GEOSPATIAL TECHNOLOGY IN THE CO-TAUGHT

HUMAN GEOGRAPHY CLASSROOM

by

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ABSTRACT

Advances in technology have substantially expanded potential tools for teachers to utilize in the classroom. Often these tools are reserved for students in honors or Advanced Placement courses. This study uses an inductive qualitative case study to examine the implementation of an online geospatial tool, ArcGIS Online StoryMaps, in a co-taught ninth grade human geography course. Research questions explored in this study include the perceived effectiveness of using the geospatial technology, and the opportunities and challenges associated with the use, for both students and teachers. Results indicate that students in the co-taught setting, including those with Individual Education Plans, positively reviewed using ArcGIS Online to advance their spatial thinking abilities. In addition, students and teachers perceived the lesson to be engaging and worthwhile. Based on this study, inclusionary education settings should include geospatial technologies in lesson plans.

I. INTRODUCTION

Geographic education in high schools changed fundamentally in the past few decades with the technologic revolution that has infiltrated schools and students' daily lives. Many practices that were long used in the classroom have been overhauled with advances in technology and accessibility of advanced software systems for both students and educators (Reardon & Leonard, 2019). The usage of geospatial tools, such as Google Maps or Waze, has become increasingly common in everyday life as students become accustomed to using smart phones offering mapping, navigation, and global positioning system (GPS) tools. Education has mirrored this shift to using technology more frequently as programs like ArcGIS from the American Environmental System Research Institute (ESRI) have become more easily accessible and user-friendly. The use of geographic information systems (GIS) in geography education engages students in relevant content and develops technological and analytical skills (Webster, 2017). The implementation of these programs has also coincided with a rise in specifically teaching geography.

Courses such as Advanced Placement Human Geography (APHG), from the College Board, have created new opportunities for students to expand their spatial thinking (Webster, 2017). Spatial thinking can be defined as "a collection of cognitive skills comprised of knowing concepts of space, using tools of representation, and reasoning processes" (National Research Council, 2006, p. 12). The curriculum for APHG consists of seven units focusing on various geographic concepts with three consistent big ideas incorporated into each unit: Patterns and Spatial Organization, Impacts and Interactions, and Spatial Process and Societal Change (College Board,

2021). These big ideas seek to expand students' spatial thinking abilities using relevant topics in each unit of study. The reasoning for the emphasis on spatial thinking can be explained when examining how spatial thinking extends beyond the classroom to every aspect of life, from moving a piano down steps, to providing directions to someone, to mapping a social network (Sinton et al, 2013). AP Human Geography was first offered to high school students in 2001 and produced a total of 3,272 students taking the exam at the end of the course to earn college credit (Gray, Hidlebrant, & Strauss, 2006). In twenty years, that number has risen drastically with 193,660 students taking the exam in 2021 (Packer 2021). While this increase may seem promising, 15.3 million students are enrolled in high school in the United States (NCES, 2021). The number of students enrolled in APHG makes up a very small percentage of the total students that could potentially take a geography course. Many leaders in geography education have advocated for national standards, however, very few states have required geography courses (Boehm, 2015). Without strict standards in place, oftentimes individual high schools are left to decide if and how geography classes will be conducted. Including geography in existing social science courses, or creating standalone geography courses, can lead to significantly different student learning outcomes. In either scenario, creating a learning environment that includes teaching methods that utilize programs, like ArcGIS Online, can help students improve spatial thinking abilities while using technology that is applicable to twenty-first century issues (Li, 2020).

Another relatively new concept that has taken root in many high schools is the inclusion of special education students in regular education classrooms. To create a more inclusive learning atmosphere, schools pair a content teacher with a special education

teacher to co-teach a class that contains students with a variety of learning abilities and special accommodations. Instead of a tracking program that separates students into honors, regular, and special education courses, the co-taught setting includes a mix of students from all the former classes. Students within special education programs have Individual Education Plans (IEPs). These plans target specific needs that help students comprehend and understand required content and course material. A written IEP includes the specific program a student is enrolled in within the school, specific services the student receives, and other accommodations such as curricula recommendations or preferred teaching methods to help that individual student's needs (Siegel, pg.5, 2020). School districts vary on how students with IEPs are placed into educational settings, sometimes by placing the student in the general education classroom, in co-taught classrooms, in special education classrooms, or in self-contained special education classrooms. Schools generally have some variation of all these settings, and student placement will depend on individual circumstances. By creating an environment with student diversity, students are exposed to classmates that can help with the learning process. Increases in student reading levels have been documented, especially for the students that typically would be in a self-contained setting (Gokbulut, Akcamete, & Guneyli, 2020). Providing opportunities for mixed ability level provides students with the opportunity to benefit from the social aspects of education while learning with and from peers (Sinclair, Bray, Wei, Clancy, Wexler, Kearns, & Lemons, 2018).

This research focuses on a lesson taught in the co-taught setting. Five models have been outlined in previous research that analyze the best methods for co-teaching for student success including: one teach/one assist, station teaching, parallel teaching,

alternative teaching, and team teaching (Burks-Keeley & Brown, 2014). Depending on the classroom setting and the need generated from the lesson, implementation of a specific model of co-teaching can vary daily. The overall effectiveness of each model depends on the class structure and the teachers' preferences. For example, the one teach/one assist model may be used in a lecture or discussion with the primary content teacher taking the lead role and the special education teacher moving around the room helping individual students with issues that arise. Station teaching may be more effective when students have small tasks that can be broken down into different learning centers within the classroom in which time can be spent at each with students rotating from station to station. The parallel teaching model splits the class into two groups that are taught at the same time each by one of the course teachers. The parallel model can allow for differentiation with the groups of students possibly allowing one group more in depth coverage of a topic or additional time for discussion. The alternative teaching model is like the parallel teaching model, but only a small group of students is separated to work with one of the teachers usually for accommodations listed in IEPs. The last type of co-teaching model, and the one used in this research, the team-teaching model, focuses on both the content teacher and the special education teacher playing instrumental roles in the classroom and working together without one assuming a superior position. Both teachers move around the classroom and take leadership roles in teaching the lesson. This model was selected for this research because it is the most frequently used model for this course throughout the school year and the students are the most familiar with both teachers acting in similar roles. To encourage the most authentic results, the lesson implemented for this research needed to resemble a normal class day as close as possible.

By implementing a geography lesson using geospatial technologies as a tool into a co-taught classroom, this research examines opportunities and challenges of special education students in the general education classroom, while also analyzing the overall effectiveness of geospatial technology in developing students' spatial thinking, and students' perceptions of using the tool. Many co-taught classes fail to utilize geospatial technologies given the perceived constraints of the students enrolled in the course. This research provides data that will be useful to co-taught and regular human geography educators when incorporating these technologies into classroom lessons. Many AP Human Geography teachers already implement geospatial technologies because of the perceived level of student ability, and successes have been researched on the impact on student spatial thinking because of utilizing the technology (Webster, 2017). However, these same educators oftentimes overlook co-taught and/or regular level courses based on the perceived challenges of implementation.

Research Questions

Currently very little research exists examining the usage of geospatial technologies in the co-taught human geography setting. The goal of this research is to contribute to the pool of geography education research in geospatial technologies, while also contributing to the co-teaching research base. This study can inform co-taught classroom teachers of the challenges and successes of incorporating geospatial technology lessons and student perceptions of using the technology. This research will also provide novice teachers that may have very little experience using geospatial technology a basis and guide to begin incorporating them into the classroom, regardless

of the level of students. The questions this research seeks to answer are:

- To what extent do students enrolled in a co-taught human geography course perceive the effectiveness of using geospatial technologies such as ArcGIS Online StoryMaps to study a world religion?
- What opportunities and obstacles impacting spatial thinking abilities are perceived by co-taught students and teachers when using ArcGIS Online?

