Landscape of Geography in US Higher Education

Submitted as partial fulfilment of a Master's of Science in Geospatial Technologies

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Abstract

In recent years, "cartographers" and "specialists in geography" have often been cited as growing occupations in the United States. Responsively, Geography departments in US higher education institutions are appealing to a perceived need for "geographic skills" in the American workforce—specifically for GIS. Historic growth and decline of Geography in American higher education have not, however, coincided with perceived workforce needs. This study adopts a geographical text analysis approach in order to examine where and how Geography departments across the United States define and discuss "geography" and "GIS." In doing so, it highlights regional inconsistencies in language use and depicts how the rise of GIS is impacting the modern landscape of Geography in US higher education.

1. Introduction

Geographic information and geospatial, or location-based, technologies are growing sectors of the American economy, influencing almost every facet of modern life, from tracking lost cell phones to monitoring disease outbreaks like Ebola. The emergence of these technologies has increased demand for workers who can analyze and interpret geographic information.

— US Government Accountability Office (GAO) Report: "K-12 Education: Most Eighth Grade Students Are Not Proficient in Geography", 2015

In the past, public, private, and educational organizations catalogued and stored spatial information as paper maps. Much has changed, however, since the origins of geographic information systems (GIS). The history and definition of GIS varies "depending on who is giving it" (Pickles 1995). One variation of the narrative credits Roger Tomlinson with coining the term "GIS" in the 1960s in his work developing the Canada Land and Geographic Information System—an inventory of land-based information (Walford 2016). Other narratives recognize that "the text and context of GIS is heavily underwritten by a military agenda" (Smith 1992). Regardless of its first reported use, GIS initially served as an organization system for geographic and spatial data.

Today, however, thanks to the growth of other technologies such as the Internet, mobile communications, global positioning systems, geoprocessing software, and crowd-sourced geo-data, GIS has generally become "a combination of a database and a computer mapping system" (Gregory *et al.* 2015). It has also become "an indispensable part of our daily lives, whether we realize it or not" (Walford 2015). While GIS enables everything from satellite navigation to tracking the course of weather systems and disease outbreaks (WHO 2006) and can empower marginalized groups to advocate for change (Elwood 2002), it is also used to direct precision drone strikes (Gregory 2011) and can be used to justify

discriminatory police behavior (Jefferson 2017). In short, "GIS may be both empowering and disempowering" (Wilson 2015). Therefore, it is important to understand the power and consequences that come with the growth of GIS.

Critical GIS "attends to the ways in which this technology is not just software, but actually produces society—it is central to the planning, management, destruction, and reinvention of our neighborhoods, cities, and nations as well as to those who hope to profit from its proliferation and use" (Wilson 2015). This project adopts a critical lens to examine the impact GIS has had on the very academic discipline it stems from: Geography. With an increasing use of GIS across fields and occupations, "cartographers" or "specialists in geography" are regularly cited as growing occupations in the United States, as demonstrated in the example of the US GAO report above.

Schools and Geography departments in US higher education are responding to this perceived need for "workers who can analyze and interpret geographic information" (US GAO 2015) by increasingly offering courses and programs in GIS (AAG 2017). This warrants a critique because the Geographic discipline has a complex history in the United States—complicated even more in the modern era by the emergence of GIS and perceived workforce demands for geographic skills.

With the growth of GIS and workforce demands in mind, this project seeks to portray the modern landscape of higher-level Geography in the United States. To do so, it conducts a geographical text analysis of the language used by US Geography departments on their public webpages. Geographical text analysis combines qualitative and quantitative techniques from corpus linguistics, critical discourse analysis (CDA), and GIS "to understand the geographical patterns and meanings within texts" (Cooper *et al*. 2015). It draws on the argument that "language is a primary method of communication which allows us to come to a shared understanding of how the world is structured" (Cooper *et al*. 2015). While geographical text analysis is a relatively novel methodological approach, its interdisciplinary methods help to parse out spatial narratives—such as how GIS is impacting Geography departments across the United States.

2. Literature Review

In order to explore how GIS is impacting the Geographic discipline in the United States, this project draws from five broad themes in previous research: Defining Geography, Defining GIS, History of Geography in American Higher Education, GIS in Education, and Critical GIS.

2.1 Defining Geography

Particularly because of its use in a wide variety of contexts, it is important to discuss the word "Geography" (capitalized in reference to the academic discipline). In a literal sense, the word's etymology is quite simple and based on the Greek words *Gaea* for "Earth" and *graphein* for "to write about," that is "to write about the Earth." In terms of geographical studies, however, its meaning is more complex. As *Mayhew* (2009) carefully noted in *A Dictionary of Geography,* "It would take considerable temerity to find a unifying definition throughout the twists and turns that the discipline has taken."

This project will adopt a commonly cited definition offered by the American Association of Geographers: "Geography is the science of place and space… [it] is unique in linking the social sciences and natural sciences together" (AAG n.d.). While other countries may have different approaches to defining Geography, North America generally recognizes two main branches: physical and human. The *Annals of the Association of American Geographers* further divides these into four major themes: Geographic Methods, Human Geography, Nature and Society, and Physical Geography, Earth and Environmental Sciences.

With Geography broadly serving as a "link" or "connection" between social and natural sciences, it consequently adopts both quantitative and qualitative methods (Clifford *et al*. 2016; Bonnett 2012; Smith 1992). This hybridity within the discipline is important to highlight when considering the introduction of GIS.

2.2 Defining GIS

One of the goals of this project is to note that, although occasionally used interchangeably, "GIS" and "Geography" are not equivalent. GIS also differs from the field of analytical cartography, which deals more with the theoretical and mathematical background behind cartography (Clarke and Cloud 2000). In addition, it differs from GIScience, which *Goodchild* (2008) defines as "the discipline that uses geographic information systems as tools to understand the world . . . a legitimate subfield of information science."

Unfortunately, GIS is also more difficult to define. As explained by *Pickles* (1995), "Part of the reason has to do with the ways in which GIS has developed within different disciplines and research contexts (in agriculture, botany, computing, business, photogrammetry, geology, zoology, surveying, engineering, and geography), for each of these fields puts its own particular stamp on the claims it makes to GIS." Therefore, GIS should be considered a technology, tool, method, or practice (Pickles 1995) *within* Geography and not representative of the whole discipline. This concept is discussed further in Section 2.4: GIS in Education.

2.3 History of Geography in American Higher Education

The history of the Geographic discipline in the United States is much longer and more complex than can be summarized in this section. It is introduced here because, although the discipline experiences periods of growth and decline, its popularity has not been linked to perceived workforce needs—until the modern era.

