is elected.

The questions asked by the students were quantified into the number of compelling questions, guiding questions and several other categories (i.e. geography questions, political questions, etc.). In this way, it is possible to compare datasets overtime and notice patterns before, during and after.

Out of 19 students in the class, 13 completed the assessment and performed inquiry. These 13 students yielded a total of 67 questions. Out of these 67 questions 42 of them were classified as Low Level Guiding Questions. 13 of them were classified as High Level Guiding Questions. 11 of them were Low Level Compelling Questions and 1 question was determined to be a High Level Compelling Question.

From the total sample of 67 questions, it was also determined that 33 of these questions were Low Level Geography Questions and 14 of these questions were High Level Geography

Questions, meaning 47 of the questions asked pertained to geography. 3 questions were politically opinionated, 2 questions directly addressed and challenged the electoral college, 12 questions generally questioned the electoral process of the U.S., and there was 1 question that was off topic from the provided material.

Dataset #3 - Impact of Group Work on Inquiry

Dataset 3 is in the form of quality questions pulled from maps and students worked in small groups to formulate them. The form used to gather data was less structured compared to the other datasets. Students were simply instructed to ask questions rather than to complete the organizer as in former interventions.

This form of data collection was done in order to establish a baseline performance for student inquiry while using traditional maps. The added edition of this dataset was the group work. Students were able to work together and collaborate to make stronger questions.

Table 3

Small Group Student Inquiry When Given Traditional Maps

	Total Sample	Percentage
Low Level Guiding Questions	**9**	**36%**
High Level Guiding Questions	**13**	**52%**
Low Level Compelling Questions	**3**	**12%**
High Level Compelling Questions	**0**	**0%**
Total Questions Collected	**25**	**100%**

Note. Guiding Questions are typically questions that can be answered using a yes or not answer or a researchable factual answer. Compelling questions are open ended questions that require an open ended answer.

This collection was done on January 30th, 2020. Students had just completed their lesson on the Constitution and were now beginning a lesson on the Electoral College and how the President is elected.

Out of 19 students in the class, all 19 completed the assessment and performed inquiry. These 19 students yielded a total of 25 questions. Out of these 25 questions 9 of them were classified as Low Level Guiding Questions. 13 of them were classified as High Level Guiding Questions. 3 of them were Low Level Compelling Questions and there were 0 High Level Compelling Questions.

From the total sample of 67 questions, it was also determined that 33 of these questions were Low Level Geography Questions and 14 of these questions were High Level Geography Questions, meaning 47 of the questions asked pertained to geography. 3 questions were politically opinionated, 2 questions directly addressed and challenged the electoral college, 12 questions generally questioned the electoral process of the U.S., and there was 1 question that was off topic from the provided material.

Dataset #4 - Impact of Interactive Maps on Student Inquiry

The data is in the form of quality questions pulled from interactive maps. Students worked individually as in datasets 1 and 2 to complete the provided graphic organizer.

This form of data collection was done in order to check the quality of questions when given an interactive mapping software to navigate. The quality of questions will likely determine the impact of the software on social studies instruction.

Table 4

Student Inquiry When Given Interactive GIS Maps

	Total Sample	Percentage
Low Level Guiding Questions	**44**	**62.9%**
High Level Guiding Questions	**18**	**25.8%**
Low Level Compelling Questions	**5**	**7.1%**
High Level Compelling Questions	**3**	**4.2%**
Total Questions Collected	**70**	**100%**

Note. Guiding Questions are typically questions that can be answered using a yes or not answer or a researchable factual answer. Compelling questions are open ended questions that require an open ended answer.

The intervention was done on February 4th, 2020. Students had just completed their lesson on the Constitution and were now beginning a lesson on the Electoral College and how the President is elected.

Out of 19 students in the class, all 9 completed the assessment and performed inquiry. These 9 students yielded a total of 70 questions. Out of these 70 questions 44 of them were classified as Low Level Guiding Questions. 18 of them were classified as High Level Guiding Questions. 5 of them were Low Level Compelling Questions and there were 3 High Level Compelling Questions.

From the total sample of 70 questions, it was also determined that 35 of these questions were Low Level Geography Questions and 5 of these questions were High Level Geography Questions, meaning 40 of the questions asked pertained to geography. 1 question was politically opinionated, 13 questions directly addressed and challenged the electoral college, 25 questions generally questioned the electoral process of the U.S., and there were 2 questions that were off topic from the provided material.

Data Set #5 - Survey Results

The data is in the form of a survey and was collected to gauge preference as to which form of lesson and maps students preferred as well as which form students felt were easiest to use. The survey was conducted on February 6th, 2020 as a conclusion to the lesson on the electoral college. This data does not provide a datapoint for inquiry, rather preferences and comfort during the interventions.