II. LITERATURE REVIEW

GIS in APHG and Human Geography

With the rise of technology and access to geospatial technologies in the classroom, an increasing number of studies have been completed analyzing geospatial technology use in schools. Most of these studies focus on the College Board's AP Human Geography, science courses, or physical geography courses (Bodzin, Hammond, Fu, & Farina, 2020; Makinster, Trautmann, & Barnett, 2014; Webster, 2017). These courses are typically seen as the easiest to incorporate geospatial technologies into curriculum given the nature of the subjects. For example, students in APHG engaged in a study that analyzed the effectiveness of incorporating geospatial technologies in developing spatial thinking and expanding their own cognitive maps (Webster, 2017). This study focused on an AP course which generally has the highest achieving students. Students that elect to take an AP class often have higher test scores and are perceived as more capable of using new technologies. The results of the study by Webster show the benefits of using geospatial technologies with a group of students that can effectively learn from all teaching methods. Another study that produced similar results demonstrating the effectiveness of using geospatial technologies used tenth grade world geography honors classes, specifically citing higher motivation and academic success as reasons for the decision (Metoyer & Bednarz, 2016). Again, students were specifically chosen because they achieved at rates higher than their peers. Students that achieve at high levels can adapt easily to teaching methods and effectively learn course material. One study that does target a lower ability group focused on middle school students using geospatial technologies and did show the effectiveness at that level, but

now is almost twenty years old, and with advances in technology, could be further explored (Baker & White, 2003). Technology has changed drastically since the early 2000s and this research needs to be expanded on to show current opportunities and challenges with groups of lower ability students. While studies show the benefits of using geospatial technologies in these classes, little attention has been devoted to another style of education that has been increasing, co-teaching.

New research in the application of GIS has highlighted the benefits for student achievement and interest when using the technologies. Students generally are more engaged with the course content as they use geospatial technologies to solve a task and discover information for themselves (Ivan & Glonti, 2019; Norton, Li, Mason, Washington-Allen, 2019). Increases in spatial thinking after using web-based GIS technologies show students more effectively learn than when teachers use conventional methods of teaching geography (De Miguel Gonzalez & De Lazaro Torres, 2020; Jo, Hong, Verma, 2016; Perugini, Bodzin, 2020). While using GIS students are often more responsible for their own learning and completing project-based lessons instead of passively consuming information like the traditional model of teaching. Students perceive lessons to be more engaging when using geospatial technologies to study various subject matter (Goldstein, 2010; McGowan, 2020; Milson & Earle, 2007). Research shows that using geospatial technologies in the traditional classroom setting produces positive results in achievement and engagement for students, and an expanded view should be taken to account for nontraditional classrooms as well.

As more students engage in lessons utilizing geospatial technologies, some researchers have called for national standards and potentially standalone courses in

which students can study curriculum across content areas using the geospatial technology. Including GIS in the high school curriculum and creating some national standards that can help ensure exposure are a priority for many researchers (Wu, Li, Liu, Cheng, & Zhu, 2018). The proposal for an Advanced Placement GIS course could potentially see high school students earning college credit for taking the course (DeMers, 2016). Other research suggests that GIS and geospatial technologies have become so intertwined in students' daily lives that the creation of a geospatial technologies and spatial thinking course could help students better understand the tools they are already using (Nielsen, Oberle, & Sugumaran, 2011). While these proposals may eventually lead to geography education and geospatial technologies becoming more widespread in high school classrooms, a significant barrier to implementation still stands. Currently many educators fail to utilize geospatial technologies as they have little training in the technologies themselves or perceive the software to be too complex to use in the classroom (Henry & Semple, 2012). Some researchers argue that a wider implementation of geospatial technologies depends on teachers becoming more comfortable using and teaching the programs. Some research suggests that more widely used geospatial technology programs depend on cost-efficient professional training for educators that can be completed to assist with challenges and misunderstandings of implementation (Osborne, van de Gevel, Eck, & Sugg, 2020). Because teachers have reservations about using geospatial technologies in the classroom, only students that are perceived as highly capable will benefit from lessons that incorporate these systems as teachers do not have the confidence to attempt to bring them into settings with lower achieving students.

Co-Teaching

The second major aspect to this study focuses on the type of course that students participating in the research are enrolled in for the school year. This class is classified as a co-taught human geography course, indicating a portion of the students in the course have IEPs. No research could be found specifically incorporating any type of geospatial technology into a co-taught class. In fact, research in co-taught high school classrooms is relatively limited in the geography education setting. To better understand the dynamics of the course the following information is necessary, especially for anyone unfamiliar with the setting.

The concept of co-teaching, or team teaching, has been implemented in classrooms since the 1950s. Bringing together two teachers in one classroom that teach different subjects, or have different specialties offers students the chance many benefits. Time saved in planning, better use of visual aids through more complete preparation, more uniformity in instruction, less repetition for teachers, and more accountability for students are arguments for more team-teaching dating back to 1961 (Drummond, 1961). The ability to work with another professional allows both teachers to focus on their role within the classroom. Another research study completed in 1963 offered a different perspective combing a geography teacher with an English teacher to help students learn the content of the course, while also having a specialist that can assist with the literary aspects (Jirak, 1963). Throughout the 1960s and 1970s co-teaching became more prevalent as the right to a free appropriate public education without discrimination based on disabilities created a new surge of inclusionary thinking (Smith, 2012). By including

special education students in the traditional classroom, a more inclusive learning environment is created targeting better social development. More research detailed the benefits to faculty and students engaged in the co-taught model, such as a co-teaching experiment at the University of Rhode Island which demonstrated favorable comments from all parties after a semester of implementation (Kirwan & Willis, 1976).

More recent research provides similar data showing the benefits of co-teaching in teacher and student perceptions of the individual course being studied. Often, teachers are initially reluctant to the idea of co-teaching. Having little background in working in tandem with another professional, many teachers believe they need additional training, better development of coteaching partnerships, and more administrative support for co-teaching to be effective (Feustel, 2016). Teachers have unique approaches in the classroom and sharing the decision making with another professional can be difficult at first for many first-time co-teachers. As teachers gain experience and work within the co-taught model, perceptions of the effectiveness and overall atmosphere of working within the model generally tend to be positive (Kohl, 2021). Students and teachers both reported positive experiences in the co-taught setting when there is active support provided for all students and parity is observed in the relationship between co-teachers (Strogilos & Vasilis, 2019).

In addition to the inclusionary model of co-teaching incorporating a special education teacher with a content teacher, other models exist that are based in similar ideology, but instead combine teachers with differing content areas, such as English, history, and biology. A study that examined test scores after the change to multi-disciplinary teaching shows growth from averaging just below fifty percent proficiency

increasing to seventy-five percent proficiency, with most students exceeding their projected growth in each year of the program (Clemens & McElroy, 2011.) This type of co-teaching will not be explored in this research but is important to acknowledge as it has the potential to change one way classrooms function in education.

Co-teaching offers students with learning disabilities the opportunity to learn with regular education peers. Students with IEPs historically score significantly lower on standardized exams. For example, in the United States, students that have IEPs and took the National Assessment of Educational Progress (NAEP) exam in geography scored about .73 standard deviations lower on average than students without an IEP on NAEP Geography in 1994; .6 standard deviations lower in 2001; .64 standard deviations lower in 2010; .78 standard deviations lower in 2014; and .72 standard deviations lower in 2018 (Solem et al., 2021). On standardized exams students with learning disabilities are allowed to use accommodations to ensure equal access to the test and to prevent their disabilities from threatening the validity of the test score, and significant performance gaps still exist (National Academies, 2019). Engaging students in the co-taught setting may allow access to instructional tools that can help address some of the gaps currently present. Because of the lack of research presently available using geospatial technologies with students that have learning disabilities, this study can shape future research in the inclusionary settings using varying forms of these technologies.

Summary

While literature exists on the benefits of incorporating GIS into the high school classroom and the benefits of co-teaching, there is a significant gap in the combination of

the two ideologies. Studies have documented students in the AP and honors setting using geospatial tools to enhance spatial thinking abilities. Research in co-teaching also shows the benefits perceived by both students and teachers engaged in the process. This research will further develop the ideas of both categories through the exploration of using geospatial technology in the co-taught setting.

III. METHODOLOGY

Research design

This research focuses on student perceptions of the implementation and use of geospatial technologies to expand their spatial thinking abilities through an inductive qualitative case study methodology. Inductive research builds patterns, categories, and themes from the bottom up by organizing data to allow researchers to detect themes that can be further explored (Cresswell & Cresswell, 2018; Soiferman, 2010). Data consist of teacher observation, student work, and student free response surveys that were collected throughout the lesson. The data were then examined to find common themes regarding co-taught student perceptions of geospatial technology and successes and challenges of implementation in the co-taught classroom. The research procedures are presented in Figure 1.