Academic geography has existed in American higher education since the 17th century with the opening of the country's first colleges including Harvard, Princeton, Columbia, and Brown (Martin 2015; Stoltman 1990). At the time, "[i]t was understood that geography was an environment experienced, an adjunct to national development, a source of vital statistics in time of war, a hearth for circumstance relevant to international adjudication of national or international study, and for these reasons a subject, yet not a discipline" (Martin 2015).

Gradually, the subject did grow into a discipline thanks to the work of government agencies such as the US Geological Survey, the influence of visiting European geographers, and an increasing number of influential American geographers (Martin 2015). Following 1850, a number of geographical societies even began to emerge in the United States including the American Geographical Society (1851), National Geographic Society (1888), and later, the American Association of Geographers (1904) (Martin 2015). Geography departments were opened in other academic institutions across the country, although often binomial with other departments such as "geology-geography." Growth occurred especially "in the early 1940s when it became clear that geographic understanding was essential to a country being drawn into a world war" (Murphy 2007).

And yet, Geography gradually began to disappear from some of the oldest institutions in the country. Although every school has a different history with the discipline, arguably the most impactful was when—influenced in part by clashing personalities and budget cuts—Harvard President James Conant determined that "geography is not a university discipline" and closed the school's Geography department in 1948 (Murphy 2007). This decision cast a shadow over other Geography departments across the country (Murphy 2007). Even today, when Geography departments are closed due to "neoliberal economic policies decid[ing]

what particular aspects of knowledge are valuable and what are not," their stories are compared to Harvard's (Lahiri-Dutt 2018).

In 1989, two years after the publication of polls revealing a national "ignorance of geography," one former secretary of defense appealed to Harvard to "initiate a widespread re-introduction of geography in schools and universities" (Smith 2003). It was not until 2005—following the resurgence of quantitative methods of geographical research and the growth of GIS as a "marketable skill"—that Harvard reintroduced a variation of Geography in the form of its Center for Geographical Analysis (Reed 2006). Although the discipline's history in the United States is much larger and more complex, Harvard's relationship with Geography in many ways sets a precedent for the rest of the country.

Figures 1, 2, and 3 were published by the American Association of Geographers and are based on data from the National Center for Education Statistics. Charts show short-term trends for degrees awarded in Geography and "two closely related but separate disciplinary degrees": "GIS and Cartography" and "Geography, Other" (AAG 2017).

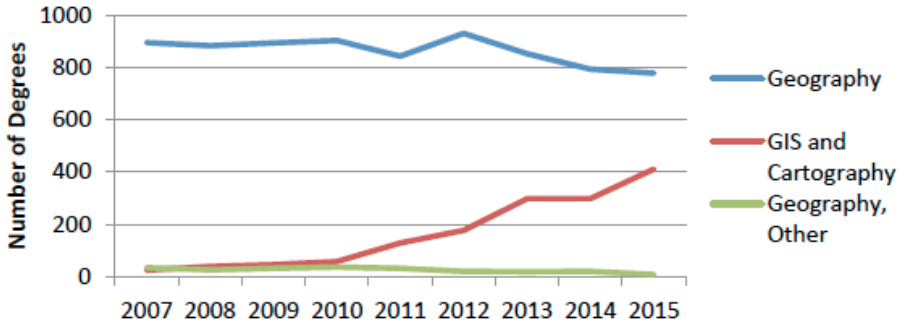

Figure 1. Bachelor's degrees awarded annually, 2007-2015 (AAG 2017).

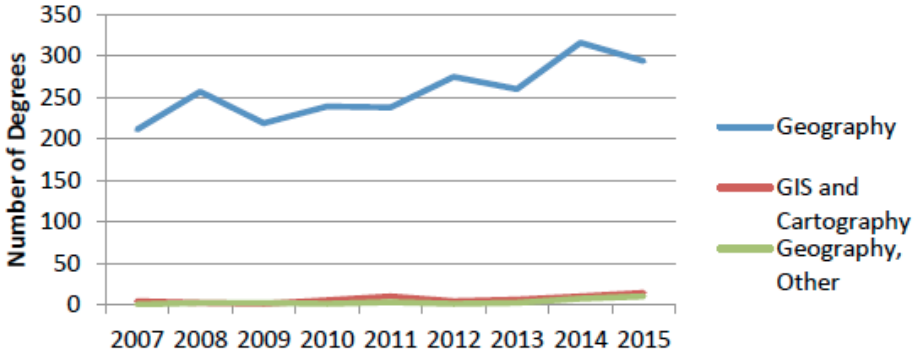

Figure 2. Master's degrees awarded annually, 2007-2015 (AAG 2017).

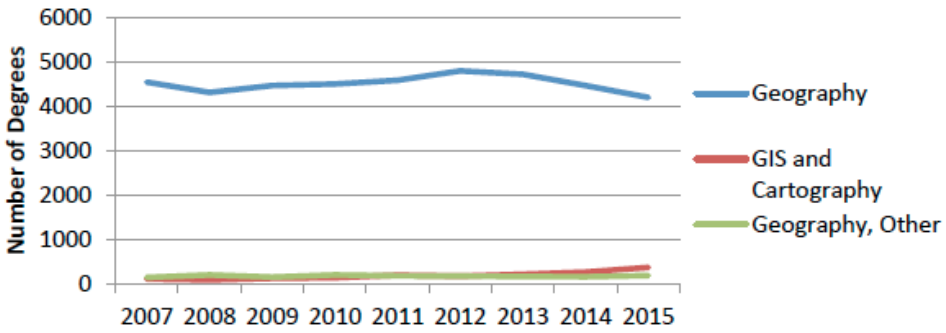

Figure 3. Doctorate degrees awarded annually, 2007-2015 (AAG 2017).

Negative growth trends can be seen at the bachelor's and master's levels for Geography. Although the trend is minor compared to Geography, positive growth can be seen across all levels of "GIS and Cartography." The report notes how "bachelor's and master's degrees awarded in GIS and Cartography have far outpaced those of all social sciences and all disciplines" (AAG 2017). The report also questions whether the rise in degrees awarded in GIS and Cartography might account for the decline in degrees awarded in Geography. Although these trends are relatively modern, it is important to reflect on what impacts these developments might have on the discipline of Geography.

2.4 GIS in Education

As an example of how GIS and geospatial technology have taken a spotlight in education, the first chapter of *Geography for Life: National Geography Standards, Second Edition* is "How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information" (NCGE 2012). There are a number of perspectives and critiques on the relationship between GIS and education.

