UTILIZATION OF GEOGRAPHIC INFORMATION SYSTEMS TECHNOLOGY IN MIDDLE AND HIGH SCHOOLS IN THE STATE OF MARYLAND

by

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THESIS APPROVAL PAGE

This is to certify that the thesis prepared by Ashley Lesh Buzzeo entitled Utilization of Geographic Information Systems Technology in Middle and High Schools in the State of Maryland, has been approved by the thesis committee as satisfactorily completing the thesis requirements for the degree Master of Arts in Geography and Environmental Planning.

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ABSTRACT

Utilization of Geographic Information Systems Technology in Middle and High Schools in the State of Maryland

Ashley Lesh Buzzeo

Over the past decade there has been a growing interest in the use of geographic information systems (GIS) technology for kindergarten through12th grade education. This study examines if and how Maryland teachers are utilizing GIS in the classroom. In addition, the study considers the perceived instructional benefits of this technology, as well as the factors constraining or preventing wider adoption of GIS in Maryland's schools.

A self-administered, cross-sectional Internet questionnaire was sent to science and social studies teachers in the State of Maryland who teach grades 6-12. Of all respondents, 86.8% are not currently using GIS in their classroom. The survey results confirmed that: 1) Teachers lack training and do not possess educational background in geography and GIS; and 2) The lack of easy-to-use software, digital geospatial data, teacher training, and educational pedagogy, particularly lessons key to state standards, prevent teachers from utilizing GIS as an educational tool.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

Introduction

Over the past decade there has been a growing interest in the use of geographic information systems (GIS) technology for kindergarten through12th grade education. For example, some educators are using GIS in the classroom to promote geographic literacy by encouraging spatial problem solving and critical thinking, and teachers nationwide are becoming more aware of the benefits of using GIS as a teaching tool in relation to specific geographic lessons. This trend is borne out by several studies undertaken at a national level regarding the use of GIS in primary and secondary schools (Audet and Bednarz, 1999; Baker and Bednarz, 2003; Baker and White, 2003; Kerski, 2003; Wigglesworth, 2003). To date there has been little or no research into the adoption of GIS for K-12 instruction in specific states such as Maryland. This study helps to fill some of the gaps in the literature regarding the spread and adoption of GIS in classrooms for it examines the extent to which Maryland secondary school teachers are utilizing GIS. In addition, the study considers the perceived instructional benefits of this technology, as well as the factors constraining or preventing wider adoption of GIS in Maryland's schools.

Science and social studies teachers are particularly interested in implementing GIS in secondary education. Many secondary education courses have a strong geographic component. GIS allows teachers to use geography and as a means to integrate research and to ask questions about and propose solutions to environmental problems. However, the extent to which educators

are using GIS in the classroom is largely unknown. What is known suggests that the adoption of GIS for classroom instruction throughout the United States is limited.

National curriculum standards for geography exist, but state curriculum standards for geography in Maryland do not. Educators in the State of Maryland have created a voluntary state curriculum that describes by grade level and content area specifically what students should be learning, and sets standards for science and social studies. Unfortunately, the standards do not contain references to geographic knowledge and skills.

Core learning goals have been established in the science and social studies content areas with indicators that address geographic knowledge and skills, and, more importantly, the areas where GIS can be used as a tool to aid in learning (MSDE, 2006). Specifically, Goal 2, Expectation 1, Indicator 2 of the concepts of Earth/Space Science specifies that students demonstrate the ability to use scientific skills and processes to explain the physical behavior of the environment, Earth, and the Universe. Explicit tools and techniques are listed, such as imaging, Geographic Information System, the Global Positioning System, and spectroscopy. Expectation 2, Indicator 3 of the core learning goals for environmental science specifies that students be able to understand that populations grow or decline by a variety of factors, such as medical, agricultural, and cultural factors, all of which can be visualized and analyzed by using GIS. Expectation 3, Indicator 2 of the core learning goals for environmental science specifies that students be able to analyze relationships between humans and the

Earth's resources, particularly relationships between humans and air quality, water quality and quantity, land resources, and biological resources.

Prior studies and the reported practical experience of people in the State of Maryland show that four components must be in place for GIS implementation in secondary education: software, existing digital geospatial data, teacher training, and lesson plans (pedagogic materials that map to the state standards in geography). A portion of this research seeks to determine if these four items are available and if science, environmental science, and social studies teachers in the State of Maryland are utilizing them.

Statement of the Problem

This study examines how Maryland teachers are utilizing GIS in the classroom. Specifically, this study documents:

1. Extent to which Maryland teachers are using GIS.
2. Ways Maryland schools are using GIS.
3. Key barriers to introducing GIS into Maryland education.