This survey was conducted post intervention to reveal insight from the students on their opinions of the interventions. There were a total of 11 responses given by students. When asked which map the students preferred most, 54.5% of the responses agreed that the traditional maps were preferred over the interactive maps. Yet when asked which maps were more interesting 81.8% of the respondents chose interactive maps over the traditional maps.

72.7% of the responses said maps made it easier than written sources to develop inquiry and create questions. 54.5% of the respondents said it was easier to use interactive maps over traditional maps to ask questions. These responses correlate well with the results from datasets 1 through 4.

All the students agreed that they enjoyed the lesson for a variety of reasons. However, when asked to comment there were 3 comments that directly addressed the confusion caused by using a new technology. “Learning the software of the interactive maps was a little confusing.”, and “The interactive maps were a little confusing to understand.”

Chapter V: Discussion

Overview

The purpose of this study was to investigate what impact GIS and interactive maps have on the quality of inquiry performed by students. Geography has long been a focal point for social studies instruction and is known to positively impact other social studies. The research for this study is to investigate the impact of using interactive maps over traditional maps in social studies instruction.

As seen from the data presented in the previous chapter it is clear that there is a substantial difference in the types of questions that were asked when given no maps compared to traditional maps, and then again when compared with interactive maps. The data reveals an increase in questions that specifically consult or challenge the electoral process between datasets 1, 2 and 4. 4% of the questions asked consulted the electoral college in dataset 1. This increased to 17% in dataset 2, and then 36% in dataset 3.

This suggests that students are growing more confident depending on the type of resource in use. It also suggests that students were able to comprehend the information from the maps in datasets 2 and 4. Ultimately, the interactive maps enabled students to investigate the election results in the greatest detail and therefore, students could formulate their own opinions in the form of questions. .

Before conducting the study, it was assumed that students would create more high level compelling questions than guiding questions when given interactive maps than their traditional counterparts. This hypothesis was based on the research on multiple studies where students were empowered by GIS to use inquiry in order to problem-solve (Weisse, Omri, White, Roth &

Naughton-Treves, 2015). The results indicate that the quantity of compelling questions asked did not increase when given the interactive maps.

The number of political science questions that were asked regarding elections, political parties and the overall American political system also increased substantially. In dataset 1 12% of questions targeted American politics. The number of questions increased in dataset 2 to 25% of questions asked, and again in the 4th intervention to 56%.

When using interactive maps over half of the questions designed by students proved to be political. This corresponds to prior research done on the intersectionality of the social studies disciplines and the work done on the C3 Frameworks for social studies instruction--students are able to learn political science and history from geography and vice versa (Fitchett & Good, 2012). However, this research suggests that interactive maps are a greater resource for students when trying to investigate other social studies disciplines.

High Level Guiding and Compelling Questions

While the study highlights the success of interactive maps over traditional maps in this regard. It must be noted that the quantity of High Level Geography Questions asked between interventions 2 and 4 did not improve. When using interactive maps only 12% of the geography questions asked were considered to be High Level Questions versus 29% from traditional maps. This is the exact inverse that was expected from this study. Students were asking higher leveled questions using traditional maps when compared to their interactive counterparts.

It was also believed that because the students would be conducting inquiry repeatedly that the quantity of High Level Compelling Questions would increase in each intervention. The study reveals that this is also not evident.

What can be noted is the specific content students chose to elevate into questions. The first data collection was conducted without any maps. The students read a political article on the 2016 election and how the electoral college impacted the U.S. elections. Students asked questions Compared to the second intervention where students did not have access to a map, students asked a total of 47 geography questions compared to just 2 from before--an increase from 2% to 70%--the largest increase in the entire study. The results clearly indicate that when students do not have access to a map of any kind they are unlikely to generate geographical questions. This can be seen again when 57% of the questions asked by students in intervention 4 were geographic in nature.

Because all students were instructed to ask both guiding and compelling questions, the best indicator of successful inquiry is the quantity of High Level Questions asked versus Low Level Questions. The results reveal that students asked the greatest ratio of High Level Questions during intervention 3 with 52% of the questions being High Level. These results suggest that group work and student collaboration is the cause. Intervention 3 was the only intervention done in small groups and yielded the greatest amount of High Level Questions asked.