Since the introduction of digital mapping programs, the emergence of the Internet, and the growth of GIS software and applications in schools in the 2000s, new Geography degree programs have been founded and student enrollment has gradually risen (Walford 2016; Murphy 2007). Some argue that Geography programs have expanded because of the "GIS revolution" and that new geographic technologies should be leveraged "to enhance geography's standing within the university" (Murphy 2007; Richardson and Soils 2004). Geography, after all, is "a subject of essential hybridities and of new discourses and enquiry" (Clifford *et al.* 2006). From this general perspective, "Geography as a discipline can both survive in and benefit from this changing educational landscape" (Erickson 2012).

Other approaches are more critical. One earlier perspective cautions that "instead of serving as an instrument enabling people to think geographically, GIS will have become geography itself" (Downs 1997). Already, perceived demand for skills in geospatial technologies has led to an increased number of GIS degrees and programs outside of the geographic discipline (Perkins 2015; Brown *et al.* 2004; Pickles 1995). It should be noted that the author of this study is pursuing a degree in Geospatial Technologies that is housed within an Urban Studies department.

While "geography does not have a monopoly on GIS education," another concern questions how much of this growth focuses on "technical training rather than on building strong intellectual foundations" (Brown *et al.* 2004). Within the geographic discipline, "programmatic advocacy of GIS" often entails the "self-defeating renunciation of an intellectual (as opposed to technical) agenda" (Smith 1992). In addition to concern about the lack of foundational education, another perspective observes that the valorization of GIS may produce a misleading sense of a pathway to post-education employment (Thatcher and Imaoka 2018).

By critically examining how GIS has affected the Geographic discipline across the United States, this project aligns itself with this second, more critical perspective concerning the role of GIS in higher education. The programmatic advocacy and valorization of GIS has potential to mislead students and can result in a renunciation of other academic Geography agendas. A modern example of this is the University of Wyoming, which suspended enrollment in all Geography department degree programs in November 2018. This suspension is based on a proposal from the school's provost office to "reorganize, consolidate and reduce academic programs in geography" in order to, among other reasons**, "**contribute to a new suite of high-demand degrees in Geographic Information Science and Technology" (University of Wyoming 2019).

2.5 Critical GIS

The origins of critical GIS herald back to the late 1990s when critical GIS referred to "an area of research positioned at the intersection" of geographic representation and the critical capacities of social theory (Wilson 2017). It recognizes and critiques potentially harmful impacts of GIS technology and its use. Contrary to what its title suggests, critical GIS is regarded by Human Geographers and GIScientists to be "less of a field and fixed basis for identity" and "more as a multitude of intellectual banners, lacking fixed essence …" (Thatcher *et al.* 2016). The critical GIS agenda may address a host of topics ranging from GIS and the environment to issues of privacy, access, and ethics. As previously described, this project adopts a critical lens through which to analyze the impact that GIS has had on Geography.

3. Intervention

In order to analyze the impact of GIS on the Geographic discipline in the United States, this project generated multiple output components. These outputs visualize differences in *where* and *how* "Geography" and "GIS" are discussed across the country. This is typical of a geographical text analysis, which draws on "a combination of spatial techniques to focus on geography, corpus linguistics to focus on text, and critical discourse analysis to focus on the ideologies of what is being said" (Patterson and Gregory 2018).

The first output of this project is a collection of maps to illustrate *where* "Geography" and "GIS" are discussed the most. The first map pair displays a weighted Kernel Density analysis of the locations of geography departments that mention "Geography" versus "GIS" the most on their websites. These maps suggest regional patterns in language use. A third map uses K-means multivariate clustering to categorize schools by commonalities in language use. Unlike Kernel Density maps, this map reveals non-Euclidian similarities in the way Geography departments discuss Geography.

The second output of this project addresses *how* "Geography" and "GIS" are being discussed across the country. This analysis entails a series of pie charts and word clouds to visualize language patterns in the corpus. This output also includes a discussion based on critical discourse analysis of these patterns.

An online, interactive version of these maps and visualizations can be found at https://aadejong.github.io/capstone/landscape_geography.html.

4. Methodology

This project employed a variation of geographical text analysis: a combination of techniques from corpus linguistics, critical discourse analysis (CDA), and spatial analysis (through the use of GIS). Corpus linguistics is "a methodology used to study language using a large naturally occurring body of text," known as a corpus (Gregory *et al*. 2015). The method of corpus linguistics entails the systematic, computational application of tools such as frequency counts and collocation in order to "indicate linguistic norms for a more generalizable whole" (Paterson and Gregory 2018). These "linguistic norms" can serve as indicators for how topics are characterized within and across society.

It should be noted that "corpus linguistics is not an analysis[;] it is a tool which can serve analysis" (Fairclough 2015). In this project, results from the corpus are processed through the lens of critical discourse analysis (CDA). Here, "discourse" does not just refer to "text." Instead, "discourse" is "language as a form of social practice" (Fairclough 2015). CDA conducts a close analysis of linguistic features within text—such as grammar, vocabulary, and punctuation—and identifies and critiques power relations within discourse or the social context from which the text originated. While "power" itself not inherently

negative, it is "open to critique when it is not legitimate or when it has bad effects" (Fairclough 2015). From a CDA perspective, power relations shape social life and "if the status quo is not systematically challenged, and is accepted as common sense, the social systems," such as the valorization of GIS in Geography "… shall remain undisturbed and be replicated" (Paterson and Gregory 2018). By applying elements of CDA, this project serves as both a critical GIS and critical language project.

Previous applications of geographical text analysis have ranged from mapping literary responses to the landscape of the English Lake District (Gregory and Donaldson 2016) to examining changing mortality patterns in nineteenth century England and Wales (Porter *et al*. 2015). Unlike previous studies, which tend to gather location information from within a corpus, this study begins with location information—Geography departments—from which to build a corpus.

4.1 Data Collection

The corpus for this project consists of text gathered from the webpages of 122 Geography departments across the United States. This source was selected because it is a readily accessible resource authored by each academic institution. By gathering text related to how departments present themselves and Geography to the public, this study is able to analyze differences in how "Geography" and "GIS" are understood in higher-level education across the country.

Department websites used in the analysis were selected based on American Association of Geographers' 2017-2018 Guide to Geography Programs in the Americas. This document lists institutions with Geography departments by state and notes the highest degree awarded by that institution (bachelors, masters, or doctoral). To sample evenly across the country and type of academic institution, text was gathered from three Geography departments in each US state, each offering a different level of degree. In states with multiple institutions offering the same degree level, a random number generator was used to sample randomly. Some states have fewer than three academic institutions with Geography departments.

Due to the varying nature of webpage structures, text was extracted manually. While automated web scraping could be employed in future studies to reduce time and increase corpus size, this method proved useful. It aided in data quality control (Geography departments feature information across a variety of web pages and in a range of formats) and helped to reveal patterns across department webpages that were not related to textual discourse (such as use of videos and images), which is often cited as a limitation of corpus linguistics. These findings are noted in the discussion.