Lesson

The lesson used in this research was adapted from a lesson created for a graduate course at Texas State University, GEO 5345: Spatial Thinking in Education, using geospatial technologies to improve spatial thinking abilities in the topic of political boundaries (See Appendix A). As part of the culture unit in human geography, students study popular and folk cultures, languages, world religions, and race and ethnicity. This lesson used a similar format as the one previously created but instead focuses on world religions. The religion unit in co-taught human geography falls after students have already completed coursework on popular and folk cultures and languages, and before race and ethnicity. Student learning objectives for this lesson fall in line with those

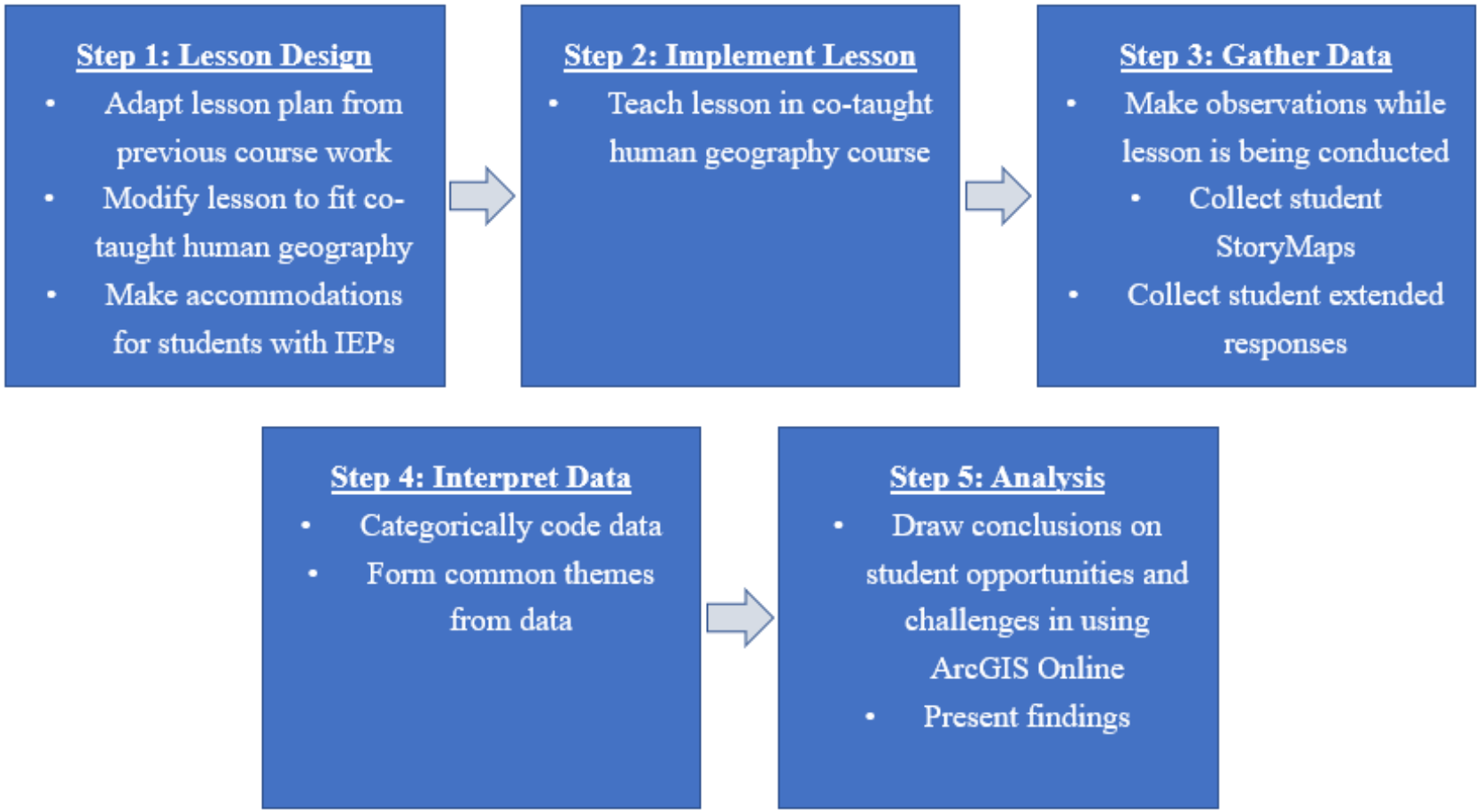


Figure 1. Research Design

presenting in the APHG curriculum. The co-taught course in this lesson adapted many of the same learning objectives as the AP program for continuity and ability to move students into different placements if needed. Students are expected to be able to explain major world religions distinct places of origin and the ways they diffused to other locations. Before beginning this lesson, students briefly were introduced to world religion through a short lecture, a video on the five largest religions, a video showing religious group identity over time, and a textbook reading on the geography of religion. For this lesson, students were randomly assigned one of six religions using an online group making generator. All materials for this lesson were distributed electronically through our learning management system. Students downloaded the instructions for the assignment which included the necessary information to be included in their ArcGIS StoryMap (See Appendix B).

Before beginning on the creating of the StoryMaps, students researched information that they would later include in their project for two fifty-five-minute class periods. On the third day of the lesson, students accessed detailed instructions for creating an account on ArcGIS and basic methods of using the platform. Students worked in class for one forty-two-minute class period and two fifty-five-minute class periods to complete their StoryMaps. Because of the co-taught nature of the class with some students receiving extended time as part of their accommodations, and additional fifty-five-minute class period was used to finish by some students as the rest of the class moved on to an enrichment assignment that covered material from other religions that students were not assigned. This is a common practice in the co-taught setting with such a wide range of ability level of students in one class. Enrichment materials offer additional

opportunities for the highest achieving students, while not leaving lower achieving students behind in the course sequence.

One unforeseen adjustment that had to be made during the lesson implementation came from the ArcGIS Story Map website. In a school, all students are connected to the same Wi-Fi signal, meaning they are all tied to the same Internet Protocol (IP) address. When first attempting to create free public accounts, students faced an error screen that said too many attempts were made from the same IP address. Students then could not access the website to create their account until a short time had passed. A solution implanted during the lesson to solve the problem was to have each small group of students, or pod, create accounts in waves. Each group creating accounts at staggered times allowed everyone to sign up without issue.

Participants

Students participating in this research were selected because of their enrollment in the co-taught human geography course that I am currently teaching at Argo Community High School (ACHS). All participants are current ninth grade students. ACHS offers three levels of human geography to all ninth-grade students to take as electives. Currently, only two years of social science courses are required for graduation, with one year of United States history, one semester of government/civics, and one semester of economics being the only required courses. Because of only a two-year social science requirement, not all ninth-grade students take one of the human geography courses. The section of co-taught human geography used for this research consists of students that enrolled in the course by choice. Enrollment in human geography has grown at ACHS as

the course has only been offered since the 2018-2019 school year.

ACHS is in Summit, Illinois in the southwest suburbs of Chicago, just outside of Chicago city limits. Students that attend ACHS live in the communities of Bedford Park, Justice, Summit, and Willow Springs. According to the United States Census Bureau, these villages collectively had a median household income of $67,720 in 2020 (United States, 2021). The area has as mix of industrial and residential areas with one factory, Ingredion, being one of the largest employers for residents. Ingredion was formerly known as Argo Corn Products which originally opened in 1916 leading to the naming of the school Argo Community High School when it opened in 1920. The demographics of the community also changed over time as many different immigrant groups saw economic opportunity in the factory setting and moved to the area.

The ethnic background of students in the study is diverse due to the diversity in the communities that feed into the school. As a whole, ACHS school consists of a student population that identifies as 51.8% Hispanic, 32.1% White, 11.3% Black, 3.3% Two or More Races, 1.4% Asian, and 0.1% American Indian and is also classified as a Title 1 school with 62.5% of students reported as low-income (Illinois, 2020). The twenty-three students in this study can be classified as 11 Hispanic, 5 White, 5 Black, and 1 Asian. Many students that attend ACHS are first- or second-generation migrants to the United States from Latin America, Eastern Europe, or the Middle East and do not speak English as their first language. In this study, 13 of the students speak Spanish, Polish, or Arabic as their first language, and English as their second. This can present additional challenges with reading and writing, but after almost a full school year in the co-taught setting, the students in this research as accustomed to reading, annotating, synthesizing, and writing.

In total, twenty-three students participated in the study, twelve of which have IEPs. The most common accommodations included in these IEPs are extended time for assignments, having tests or quizzes read aloud, utilizing small group settings, and frequent breaks. Because of such a high number of IEPs in the co-taught setting, some changes to the lesson must be made during the actual class period. During this research, all the student accommodations were followed to ensure students had opportunity for success without the need for unforeseen alterations. Approval for this research was granted by the Institutional Review Board (IRB).