Purpose of the Study

There is no statewide inventory of the number of secondary education teachers who employ GIS in the classroom. In fact, there is little public knowledge of who is using GIS and where GIS is being used in Maryland classrooms. The purpose of this study is to collect information directly from science, environmental science, and social studies teachers in the State of Maryland to determine how GIS is being utilized in schools.

Research Questions

This study is exploratory in nature and seeks to answer some basic questions regarding the diffusion of GIS in Maryland's middle and secondary schools. These questions include:

1. Do teachers have a lack of training and educational background in geography and GIS?
2. Why are teachers not using GIS in their classrooms?

Delimitations

This study includes the following delimitations:

1. Only middle and high school science, environmental science, and social studies teachers in Maryland for whom emails could be obtained are studied (grades 6-12).
2. Only one point in time is studied, so no current trends can be analyzed. Only longitudinal characteristics in GIS uses among teachers can be studied.

Definitions

For the purpose of this study, the following terms are defined:

Geographic information system (GIS): a computer-based system for the storage, retrieval, manipulation, analysis, and display of geospatial data. GIS software links geospatial data (where things are) with descriptive information, or attributes (what things are). Unlike a flat paper map where "what you see is what you get," a GIS can present many layers of different information (ESRI, 2002).

Geospatial data: information relating to relationships and locations of geographical features.

GIS training: any activity in which a person is learning specific skills to aid in the use of geospatial data and in the use of a GIS.

Internet Map Server (IMS): a GIS that is designed to serve maps across the Internet. Sometimes these maps are just static images allowing simple panning and zooming, while others are more complex pages. Examples of interactive maps served with IMS include maps with layers that can be turned on and off, or with features containing attributes that can be queried. A visitor to a site driven by IMS needs nothing more than a Web browser: the GIS and database are maintained on the server side (Wikipedia, 2006).

Technological literacy: the ability to use, manage, comprehend, and assess technology.

Software: code that instructs computers to complete tasks. For example, Microsoft Word, Microsoft Excel, PhotoShop, and ArcGIS are software programs.

Hardware: the physical components of a computer system. Examples of hardware include plotters, printers, and digitizers.

Layer: a group of the same type of features.

Feature: geographic phenomenon that can be represented as an object (point, line, or polygon) on a map.

Attribute: information about a spatial feature usually stored in a table. For example, attributes of a hospital may be number of beds, address, and alert level.

Basic Assumptions

This study is based on the following assumptions:

1. Science, environmental science, and social studies curricula are taught in Maryland's middle and high schools.
2. Maryland schools have adequate technologic resources to support instruction using GIS.

Limitations

This study has the following limitations:

1. Generally, it is known that most GIS users employ Environmental Systems Research Institute (ESRI) software. Unfortunately, ESRI will not provide a list of its software subscribers. As such, other ways to obtain a list of GIS users were required.
2. Teachers participating in the survey were self-selected.

CHAPTER 2

Review of Literature

Introduction

Incorporating geographic information systems (GIS) into K-12 education provides students with a real-world perspective that increases their geographic skills and knowledge (West, 2003; Wigglesworth, 2003). Publication of the first national content standards in geography (Geography Education Standards Project, 1994), and several technology standards (International Society for Technology in Education, 2000) introduced a new model of instruction for educators that stressed a more hands-on, interdisciplinary, research-based learning experience (USGS, 2005). According to Baker,

> These models are intended to teach disciplinary content through the development of high-order, inquiry-process skills (i.e., formulating research questions, designing or implementing systematic data collection, analyzing and synthesizing data, and so on). Within this vein of standards-based instruction, GIS is emerging as an instructional technology for supporting contextually rich student learning (2000, PAGE XXX).

The increasing use of instructional technology is due in part to embracing the constructivist teaching method - knowledge that is constructed by students through an active, mental process of development (Baker and White, 2003; Hill and Solem, 1999; Solem, 2001). Several case studies show that the computer can be used as a tool to enhance active participation in complex, authentic tasks (Keiper, 1999). Constructivist teaching encourages critical thinking skills and creates active and motivated learners. “Engaging students in ‘real world’ geographic problems by using spatial technologies will heighten student interest

in the field, create a greater awareness of interconnections between disciplines and consequently lead towards greater student achievement" (Laituri and Lynn, 2001).