"Geography webpages" include pages with titles such as: Department Home, "What is Geography?", Message From the Chair, "Is Geography for you?", or other pages with descriptive text authored by the department. Sampling excluded detailed course descriptions and quotes from students. One limitation of this method is the potential for accidental omission of text due to the difficulty in finding and navigating across some department websites.

The final corpus used in this analysis consists of 84,084 word tokens gathered from 122 Geography department websites over the month of June 2019. Figure 4 lists all schools included in this study. Text from each department was gathered and stored as an individual text file. Strict naming conventions aided in the organization and later analysis of gathered data.

1	2	3
AL	D	University of Alabama
AL	M	Auburn University
AL	B	University of S Alabama
AK	D	University of Alaska, Fairbanks
AZ	D	University of Arizona
AZ	M	Northern Arizona University
AZ	B	Prima Community College
AR	M	University of Arkansas
AR	M	University of Central Arkansas
CA	D	University of California, Berkeley
CA	M	San Francisco State University
CA	B	Palomar College
CO	D	University of Colorado, Boulder
CO	M	University of Colorado, Denver
CO	B	United States Air Force Academy
CN	D	University of Connecticut
CN	M	Central Connecticut State University
CN	B	Manchester Community College
DE	D	University of Delaware
DC	M	George Washington University
FL	D	Florida State University
FL	M	University of Miami
FL	B	Jacksonville University
GA	D	University of Georgia
GA	M	Georgia Southern University
GA	B	University of West Georgia
HI	D	University of Hawaii at Moana
HI	B	University of Hawaii, Hilo
ID	D	University of Idaho
IL	D	Northern Illinois University
IL	M	Southern Illinois University, Edwardsville
IL	B	Northwestern University
IN	D	Indiana University
IN	M	Indiana State University
IN	B	Valparaiso University
IA	D	University of Iowa
IA	M	University of Northern Iowa
KS	D	Kansas State University
KS	M	Fort Hays State University
KS	B	Pittsburg State University
KY	D	University of Kentucky
KY	M	Western Kentucky University
KY	B	Eastern Kentucky University
LA	D	Louisiana State University
ME	B	University of Southern Maine
ME	B	University of Maine at Farmington
MD	D	University of Maryland, College Park
MD	M	Salisbury University
MD	B	Frostburg State University
MA	D	Clark University
MA	M	Salem State University
MA	B	Westfield State University
MI	D	Michigan State University
MI	M	Eastern Michigan University
MI	B	Calvin College
MN	D	University of Minnesota, Twin Cities
MN	M	St. Cloud State University
MN	B	Gustavus Adolphus College
MO	D	University of Missouri, Kansas City
MO	M	University of Missouri, Columbia
MO	B	Missouri State University, Springfield
MI	D	University of Southern Mississippi
MT	D	Montana State University
MT	M	University of Montana
NE	D	University of Nebraska, Lincoln
NE	M	University of Nebraska, Omaha
NE	B	Concordia University, Nebraska
NV	D	University of Nevada, Reno
NH	B	Dartmouth College
NH	B	Plymouth State University
NH	B	University of New Hampshire
NJ	D	Rutgers University
NJ	B	Montclair State University
NJ	B	William Patterson University
NM	M	New Mexico State University
NM	M	University of New Mexico
NY	D	University at Buffalo, SUNY
NY	M	Binghamton University, SUNY
NY	B	Vassar College
NC	D	University of North Carolina Chapel Hill
NC	M	Appalachian State University
NC	B	North Carolina Central University
ND	M	University of North Dakota
OH	D	Wright State University
OH	M	Miami University of Ohio
OH	B	Ohio Wesleyan University
OK	D	University of Oklahoma
OK	B	University of Central Oklahoma
OK	B	Northeastern State University
OR	D	Oregon State University
OR	D	Portland State University
OR	B	Western Oregon University
PA	D	Pennsylvania State University
PA	M	Villanova University
PA	B	Mansfield University of Pennsylvania
RI	B	Rhode Island College
SC	D	University of South Carolina
SD	D	South Dakota State University
TN	D	University of Tennessee, Knoxville
TN	M	Middle Tennessee State University
TN	B	East Tennessee State University
TX	D	University of Texas at Austin
TX	M	University of Texas at San Antonio
TX	B	Texas Christian University
UT	D	University of Utah
UT	M	Utah State University
UT	B	Bringham Young University
VT	B	Middlebury College
VT	B	University of Vermont
VA	D	Virginia Tech
VA	M	University of Mary Washington
VA	B	Emory & Henry College
WA	D	University of Washington
WA	M	Central Washington University
WA	M	Eastern Washington University
WV	D	West Virginia University
WV	M	Marshall University
WV	B	Concord University
WI	D	University of Wisconsin, Madison
WI	B	University of Wisconsin, Oshkosh
WI	B	Carthage College
WY	M	University of Wyoming

1 – State Abbreviation **2 – Highest Degree Offered** **3 – Academic Institutions**

Figure 4. Academic institutions included in study.

4.2 Spatial Analysis

In order to parse through gathered text files, this project utilized AntConc, a free corpus analysis toolkit. The concordance plot tool was used to search for the frequency of specific words used in each text file. Searched words included "GIS" and "geography" (lowercase here because it was used as a search term). Other commonly used words noted across websites included "GIScience," "geoscience," and "geospatial"; concordances for these words were also noted. The "hits," or number of mentions of the searched word, were recorded for each academic institution in an Excel table.

From an Excel table, this data was geocoded by name of the academic institution using ArcGIS Online. Once geocoded, this data was transferred to ArcPro for further analysis using the software's Spatial Analyst tools.

The first spatial analysis conducted was a Kernel Density smoothing. This technique is commonly used in geographical text analysis studies as a way of illustrating concentrations of language use across a geographical area (Patterson and Gregory 2018; Gregory *et al.* 2015). Kernel Density calculates the density of input points by first calculating the probability of density then determining a search radius (ESRI 2019). In this case, the search radius for points was weighted by frequency of "geography" and "GIS" values respectively. The output of ESRI's Kernel Density tool is a raster. ArcPro's Reclassify tool was used to classify raster cells into ten categories. The classified raster was then converted into a shapefile for easier online hosting and visualization.

The second spatial analysis utilized ArcPro's Multivariate Clustering tool in order to visualize non-spatial patterns in language use. Multivariate Clustering uses a K-means algorithm to categorize data into groups with the fewest differences between feature attributes. In this case, clustering was based on each school's attribute fields for use of the words "geography," "GIS," "GIScience," "geoscience," and "geospatial."