An outlier emerged from two questions created by students pointing to geopolitics. One question raised by a student, “How many electoral college votes did Texas have in the 2012 election.” reveals a deeper level of thought. Because the article focused on the 2016 election, the student is using inquiry to test the political waters prior to the election by asking for data from 2012. This High Level Guiding Question reveals there were only 4 High Level Compelling Questions out of all 4 interventions. 3 of these High Level Questions emerged from dataset 4

which indicates that GIS may have had an impact on the ability for students to ask more complex questions.

The question, "Why did the states on the coasts tend to support the Democratic Party and the states in the middle of the country tend to support the Republican Party?" appeared 4 times in slightly different forms across data collections 2 and 4. This question is considered a High Level Compelling Question and a Geopolitical Question because it reveals the ability for students to compare two different map layers and realize geopolitical trends.

Confidence in Critique

The amount of questions that directly critique or challenge the integrity of the electoral college increased from 3 to 12 in dataset 2. This reveals that students now have raised concerns with the structure surrounding the election due to the imagery gained using maps versus just the article. This suggests that maps enable students to comprehend and critique systems and structures once they view a spatial and political map.

Another indicator of student confidence gained with interactive maps over traditional maps was the number of questions generated which directly challenged the structure of the electoral college. Students given an interactive map asked 25 questions questioning the integrity of the electoral college. This indicates that students are confident in their ability to critique the electoral system in America when using interactive maps.

The questions asked revealed students had access to more information and more content than the previous maps provided. The question, "What influences the voting choices of citizens in different countries" is a prime example of a High Level Guiding Question that was asked using GIS. The student is extending their knowledge of the American system of elections which

has sparked curiosity on the democracies around the world. Another High Level Guiding Question that was asked referred to the history of the electoral college, "What other systems of voting were proposed when the founding fathers or US government met?" This question could easily be converted into a research question or a thesis statement.

Implications

There are several implications for research to consider moving forward. First and foremost, it must be noted that this study was conducted in an 8th grade social studies classroom. Prior GIS studies that have been done were conducted on high school students as well as college aged students which may have impacted the results to a degree. This study suggests that it is possible and should be applied to middle school students.

It was believed that repetition would play a heavy role in this study. However, As mentioned earlier, the data does not reveal an impact on the number of High Level Questions asked. Because students were able to practice their inquiry skills 4 times before the study was over the students may have developed their inquiry by the time of the final intervention.

Conversely, the patterns discovered in the data suggest that this is not the only indicator for the types of questions asked by students. Students overwhelmingly asked different questions based on the scale of the information provided in the maps. For example, in dataset 1 no maps were provided to the students. The data reflected this as there were minimal questions asked regarding the geography of the U.S. Intervention 2 provided the students with multiple traditional maps of the U.S. on a national scale and the questions asked were macro reflecting the scale of the maps. The interactive maps during intervention 4 offered students the chance to manipulate the maps to access county information from each state as well as the greater U.S.

The questions asked overwhelmingly indicated that students were analyzing the information provided, rather than just repeating previous questions asked.

It may be beneficial in future GIS studies to offer more familiarity with the GIS software before conducting the study. During the survey multiple students indicated they had difficulty using the interactive maps because of technical concerns. While these maps are very powerful, they are only as powerful as the user allows them to be. Without familiarity there is a great limit placed on student access.

Limitations:

One of the most prevalent limitations that emerged during the data analysis was the ability to determine which questions are higher quality than others. As discussed earlier, it is relatively easy to determine which questions are open versus closed questions. The difficulty lies in determining which questions are a higher quality than others. To mitigate this issue, the researcher created several categories to place questions asked into. This helped to organize the questions for an easier way to reveal. In many circumstances questions were placed in multiple categories as they fulfilled the basic requirements to be included in various categories. For example, a question could be both political and geographic and so it would count twice, once as a political question and again as a geographic question.

Another fluctuation throughout the study was the sample size of participants. Out of a class of 19 students, there was only one intervention where all 19 students participated. The one intervention with full participation was intervention 3 which was performed in small groups and yielded the most cryptic results. It may be that the group setting allowed struggling students to lean on stronger students for their inquiry.

As noted previously, repetition may have had an impact on the results. All interventions targeted content surrounding the electoral college and the 2016 election. Because the intervention was repeated 4 times repetition may have had a great impact on the quality of questions students could ask. By the end of the study students had mastered the information on the electoral college which also may have had a hand in improving the quantity of geopolitical questions asked.

As noted in dataset 5, it is evident that the new technology was not easy to use for all students. This may have interfered with the quality of questions students were able to ask. If a student had trouble turning fields on or off or jumping from layer to layer, the questions they could ask would be limited to what little pieces of the maps they could access. This could explain the inconsistencies in dataset 4.