All participants had no prior experience using ArcGIS Online, however all were familiar with using programs like Canvas, OneNote, PowerSchool, Office365, and other similar educational platforms. ACHS provides all students with personal devices at the beginning of the school year. All work submitted in the co-taught human geography course is submitted electronically through Canvas. Significant time is spent in the beginning of the school year instructing all ninth-grade students how to use the learning management system and other online systems.

Data Collection

The data collected for this case study included classroom observations, student work samples, and an open-ended student reflection. Classroom observations were conducted throughout the duration of the lesson as I acted as a participant observer simultaneously teaching and helping students while documenting participant actions and conversation. I used note taking to record observations made throughout the lesson. A major point of emphasis of observations was to document peer conversations in which

students discussed their experience using the technology. I also documented frequently asked questions or concerns of which students needed individual assistance. Students submitted work that was then graded using an analytic rubric (See Appendix C). The rubric contained three categories: Use of Maps, Accuracy of Information, and Use of ArcGIS. Each category contained three possible ratings with explanations of required content needed to achieve the rating. Students were scored as expert, practitioner, or needs improvement on the rubric according to the StoryMap produced. After all students completed the StoryMap project, an open-ended reflection of at least two hundred words discussing the use of the platform was assigned (See Appendix D). In this reflection students responded to questions designed to think about what tools were used in StoryMaps to produce the final product, how maps were incorporated into the project, the ways this software engaged students with maps, and the ability of students to locate sacred places in the world as a result of using the technology. Students extended responses included answers intended to provide data on student perception of the lesson and ArcGIS StoryMaps.

Data Analysis

All data collected for this project was intended to be used to make assertions about the results of using ArcGIS Online in the co-taught classroom. After lesson implementation, data was coded to reveal patterns in students' perception of the lesson. The categorical aggregation of the data provided themes that could be further explored. Student surveys were coded into three main categories with two subsets of positive and negative sentiment. These categories consisted of student perceptions of using ArcGIS

Online StoryMaps and the impact of the platform on student spatial thinking abilities. The third category consisted of student scores on the submitted StoryMaps along with my observations during the lesson.

IV. RESULTS AND DISCUSSION

Research Question 1: To what extent do students enrolled in a co-taught human geography course perceive the effectiveness of using geospatial technologies such as ArcGIS Online StoryMaps to study a world religion?

Overall, using ArcGIS Online leads to increased student engagement in the co-taught setting. One of the biggest challenges all educators face with the rise of cell phones and electronic devices in the classroom is keeping students engaged throughout a lesson. Many times, in the co-taught setting, students have documentation in IEPs describing ways to attempt to prevent distractions, but in practice the distractions can be difficult to overcome when teachers are attempting to manage a full classroom of students. During the beginning of the lesson when attempting to first create free accounts on ArcGIS online, students began to grow frustrated with the IP issues mentioned in the lesson implementation portion above. After finally breaking through the sign-in barrier, students immediately began using the features of StoryMaps, most without needing the instructional sheet (Appendix B). I quickly noticed students moving through StoryMaps examining the features available. Many students had already began making their maps without prompting following the intuitive design of the software. With a clean interface, students could easily begin a new StoryMap and start to add data to the platform.

One of the common themes in the student extended responses consisted of the ease of using the software. Out of the twenty-three students that engaged in the lesson, twenty specifically detailed their satisfaction with ArcGIS Online being very user friendly in the extended responses once the lesson was completed. One student explained, “I liked the way the website was [made] because of how easy it was to access it and edit

it." Another student added a specific portion of ArcGIS they liked saying, "The map feature for this website was made very well and you can simply just search the location of your choice." A student with an IEP stated, "…it was easier to use and easier to add maps and mark the place I wanted to, it was also easier to edit." A second student that historically struggles to complete work in class stated, "On StoryMaps you just have to go to the search bar and type the location you want and then add it and, boom, done." One of the academically stronger students in the class added, "I think that this website is very useful and it's something I would definitely use again." Many students informally explained that with the use of technology so prevalent in modern society, incorporating an online mapping tool in the co-taught setting seemed very similar to the other technologic tools they use daily.

A second way students proved to be engaged in the lesson was through their comparisons with programs they have frequently used for other research projects in the past, mainly Microsoft PowerPoint. Encouraging classroom discussion on academic issues can be a difficult task for teachers to organically produce. During the lesson, I heard many instances of students telling other students at their small group of desks to see the work that they produced using a feature on StoryMaps and explaining reasons the software was superior to other programs used in the past. Throughout the surveys as well, a common theme consisted of ArcGIS being a significant upgrade from using PowerPoint. One comment from a lower achieving student pointed out one of the issues they perceive with using PowerPoint by saying, "…all a PowerPoint shows is words and doesn't really have anything else. Another student with an IEP stated, "When I go down the slides it goes to the different locations… it was super easy to write down my facts and

make the slides." A third student also with an IEP stated, "I feel like StoryMaps was a good website or app to use and I think it's better than PowerPoint, it's easier to use and it has a lot of cool things…there is a couple stuff you can only do on StoryMaps unlike PowerPoint." Students were engaged as they felt the software allowed them to create a product that was visually appealing and easy to learn.

The scores from the assignment also represented a higher engagement level than other types of assignments completed in the past. This is a third source documenting increased levels of engagement while using this geospatial technology. All of the students participating in the lesson submitted an ArcGIS StoryMap to Canvas. The normal homework completion rate is substantially lower, and many students regularly earn zeros for missing assignments. The overall class average based on the analytical rubric (Appendix C) was a 41.48 out of 45 possible points, or a 92.18%. The class average grade at the time for the co-taught course was a 78.43% (Table 1).

Table 1. Grades

Class Grade	Lesson Grade	IEP
82%	93%	
92%	100%	IEP
47%	67%	IEP
75%	100%	
100%	100%	
69%	87%	IEP
68%	100%	IEP
84%	100%	
59%	87%	IEP
95%	100%	
94%	100%	
82%	100%	IEP
98%	100%	
68%	93%	IEP
73%	93%	
67%	87%	
43%	73%	IEP
97%	100%	IEP
50%	60%	IEP
90%	93%	
83%	87%	IEP
94%	100%	

Students reported enjoying the lesson and using ArcGIS StoryMaps much more than other coursework. One student even hoped for another lesson involving a similar technology writing, “I do hope we do something similar to this in the future.” Another student that spends most of the school day in self-contained special education classes but has co-taught human geography as one class that is in the regular classroom setting, submitted this project to earn one of the highest grades of the year while stating, “The tools I used will help others understand a bit better like it did for me.”

One complaint from multiple students focused on the ease of which photos can be added to the StoryMap. To add a photo, the photo file must be saved onto the student’s computer. Then a file upload occurs to use the photo in the StoryMap. This process is

slightly more complicated than pasting a photo in other platforms, (i.e. PowerPoint, Word). In discussing the pros and cons of using ArcGIS Online, one student stated, "I didn't really dislike anything (about using StoryMaps) other than how you get pictures." This theme appeared throughout the surveys as students had some initial learning curve to properly format photos in the software.

Research Question 2: What opportunities and obstacles impacting spatial thinking abilities are perceived by co-taught students and teachers when using ArcGIS Online?

Geospatial lessons can lead to perceived increases in spatial thinking abilities for students with and without IEPs. In addition to overwhelming positive feedback and engagement in the lesson, students reported increases in their perceived spatial thinking abilities. Most students that participated in this lesson lack the academic vocabulary to specifically state advancements in spatial thinking, but the language used describes the ideology in an informal manner. In this co-taught human geography course, spatial thinking is often referred to informally by students when they discuss their understanding of space. Common examples students mentioned while participating in this lesson, and in the surveys, included the organization of political boundaries, the diffusion of religion from hearths, and the number of followers of religions around the world. Building an understanding of how to think spatially can be very difficult for students that have little background information from which to expand their ideas of space. In the co-taught setting, students with learning disabilities must also overcome an additional barrier when attempting to improve their spatial thinking abilities. Students reported overall positive

impacts to spatial thinking from using ArcGIS Online in the surveys and in my observations in class during the lesson.

One of the first ways students demonstrated their perceived increases in spatial thinking is through their descriptions of using political boundaries. Most students in this co-taught human geography course do not have a broad basis of knowledge on the countries of the world, but through this lesson, students reported positive results. When discussing how StoryMaps influenced spatial thinking, one student wrote, "This tool helped me think about real location… I could easily put a picture of India or China (in a PowerPoint) and describe what it does without even knowing where the country is located." Instead of simply stating information about a country, students can locate the country on a map within the StoryMap platform (Figure 2).