The optimal number of clusters was determined by calculating an optimized pseudo-F statistic chart. A larger F-statistic indicates "how many clusters will be most effective at distinguishing the features and variables" specified. As can be seen in Figure 5, the largest F-statistic for this dataset was 30. However, the number of clusters used in this analysis is 6 because it was the lowest number of clusters with the highest F-statistic. This allows for easier interpretation of variation between clusters categories.

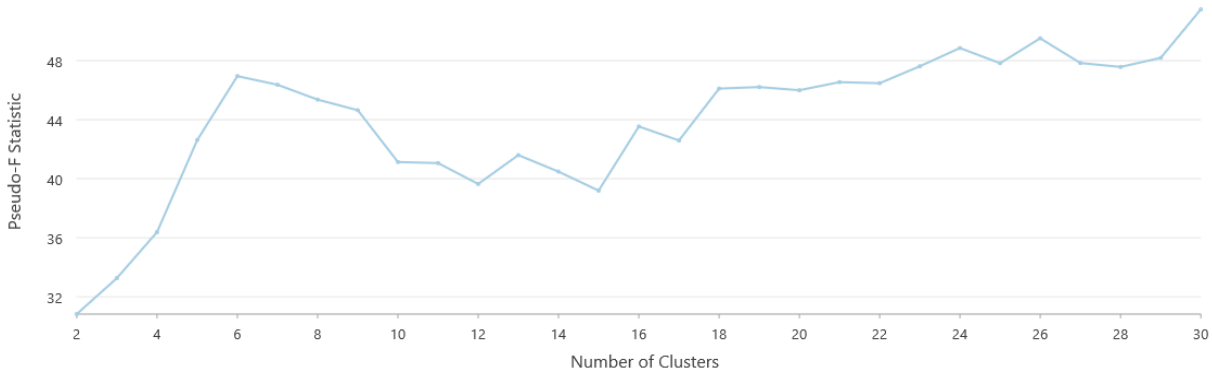

Figure 5. Optimized Pseudo-F Statistic Chart

Output from the Multivariate Clustering tool is a feature class. For more interactive online visualization, however, an Excel file of this dataset was exported from ArcPro and symbolized using AnyChart's JavaScript Dot Map. This project utilized JavaScript templates from AnyChart, a commercial library that is free for educational and nonprofit use, in order to create interactive visualizations. AnyChart templates were also used in the following section.

4.3 Discourse Analysis

In addition to mapping *where* "Geography" and "GIS" are most frequently mentioned, this study also highlights differences between *how* Geography departments define and discuss "Geography" and "GIS." To do this, AntConc was also used to prepare data for a critical discourse analysis.

AntConc's concordance tool was used to search for the phrases "geography is" and "GIS is." This technique allowed for a qualitative analysis of co-text, or surrounding text. (Figure 6 shows the primary results of a concordance search for "geography is".) Each concordance hit was manually diagramed to identify the nouns, modifiers (adjectives), and activities (verbs) used to define "GIS" and "geography" respectively. This data was noted in an Excel table.

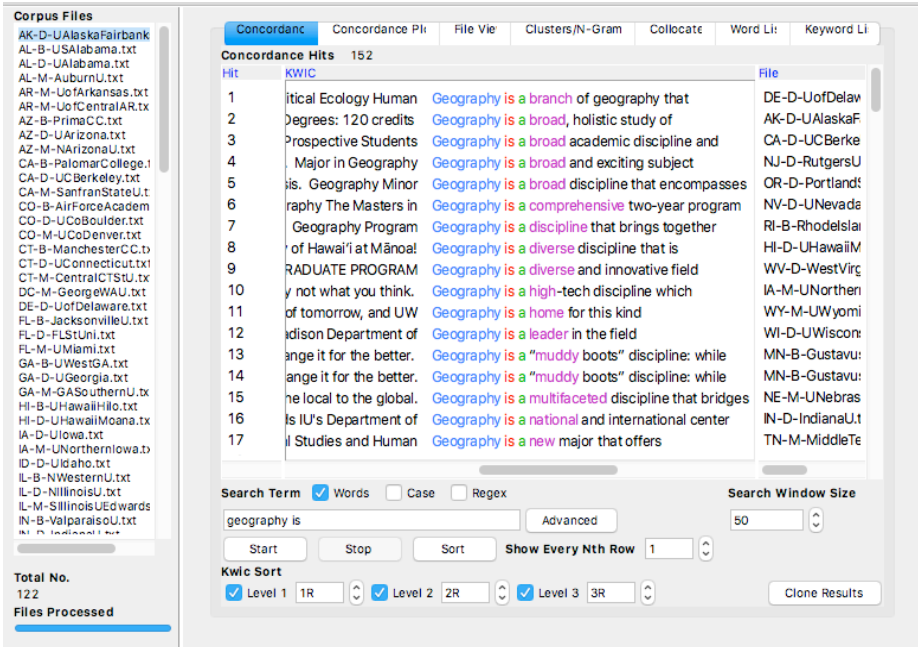

Figure 6. View of concordance search in AntConc.

From Excel, this information could be displayed in a number of ways. The first set of visualizations is four pie charts that sought to answer whether there is a difference in language use by highest level of degree offered by academic institutions. The second set of visuals is a series of tag clouds that illustrate general differences between how "Geography" and "GIS" are discussed. These charts are created using AnyChart templates and stored as HTML files that were easily integrated into the webpage. These visualizations, in addition to observations noted during data collection, allowed for a critical discourse analysis.

5. Discussion

As perceived demand for geographic skills and degrees awarded in GIS and Cartography rise (AAG 2017), this study seeks to portray the modern landscape of Geography in US higher level education. To do so, it utilizes geographical text analysis in order to draw out patterns and meanings in *where* and *how* Geography departments discuss "Geography" and "GIS" on their public-facing webpages.

5.1 Spatial Analysis

The first component of this geographical text analysis is a spatial analysis of patterns in *where* "geography" and "GIS" are discussed. Two calculations—Kernel Density and Multivariate Clustering—were used to map spatial patterns.

These Kernel Density maps are a spatial interpolation of where "geography" (Figure 7) and "GIS" (Figure 8) are most frequently mentioned across the country. Both words show the highest concentration of mentions in the Northeastern United States followed by the Midwest, Pacific Northwest, and southern California. While these regional concentrations are very similar due to the shared location of schools, there are also notable differences. In the Pacific Northwest, "Geography" is concentrated around schools in Oregon while "GIS" centrally radiates from Idaho. On the eastern side of the country, "Geography" has high concentrations of mentions down the East Coast and across the South, but "GIS" has pockets of concentrations around Boston, Washington D.C., Chicago, and between Alabama and Arkansas.