Another factor surrounding the utility of the software may have been the age of students. Middle schoolers can still have difficulty navigating more advanced swaths of data compared to high schoolers and university students. Much of the research conducted in earlier studies targeted high school and undergraduate aged students (Weisse, Omri, White, Roth & Naughton-Treves, 2015 and (Hall, 2017)). The age of development may have had an impact on the students' ability to interact effectively with the software.

The traditional maps given to students were presented on a national scale. However, the GIS map was able to emphasize the state and county levels of geopolitical data and content. This may have impacted the types of questions students were able to provide for dataset 4 versus the others. In future studies it may improve consistency in interventions if a traditional map of Connecticut's counties was offered during intervention 2.

Conclusions

To conclude it cannot be determined based on the data whether or not GIS and interactive map instruction in a social studies classroom has a greater impact on student generated inquiry. However, it is suggested that student comprehension of content is heightened when using a map versus not using a map. It is also clear that students preferred GIS due to the interactive capabilities.

As discussed previously, student inquiry improved greatly between the first and final datasets. In addition, students overwhelmingly responded in the survey that they found the interactive maps more enjoyable and fun to use compared to the traditional style maps..

What most surprising was the confidence in student generated questions when using interactive maps. It was suspected that students would be most confident in critiquing the electoral college during intervention 3, when in small groups. However, overwhelmingly, students asked questions that critiqued the electoral system during intervention 4.

Ultimately, the study did not prove the impact of interactive maps on the quantity of High Level Questions asked. This does not mean that interactive maps are not a fruitful resource for the classroom. On the contrary, GIS has proved to be a powerful tool for the social studies classroom. While future research and proper implementation is certainly needed it can be determined that interactive maps do increase the different types of questions asked by students. Students are granted a unique perspective and insight into a topic when using GIS. The ability to manipulate a map and interact enables students a rare opportunity to see things that can otherwise not be seen from traditional style maps.

Appendix A

Newsela Article - Open and Closed Questions

USE THE NEWSELA ARTICLE ON THE ELECTORAL COLLEGE CREATE YOUR OWN QUESTIONS ABOUT THE ELECTORAL PROCESS.

2 OPEN QUESTIONS:

-
-

2 CLOSED QUESTIONS:

-
-

NOW CHOOSE ONE QUESTION YOU CREATED AND FLIP IT.

-

Appendix B

Using Maps - Open and Closed Questions

DIRECTIONS: USING THE MAPS PROVIDED ON THE U.S. AND THE ELECTORAL COLLEGE ANSWER THE QUESTIONS BELOW.

Which states have the largest amount of electoral votes?

Which states have the least amount of electoral votes?

Where do most people live in the U.S.?

NOW PRACTICE CREATING YOUR OWN QUESTIONS BELOW USING THE INFORMATION FROM THE MAPS.

2 OPEN QUESTIONS:

-
-

2 CLOSED QUESTIONS:

-
-

Appendix C

Interactive Map Assignment

Directions: Click on this link to access the map.

FOLLOW THE STEPS BELOW TO ANSWER THE QUESTIONS.

Click the **"Content"** button on the left side of the screen and turn off all layers. Click on **"Basemap"** and select the **"Imagery with Labels"** option.

Turn on the **"2016 General Election Results"** and click on different states to see the popular vote results.

How many votes did Hillary Clinton win in Connecticut?

-

How many votes did Donald Trump win in Connecticut?

-

Next, turn on the **"2016 Election by County"** layer.

Which CT counties did Hillary Clinton win?

-

Which CT counties did Donal Trump win?

-

NOW ASK 2 CLOSED QUESTIONS AND 2 OPEN QUESTIONS BY EXPLORING THE MAP ON YOUR OWN.

CLOSED QUESTIONS:

-
-

OPEN QUESTIONS:

-
-

CREATE A THESIS STATEMENT ON WHETHER OR NOT YOU BELIEVE THE ELECTORAL COLLEGE IS A GOOD WAY TO ELECT THE PRESIDENT. WHY DO YOU THINK THIS?

Thesis Statement:

Appendix D

Questionnaire

Answer the questions below

Questions:

1) Which map did you prefer the most?
    a) Interactive Maps
    b) Paper Maps

2) Which map did you find most interesting?
    a) Interactive Maps
    b) Paper Maps

3) Which map helped you understand the 2016 election more?
    a) Interactive Maps
    b) Paper Maps

4) Did you find it easier to create your own questions using paper maps or using written sources?
    a) Maps
    b) Written Source

5) Did you find it easier to ask questions about paper maps or interactive maps?
    a) Interactive Maps
    b) Paper Maps

6) Did you enjoy the lesson? Why or why not?

7) Any comments you would like to share?

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