Figure 2. Student Work Example: Buddhism

This provided an additional layer of understanding for these students. Another student

stated a similar experience saying, “By going to the exact location to show why that place is important or has importance… I would look up the location where the sacred place is located in the world.” Students used StoryMaps to develop a better awareness of the spatial distribution of countries and cities (Figure 3).

In addition to better understanding of political boundaries, students reported using the map features on StoryMaps to change the scale of the map to examine holy sites within counties. Maps can easily be manipulated in StoryMaps to stay on a desired scale students choose for each portion of the story. A student that struggled to complete course work and later transferred to a self-contained special education classroom after this lesson stated, “This tool helped me think about locations because you were able to add location and have the locations zoomed in or not.” This student is describing the ability on StoryMaps to incorporate different scales depending on the need for the portion of the project. Many students used different scales when showing the origin of the religion, and the diffusion process out from the original location. Another student stated, “It did help me because it allowed me to move around the map and zoom in to it seeing different places.” Including various scales allowed students to see the local impact of the religion they studied as well. In Figure 4, a student documented a holy site in Lemont, Illinois, which is only a few miles away from ACHS. Scale is a common theme throughout the school year in human geography that is obviously incorporated into many lessons. Empowering students to be the scale creators of maps provided an opportunity not often available through traditional types of lessons.

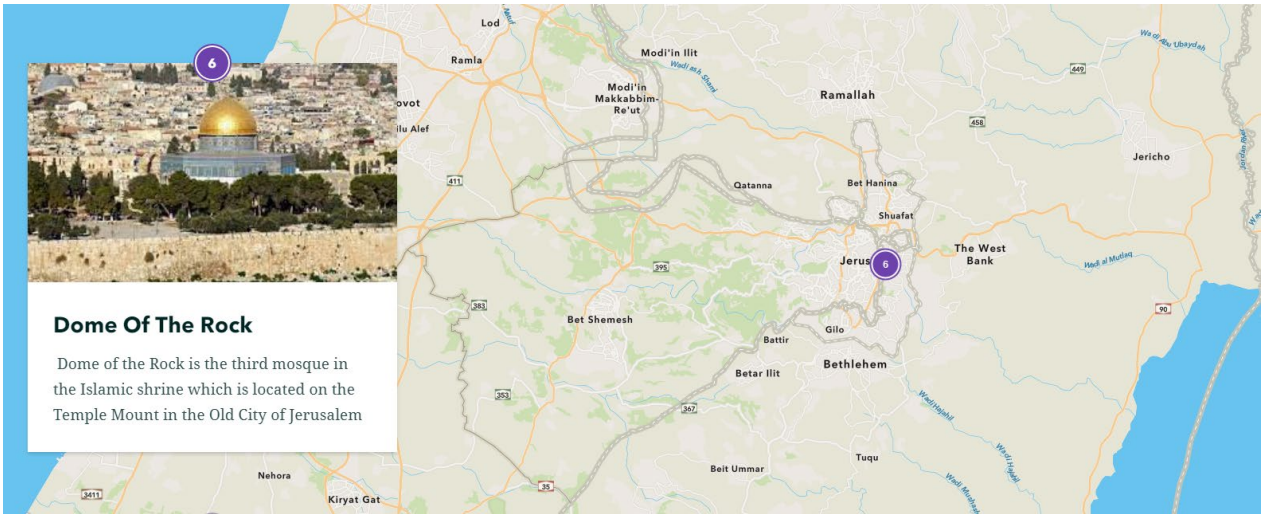


Figure 3. Student Work Example: Islam

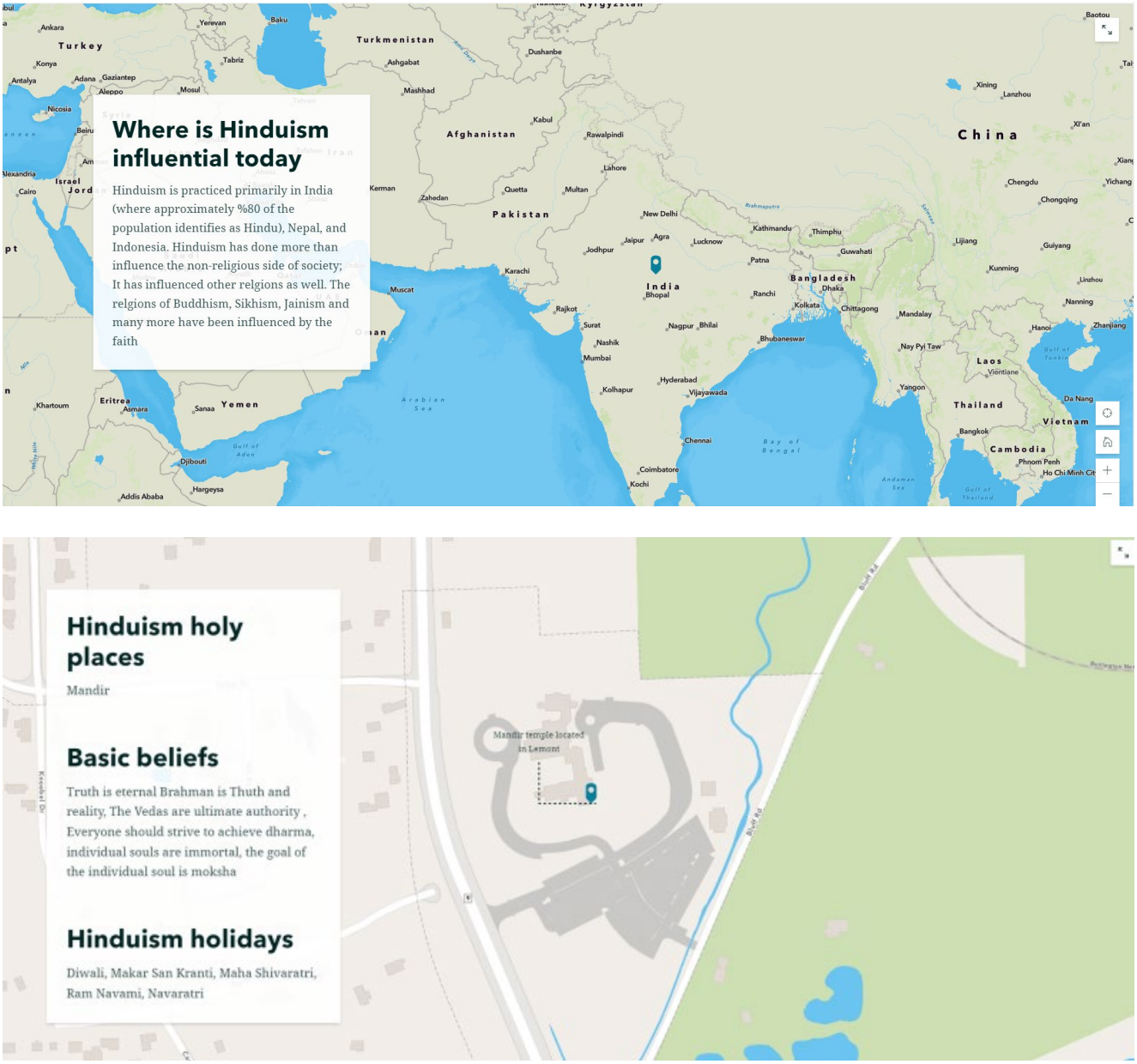


Figure 4. Student Work Example: Scale of Analysis

From the teacher perspective, observations made throughout the lesson implementation demonstrate positive opportunities for co-taught students to develop spatial thinking using ArcGIS Online StoryMaps. Individual conversations with students engaged in the software lead to these conclusions along with the lesson grades

documented above. Students eagerly asked questions regarding specifics of the diffusion of religious ideas over time. One student inquired about the ways in which religion spread and made connections to previous units of study, like migration and culture, as they discussed relocation diffusion as a major cause. Other students in the small group then added to the discussion by listing additional examples of historical diffusion. Observations documented overwhelming student support for the program with minor redirections for extensive talking and cell phones usage being the most common disruptions to the lesson.