"Geography" is mentioned in a relatively denser and even spread across the country. "GIS," however, is not far behind. This alludes to a growing spread of GIS use in Geography programs across the country. While this is not necessarily a concerning trend, it would be interesting to track if regional language use changes over time. Higher mentions of "GIS" in Geography programs would be highly indicative of the valorization of GIS cautioned by *Brown* (2004), *Smith* (1992), *Thatcher* and *Imaoka* (2018), and others.

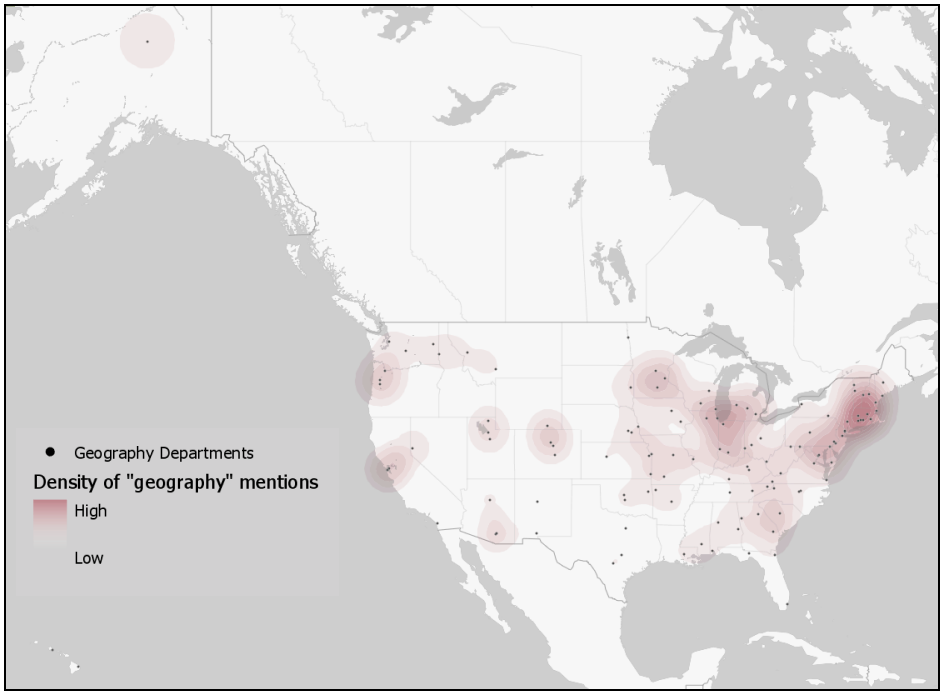

Figure 7. Kernel Density map of "geography" mentions.

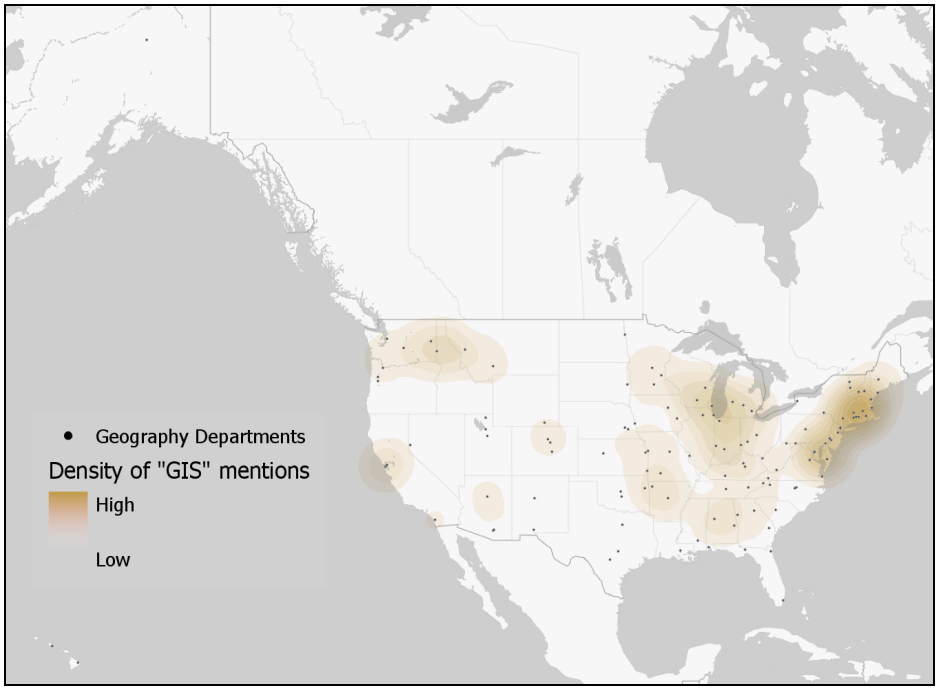

Figure 8. Kernel Density map of "GIS" mentions.

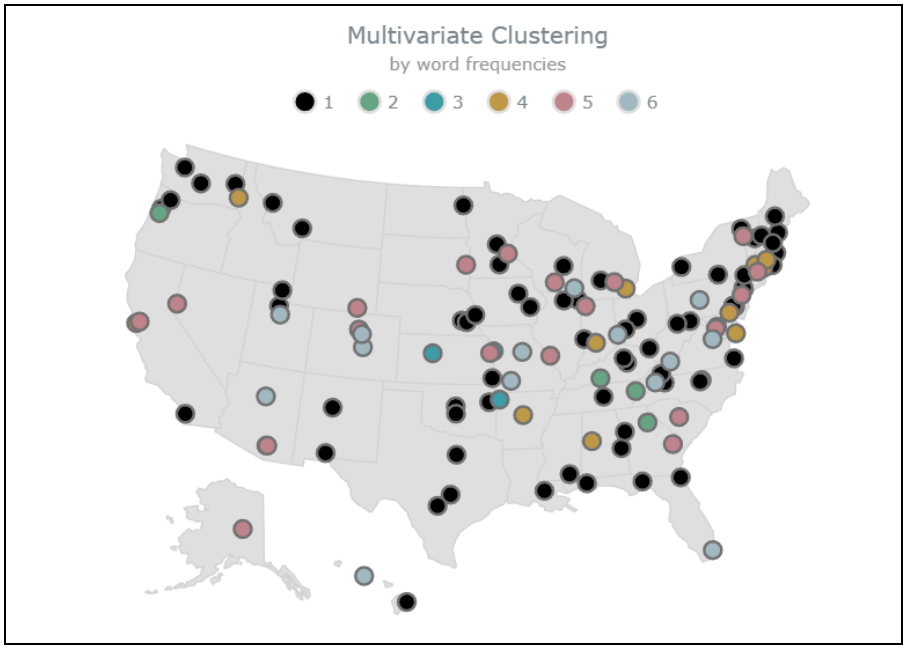

Figure 9. Multivariate Clustering map of Geography departments.

This Multivariate Cluster map (Figure 9) illustrates patterns in language use without consideration of geographic space. Instead, it categorizes Geography departments based on similarities between attribute fields for mentions of the words "geography," "GIS," "GIScience," "geoscience," and "geospatial."

Six unique clusters were determined in the analysis. Using the box-plot in Figure 9, each cluster can be categorized. Characteristics of each category are described in Table 2.

Table 2. Characteristics of cluster categories.

Category	Characteristic
1	Most representative of average word use.
2	More frequent use of the word "GIScience."
3	More frequent use of the word "geoscience."
4	More frequent use of the word "GIS."
5	More frequent use of the word "geography."
6	More frequent use of the word "geospatial."

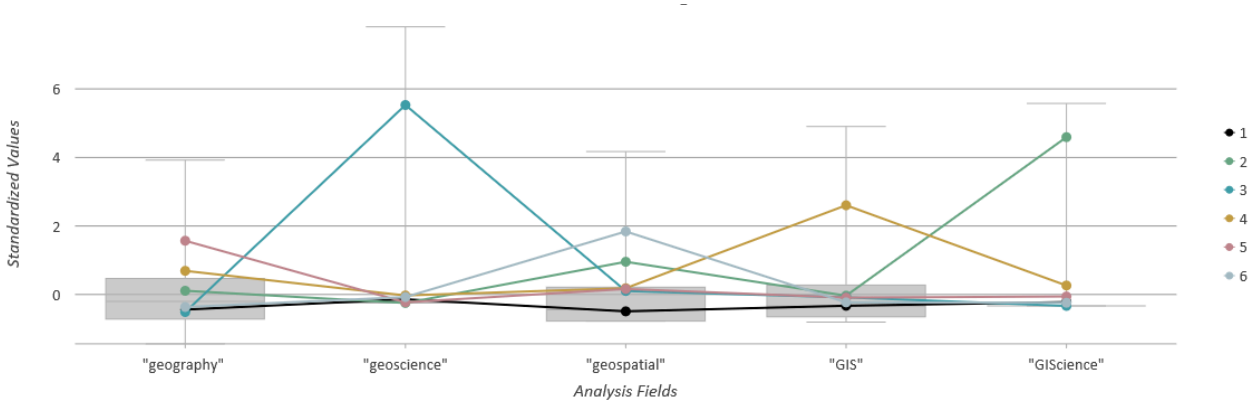

Figure 9. Multivariate Clustering box-plots.

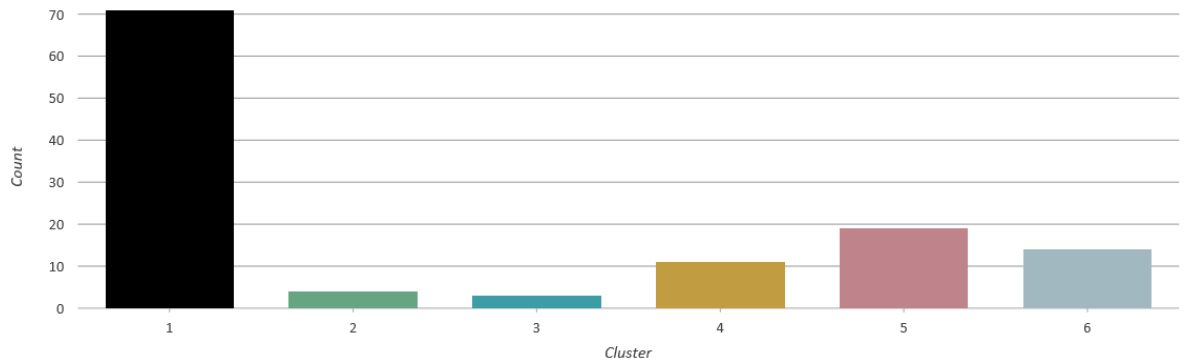

Figure 10. Chart of features per cluster.

As shown in Figure 10, Category 1 is the largest category and includes 71 schools from all across the country from Maine and Florida to Washington, California, and Hawaii. This category is most representative of average word use. Category 5, the second largest category, includes 19 schools that display more frequent mentions of the word "geography." These schools are also distributed across the country with notable clusters in California, the Midwest, and along the northeast coast.

The third largest category did not display more frequent mentions of "GIS." Instead, it was Category 6 with relatively more mentions of "geospatial." These 14 schools are spread across the central United States from Utah and Arizona to Pennsylvania and Florida. This is an unexpected trend that may be due to an increase in "geospatial" programs. This warrants further research. Category 4 is close behind with 11 schools more frequently mentioning "GIS." These schools are predominantly located on the East Coast with two outliers in the west: the University of Idaho and San Francisco State University. One cluster especially stands out in Massachusetts and Connecticut: Westfield State University, the University of Connecticut, and Clark University.

Although they only contain 4 and 3 schools respectively, Categories 2 and 3 depict clear regional trends. In Category 2, use of the word "GIScience" is dominant in southeastern schools including Western Kentucky University, the University of Tennessee Knoxville, and the University of Georgia, with Oregon State University as an outlier. Nearby, Category 3 schools—Fort Hays State University, the University of Missouri, Kansas City, and the University of Arkansas—frequently use the word "geoscience." This pattern suggests a growing use of other terminology used to describe Geography and GIS programs. It would also be interesting to track how use of these words spreads over time. Overall, this map illustrates a regional variation and inconsistency of language use in Geography departments across the country.

5.2 Discourse Analysis

"Spatial analysis, and the maps it creates, are excellent…to understand the patterns and differences, move back to the corpora."

– Patterson & Gregory, 2019

The second component of this geographical text analysis is a brief critical discourse analysis of patterns related to *how* "geography" and "GIS" are discussed across the United States. Critical discourse analysis aims to systematically explore how relationships between discourse (in this case, text from Geography departments) and wider social structures, relations, and processes are shaped by relations of power (Fairclough, 1993). This study uses

a series of visualizations in order to depict power relations in how Geography departments discuss "geography" and "GIS."

The first visualization (Figure 11) addresses whether there are significant differences in the language used by Geography departments offering different levels of degrees (bachelor's, master's, or doctoral). Despite slight differences, language composition remains very similar across all categories and is generally reflective of the corpus as a whole: nearly 60% "geography," 20% "GIS," 10% "geospatial," 4.8% or less in "geoscience," and 3.3% or less "GIScience." Geography departments offering master's degrees are perhaps the most unique with the highest mentions of "GIS" (24.8%) and "geoscience" (4.8%). These charts illustrate that, although language varies regionally, there is some consistency across departments that offer different levels of degrees.