V. CONCLUSIONS

This research shows the benefits of using GIS in the co-taught setting based on student perceptions, performances, and teacher observations. Throughout the implementation of the lesson in the co-taught human geography course at ACHS, students easily adopted the platform and discussed the many advantages of using the software over other strategies used in previous course work. This research expanded on existing studies in GIS and co-teaching by documenting the opportunities and challenges associated with bringing geospatial technology into the co-taught classroom. Students with and without IEPs responded to the content of the lesson and the geospatial technologies with very few disruptions and reported perceived benefits from using ArcGIS Online. The overall findings of this research support future use of geospatial technologies in the co-taught setting to help develop and expand students' spatial thinking abilities.

Future research in co-taught human geography can be completed to further examine the implementation of geospatial tools on a broader base of students. Having developed a rapport with students in the classroom and having significant experience teaching human geography for nearly a decade provided me with an advantage over novice teachers when using GIS in this lesson. The dynamic of the co-teaching relationship also could have a different effect on results produced with other teachers that implement similar lessons. Having worked with my co-teacher for a number of years, a comfort in classroom dynamics allowed the lesson to be team taught with few issues. Other co-teaching styles may lead to greater or fewer challenges and could be further explored by future research. In addition, other types of geospatial technology could be

studied in the co-taught setting that may be more advanced and possibly more difficult for students to use effectively. Future research may build on this study by implementing a lesson plan similar to the one used here then moving to more complex tasks.

Appendix A

Political Boundaries – AP Human Geography 4.4/4.5			
Name	Taylor Loux	**School**	Argo Community High School
Email	tloux@argohs.net	**Phone**	708-728-3200
Grade level	9		
Introduction	In this lesson, students will be introduced to concepts related to the formation of political boundaries around the world. The lesson will focus on the ways in which boundaries were created, the types of boundaries that separate states and substates, and the present implications of these boundaries. Examples of the types of boundaries included in the lesson are relic, superimposed, subsequent, antecedent, geometric, and consequent boundaries. Students will consider the spatial components of boundaries as they use geospatial technologies to analyze specific examples of states. Geospatial technologies such as Google Earth will encourage students to analyze real examples of all of the types of boundaries. Considering how boundaries affect the spatial distribution of people and services will help students understand the importance of decision making in the creation of boundaries and the potential positive or negative effects that can result from that process. Spatial thinking is vital to the understanding of these topics as students must utilize real world examples in this lesson to demonstrate their knowledge of the types of boundaries and the associated consequences of the distribution.		
Spatial thinking components of the lesson	While students engage in this lesson on political boundaries, many other aspects of spatial thinking will be incorporated and utilized throughout the lesson. Earlier in Unit 1, students applied scales of analysis to maps and created their own examples of maps at global, regional, national, and local scales. This lesson will build on that knowledge by requiring students to include political boundaries at different scales. As students include examples of political boundaries at different scales of analysis, they will apply the current material to show complex relationships between the two subtopics. Building on previous spatial thinking further develops and reinforces the importance of including spatial analysis in analysis subsequent topics. Students should connect and understand the importance of building on prior knowledge to further geographic reasoning. This lesson pushes students to use spatial thinking to better understand a topic that often is difficult for young geographers to fully grasp. Relying on spatial thinking helps to bridge gaps resulting in a much more complete comprehension of the relevant topics.		
Student learning objectives	Students will be able to… Analyze spatial patterns using types of boundaries. Describe the impact of boundaries on current economic, social, political, and environmental outcomes. Create a story map detailing boundary types using real world examples.		
Relevant standards	AP Human Geography Curriculum and Exam Description IMP -4 Political boundaries and divisions of governance, between states and within them, reflect balances of power that have been negotiated or imposed. IMP-4.A Define types of political boundaries used by geographers. IMP-4.A.1 Types of political boundaries include relic, superimposed, subsequent, antecedent, geometric, and consequent boundaries. IMP-4.B Explain the nature and function of international and internal boundaries.		

	IMP-4.B2 Political boundaries often coincide with cultural, national, or economic divisions. However, some boundaries are created by demilitarized zones or policy, such as the Berlin Conference. C3 Framework D2.Geo.1.9-12. Use geospatial and related technologies to create maps to display and explain the spatial patterns of cultural and environmental characteristics. D2.Geo.3.9-12. Use geographic data to analyze variations in the spatial patterns of cultural and environmental characteristics at multiple scales. D2.Geo.6.9-12. Evaluate the impact of human settlement activities on the environmental and cultural characteristics of specific places and regions.

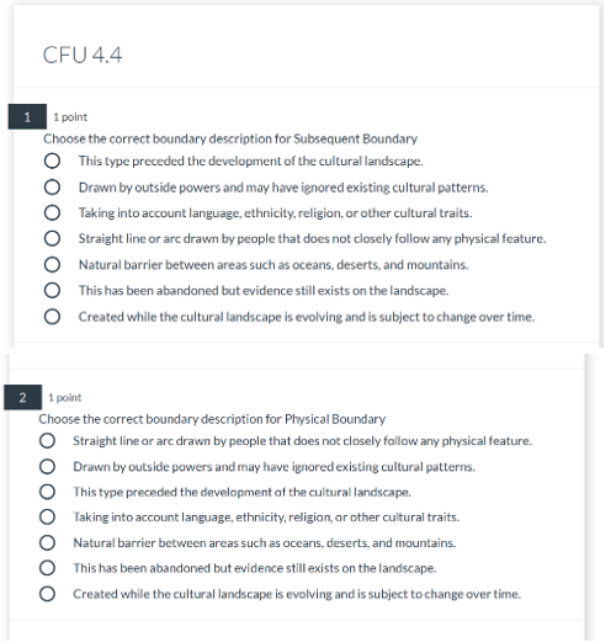
Teaching and learning procedures		**Notes for teachers or students**
(e.g., Engage Explore)	-Students should read a relevant chapter from a textbook prior to beginning this lesson. Using the AMSCO Human Geography book, pages 218 – 230 cover information necessary to complete this lesson. This lesson focuses on applying material instead of direct instruction. (Done prior to class) -To begin class, students will answer a bellringer question reviewing the major types of boundaries. The bellringer question will be available to students in Canvas and will ask "List and explain the major types of boundaries as outlined in your reading and in Topic 4.4 of the AP Human Geography curriculum". A discussion should follow with students describing each type. (5-7 minutes) -As a review/collaborative learning activity, students will complete a short lecture/activity on boundary types using an adapted PowerPoint from Michael Robinson. This PowerPoint is available on his website. Students will focus on analyzing the boundaries on slide 5 in small groups. Using the photos provided, students should categorize the boundary types based on their understanding from the reading and bellringer discussion. (Approximately 10 min) -Students will be given 5 minutes to discuss in small groups the boundary types shown in the PowerPoint slide, also provided on their Canvas page. After group discussion, we will discuss as a class the correct categorizations. (Included in 10 min activity) -Students will then use ESRI story maps to create their own map showing examples of boundary types. Detailed instructions will be included to guide students through the process. The handout attached will be provided as a step-by-step guide. (40 min)	-If no text is available on the types of boundaries used in AP Human Geography, a supplemental article may have to be provided, or additional slides may be added to the lecture explaining each type.

The following rubric may be used to score the StoryMaps.

ArcGIS StoryMap - Political Boundaries

Criteria	Ratings				Pts
Explanation of boundary types	**10 pts** **Expert** -All of Practitioner, plus a detailed explanation for each visual aid presented describing how that specific map area demonstrates the boundary type.	**7.5 pts** **Practitioner** -Identifies boundary types listed in the CED (relic, superimposed, subsequent, antecedent, geometric, and consequent). -Provides examples of each type of boundary and provides some visual aid or map to show the example.			10 pts
Use of ArcGIS to create a visually appealing product	**5 pts** **Expert** -All of Practitioner, plus a noticeable effort to go above and beyond using many types of variations of visual aids throughout the StoryMap. -Includes ideas from the professional StoryMaps provided as exemplars.	**3.75 pts** **Practitioner** -Incorporates multiple methods of presenting information. This could include google maps, ArcGIS maps, other thematic maps, or any other examples of visual aids. -Follows directions listed in the student handout to create a complete StoryMap.			5 pts
Completion of StoryMap	**5 pts** **Expert** -All of Practitioner, plus a obvious effort to fully treat this as a valued learning experience. -Student extended the assignment to include multiple examples that may not have been required, but when provided, offer a deeper look into each boundary type.		**3.75 pts** **Practitioner** -Most of the StoryMap shows effort that treated this as a valued learning experience. -Major ideas were covered in the StoryMap and most had adequate explanations.		5 pts
					Total Points: 20

	Assessment item/task (optional for extra credit)	Notes for teachers or students
	The assessment for this task will consist of grading the ArcGIS StoryMaps and students taking a short multiple choice style quiz as a Check for Understanding (CFU).	



CFU 4.4

1 1 point

Choose the correct boundary description for Subsequent Boundary

- This type preceded the development of the cultural landscape.
- Drawn by outside powers and may have ignored existing cultural patterns.
- Taking into account language, ethnicity, religion, or other cultural traits.
- Straight line or arc drawn by people that does not closely follow any physical feature.
- Natural barrier between areas such as oceans, deserts, and mountains.
- This has been abandoned but evidence still exists on the landscape.
- Created while the cultural landscape is evolving and is subject to change over time.

2 1 point

Choose the correct boundary description for Physical Boundary

- Straight line or arc drawn by people that does not closely follow any physical feature.
- Drawn by outside powers and may have ignored existing cultural patterns.
- This type preceded the development of the cultural landscape.
- Taking into account language, ethnicity, religion, or other cultural traits.
- Natural barrier between areas such as oceans, deserts, and mountains.
- This has been abandoned but evidence still exists on the landscape.
- Created while the cultural landscape is evolving and is subject to change over time.

3 1 point

Choose the correct boundary description for Geometric Boundary

- Taking into account language, ethnicity, religion, or other cultural traits.
- Straight line or arc drawn by people that does not closely follow any physical feature.
- Created while the cultural landscape is evolving and is subject to change over time.
- Natural barrier between areas such as oceans, deserts, and mountains.
- Drawn by outside powers and may have ignored existing cultural patterns.
- This has been abandoned but evidence still exists on the landscape.
- This type preceded the development of the cultural landscape.

4 1 point

Choose the correct boundary description for Superimposed Boundary

- Drawn by outside powers and may have ignored existing cultural patterns.
- Taking into account language, ethnicity, religion, or other cultural traits.
- Created while the cultural landscape is evolving and is subject to change over time.
- This has been abandoned but evidence still exists on the landscape.
- Straight line or arc drawn by people that does not closely follow any physical feature.
- Natural barrier between areas such as oceans, deserts, and mountains.
- This type preceded the development of the cultural landscape.

5 1 point

Choose the correct boundary description for Antecedent Boundary

- This has been abandoned but evidence still exists on the landscape.
- Taking into account language, ethnicity, religion, or other cultural traits.
- Drawn by outside powers and may have ignored existing cultural patterns.
- Natural barrier between areas such as oceans, deserts, and mountains.
- Created while the cultural landscape is evolving and is subject to change over time.
- This type preceded the development of the cultural landscape.
- Straight line or arc drawn by people that does not closely follow any physical feature.

6 1 point

Choose the correct boundary description for Relic Boundary

- Created while the cultural landscape is evolving and is subject to change over time.
- Natural barrier between areas such as oceans, deserts, and mountains.
- Drawn by outside powers and may have ignored existing cultural patterns.
- This has been abandoned but evidence still exists on the landscape.
- This type preceded the development of the cultural landscape.
- Straight line or arc drawn by people that does not closely follow any physical feature.
- Taking into account language, ethnicity, religion, or other cultural traits.

7 1 point

Choose the correct boundary description for Consequent Boundary

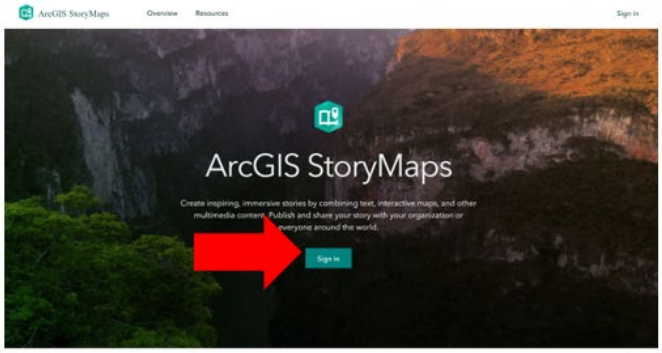
- Drawn by outside powers and may have ignored existing cultural patterns.
- Straight line or arc drawn by people that does not closely follow any physical feature.
- Created while the cultural landscape is evolving and is subject to change over time.
- Natural barrier between areas such as oceans, deserts, and mountains.
- This has been abandoned but evidence still exists on the landscape.
- This type preceded the development of the cultural landscape.
- Taking into account language, ethnicity, religion, or other cultural traits.

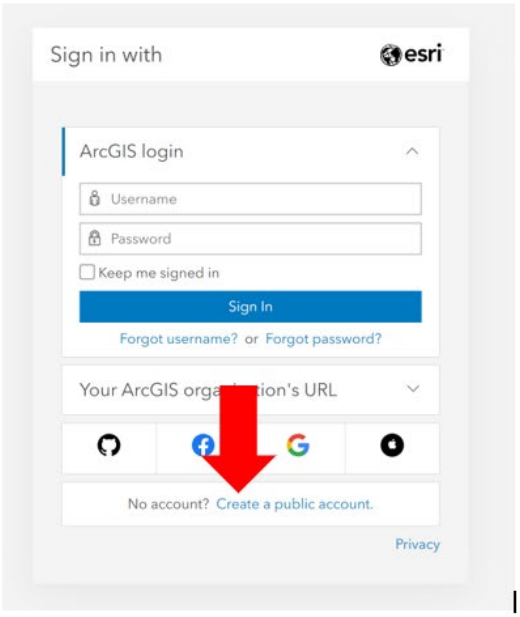
References	Notes for teachers or students
1. https://istem.maps.arcgis.com/apps/MapJournal/index.html?appid=fc2ad2922d3f47d7926d618249fccca0 2. economist.com/asia/2020/01/30/a-restive-corner-of-india-is-becoming-more-peaceful?fbclid=IwAR33ffEEW3VxpX9IwHSZS2aQEza0c-l9LMHTvjkVG2DpMl6Ub6bfMaNygaA 3. https://www.usip.org/publications/2021/03/south-sudan-10-states-32-states-and-back-again?fbclid=IwAR2IYLDLBrrrdF1_Ed1UGLC5trwyy2qZYXOr3FOyviPA-sCRj3mGS-Eqo0s	1. This story map provides insight into the different types of boundaries. This may be useful as an additional resource for students or serve as an exemplar. 2. Article from The Economist detailing administrative boarders withing India. 3. Article from the United States Institute of Peace discussing internal boundaries in South Sudan.

Appendix B

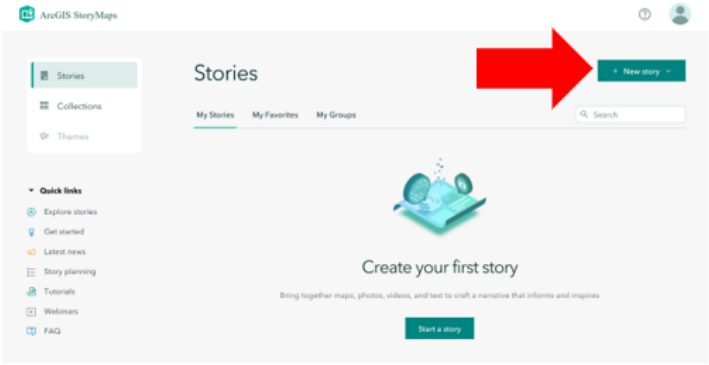
ArcGIS Story Map Student Instructions

Go to storymaps.arcgis.com and sign in if you have an account. If you do not have an account, follow the instructions to make a free account.