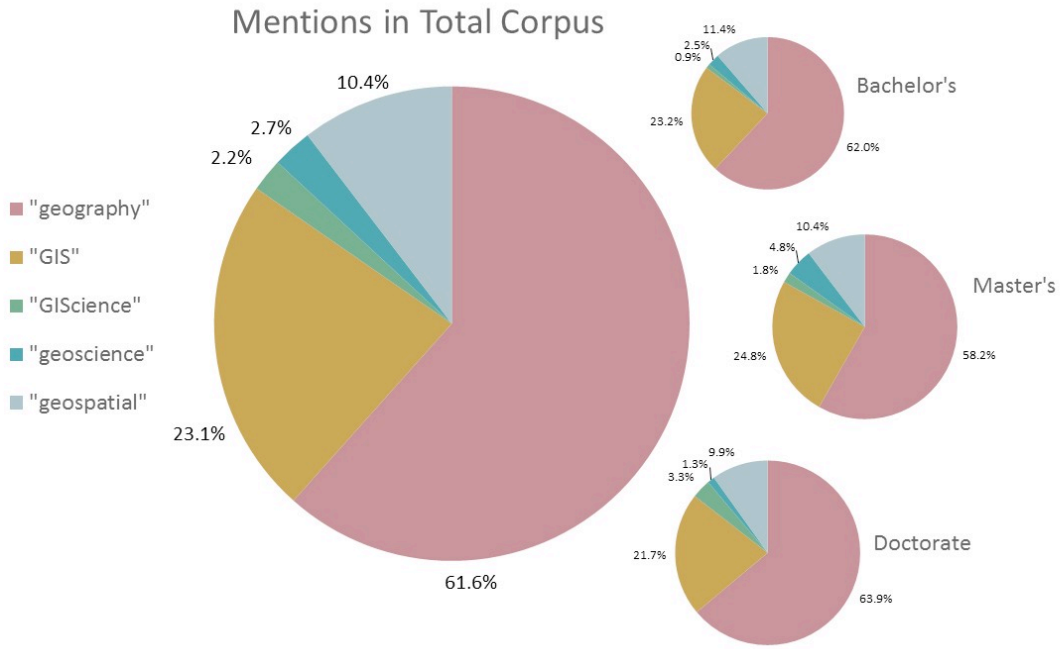

Figure 11. Word mentions by degree level.

The second visualization (Figure 12) is a series of word clouds comparing which nouns, modifiers (adjectives), and activities (verbs) are used to describe "geography" and "GIS" within the corpus and across the country. "Geography" is most commonly referred to as a "study," "science," or, as in the case of this project, a "discipline." In contrast, "GIS" is referred to as a "technology" and "tool." This dichotomy is reflective of a previous argument in this paper that "GIS should be considered a technology, tool, method, or practice" *within* Geography (Pickles 1995). And yet, another commonly used word in reference to "GIS" is "field" which elevates "GIS" to a similar status as "geography." Some schools even mention "GIS" in reference to an "employment sector" and/or "career paths": language which adds to the notion of post-graduation employment. This type of career-alluding language is not used in reference to "geography."

Figure 12. Comparison of words used to describe "geography" and "GIS."

There is also a stark difference in the adjectives used to modify the two words. "Geography" is described in moderate positivity with words such as "exciting," "comprehensive," "interdisciplinary," and "unique." While "GIS" is also described as "exciting," it is also "fastest-growing," "top-emerging," "powerful," and "versatile." In a 1995 analysis of discourse used to market geographic information systems, *Goss* (1995) refers to this type of language as "technopornography": "the technical apparatus is eroticized in an aesthetics of power, speed, and control." The same type of language that was used to market GIS technology to companies in 1995 is still being used to market GIS as an area of study today.

This observation carries over to verbs or activities related to GIS. GIS is "anticipated," "expected," "used," and "expanding." "Geography," in contrast, is much more subdued with words such as "concerned with," "situated," "designed," and "understanding." These words connote a different pace of urgency between "GIS" and "geography." It is not hard to imagine that these differences in language hold power to subliminally influence prospective students and decision-makers within academic institutions.

5. Conclusion

Those with master's degrees, specialized subject matter expertise, and experience working with geographic technologies, such as Geographic Information Systems (GIS), should have the best job prospects.

— United States Department of Labor, Job Prospects for Geographers (2016)

It's partly demographics, and it's part hydrology
But all of it includes that thing we call humanity
And now you've got your shingle and you're headed out the door
Cleaning up this mess is what Geography is for.

— Geography Professor Mark Serreze in a song to graduates, University of Colorado, Boulder (2017)

GIS and geospatial technologies have had a powerful impact on how people interact with the world and each other. For this reason, it is important to understand GIS critically, and understanding the role that GIS is playing in higher level education is no exception. This study depicts the impact that GIS has had on Geography with the goal of encouraging Geography departments in the United States to critically and contextually examine their role in educating future GIS users and sustaining the Geographic discipline.

Geography as an academic discipline is complicated to define and carries an equally complicated history in the United States. GIS was originally introduced as a tool to aid in the organization of geographic information. Today, however, its uses have grown far beyond the geographic discipline and occupations. With an emphasis on job opportunities for workers with skills in geospatial technologies—as demonstrated in the commonly cited quotation above—Geography departments have grown to better accommodate GIS. An emphasis on GIS, however, poses the risk of morphing Geography's academic agenda into one that is more focused on technical training than providing intellectual foundations for what the discipline serves to do: "[help] individuals and groups to make critical judgments and rational decisions about issues" (Stoltman 1990).

By employing a geographical text analysis of the language used by Geography departments across the country, this project depicts the modern landscape of Geography in US higher education. Spatial analyses reveal slight differences in regional concentrations of uses of the words "geography" and "GIS." Meanwhile, there is also a regional inconsistency between mentions of the words, "geography," "GIS," "GIScience," "geoscience," and "geospatial" which creates potential for confusion when distinguishing between the five words. Discourse analysis, however, reveals no observable word preference between institutions offering different levels of degrees. More importantly, discourse analysis also reveals a stark contrast in the language used to describe "geography" compared to "GIS." While "geography" is portrayed as more subdued, "GIS" is marketed with a sense of urgency and suggested promise of employment.

These findings only begin to uncover the spatial narrative of how GIS is impacting Geography departments across the United States. This study is limited by the size of its dataset, accidental omission of text during manual data collection, and possible calculation errors. Further research might expand the number of Geography departments from which to gather text and compare how language use has changed over time. It will be important to continue challenging the "status quo" of how GIS and Geography are discussed; findings from this study also suggest that language holds power to influence the future of Geography across the United States.

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