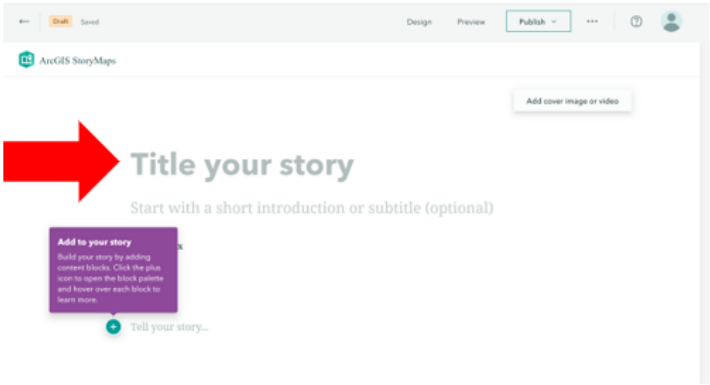




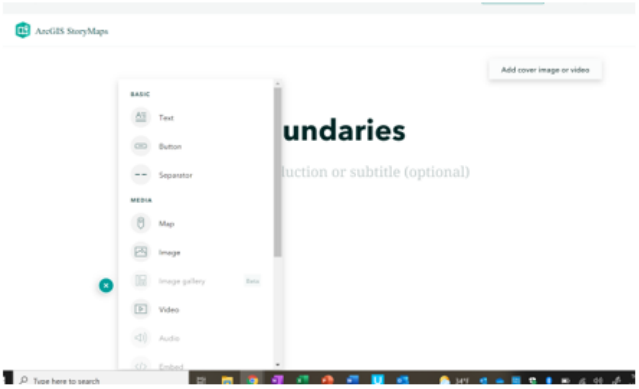
After creating a free account, you will create your first story. To do this, click on the New Story button.



ArcGIS StoryMaps provides many opportunities for you to customize your page. Start by giving your story a title. This should be related to your assigned religion in some way.



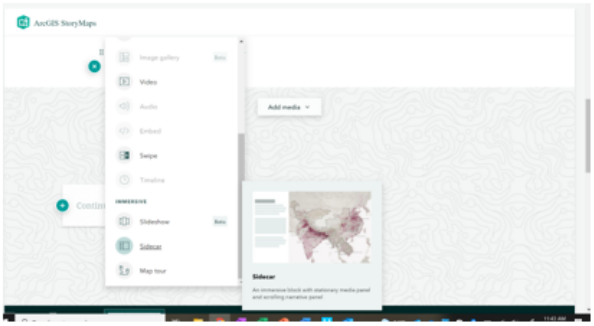
After creating a title, you can start to add text, photos, maps, images, videos, etc. to your page. To do so, click on the green plus button and choose your desired option.



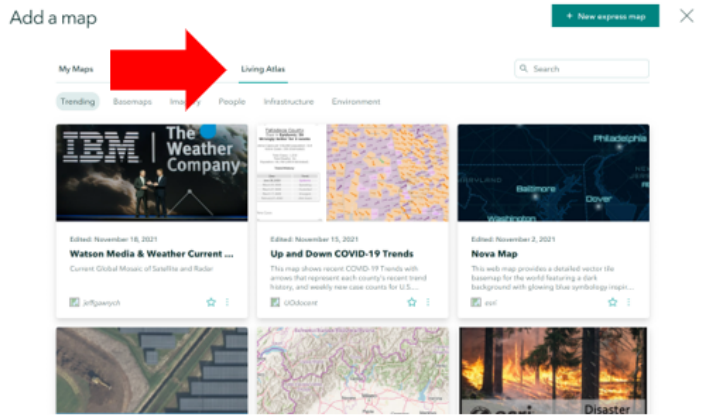
You should add maps and images of each of important places within the religion you were assigned. You should also make connections in the text to explain the significance of the religious space. All of the questions below should be answered in your Story Map.

Place of origin?	How did it spread?	Where is it influential today?	# of followers worldwide?	Monotheistic /polytheistic?
Ethnic or Universal?	Major Deity or Deities?	Founder?	When was the religion founded?	Sacred Writings?
Holy Places?	Basic beliefs?	Holidays?	Sects / Branches / Divisions?	Any other information?

Explore all of the options listed. Some of the features allow you to overlay maps with data. This is called the "sidecar" feature or the "map tour" feature. These may work well to explain your religion by including mapping with the overlaying text.

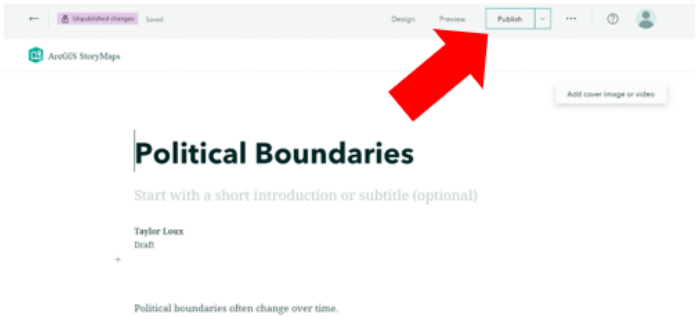


By clicking on the Living Atlas tab, after clicking to add a map, you will have access to premade data sets and maps that may be useful in showing your religious features.



Below is an example of how the sidecar feature works. This map shows political boundaries and allows for the overlaying of text.

When you have outlined all of the information necessary for the assignment, you should prepare your StoryMap for submission. You first must publish your map. To do so click on the Publish button on the top of the page.

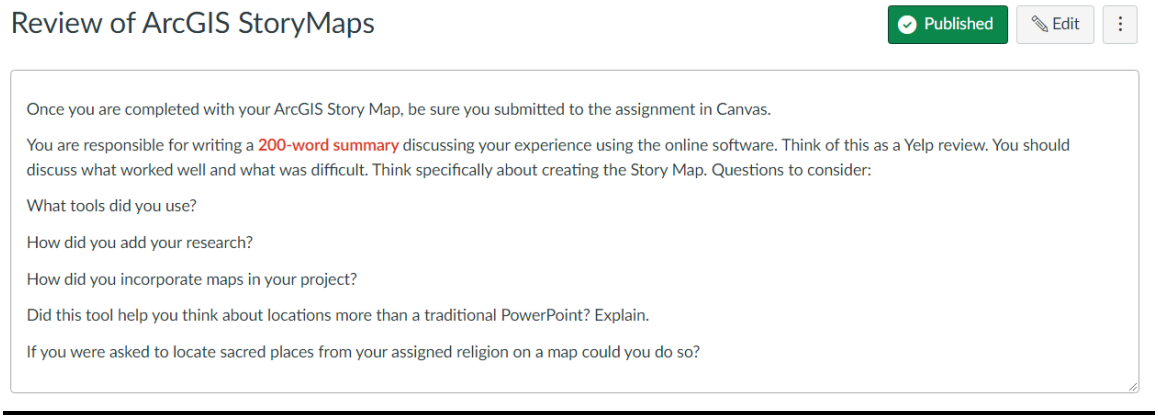


Be sure to submit your StoryMap to the assignment in Canvas. This is how I will grade your work.

Appendix C

Criteria	Ratings			Pts
Use of Maps	**15 pts** **Expert** All of Practitioner, plus the inclusion of multiple scales of maps that change as the Story Map scrolls from one location to another.	**12 pts** **Practitioner** Creates and accurately labels 3 maps within the Story Map that are relevant to the assigned religion. Each of the maps furthers the understanding of the viewer on an important geographic feature of the religion.	**9 pts** **Needs Improvement** Does not yet have at least three maps within the Story Map. Some of the maps that are provided are inaccurate in the assigned religion or do not further the understanding of the viewer by being included.	15 pts
Accuracy of Information	**15 pts** **Expert** All of Practitioner, plus a detailed description of where the religion is most prevalent today.	**12 pts** **Practitioner** All of the questions provided in the prompt are answered with information that reflects historical trends of the assigned religion. Analysis and data provided is thorough enough that someone unfamiliar with the religion could use the page to gain an accurate understanding of the history of the assigned religion.	**9 pts** **Needs Improvement** Does not yet have enough information on the page for someone unfamiliar with the religion to gain a basic understanding, or has inaccurate information.	15 pts
Use of ArcGIS	**15 pts** **Expert** All of Practitioner, plus additional images and graphics that go above and beyond to show the principles of the assigned religion. This can take many different shapes as videos, images, maps, etc.	**12 pts** **Practitioner** Uses multiple methods of presenting information in an eye catching manner. Provides both visual and written details that outline the major ideology of the assigned religion.	**9 pts** **Needs Improvement** Primarily uses one method of presenting information. Does not provide many details on the ideology of the assigned religion.	15 pts
			Total Points: 45	

Appendix D


Review of ArcGIS StoryMaps
Published
Edit
Once you are completed with your ArcGIS Story Map, be sure you submitted to the assignment in Canvas.
You are responsible for writing a 200-word summary discussing your experience using the online software. Think of this as a Yelp review. You should discuss what worked well and what was difficult. Think specifically about creating the Story Map. Questions to consider:
What tools did you use?
How did you add your research?
How did you incorporate maps in your project?
Did this tool help you think about locations more than a traditional PowerPoint? Explain.
If you were asked to locate sacred places from your assigned religion on a map could you do so?

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