GIS in Schools

Private industry, government, and higher education continue to implement GIS in an increasing manner; however, GIS use in K-12 classrooms in the past decade has grown only slightly (Audet and Bednarz, 1999; Baker and Bednarz, 2003; Baker and White, 2003; Kerski, 2003; Wigglesworth, 2003). Results of a national survey of teachers conducted in 2000 (Kerski, 2003) showed that less than two percent of American high schools used GIS in their curriculum. The National Council for Social Studies (NCSS) conducted a poll of 250 social studies teachers in the nation relative to ranking the use of integrating computers into the classroom. The average ranking was 8 out of 10, which suggested to the NCSS that school priorities are changing and technology is being used more as a teaching resource. However, when asked about the use of GIS, only 11% of the educators polled by the NCSS had heard of GIS. The teachers responded that providing training on how to use GIS was "essential" and "vital" in integrating this to the classroom (PBS, 2005).

Teacher Use of Educational Technology

All research reviewed in the literature is nationwide in nature; little research exists for localized regions. The State of Maryland, however, has adopted the most recently revised *Maryland Plan for Technology in Education*

(2002), created by the Maryland Business Roundtable for Education (MBRE). Maryland is incorporating technology into the curriculum, is spending millions of dollars in the implementation, and is consequently broadly recognized as a national leader in data collection, assessment, and accountability. Five main objectives were established with this technology integration (MSDE, 2002-2005):

1. Access to technology will be universal.
2. All teachers will possess the knowledge and skills to effectively use and integrate technology into their classrooms.
3. Technology tools and digital content that engage students will be seamlessly integrated into all classrooms on a regular basis.
4. Technology will be used effectively to improve school administrative functions and operational processes.
5. Effective research, evaluation and assessment will result in continuous improvement in the implementation and use of technology.

The *Maryland Educational Technology Plan for the new Millennium* is a revised five-year plan for technology in 2007 – 2012. The core vision of this plan states (MSDE, 2007),

> Through engaging classrooms that have current technology resources available to all students and educators as a part of their daily work, every child will reach his or her potential and achieve success. Not only will technology be available in whatever forms they take in the coming years, but rich, digital content will be available in a variety of formats. The individual learning styles and needs of every child will be addressed by using technology to differentiate instruction and provide accessible resources to all students.

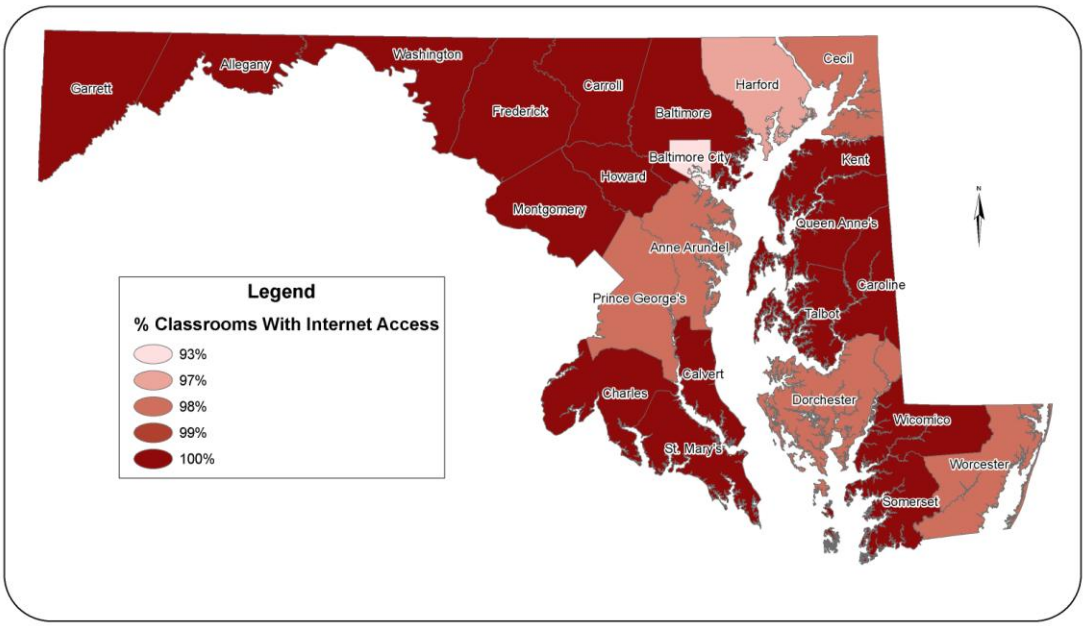
This plan has five objectives in place to help meet the overall goal of improving student learning in all content areas and the technology skills critical to students'

ability to contribute and function in today's information technology society (MSDE, 2007). The objectives are:

1. Improve student learning through technology.
2. Improve staff's knowledge and skills to integrate technology into instruction.
3. Improve decision-making, productivity, and efficiency at all levels of the organization through the use of technology.
4. Improve equitable access to appropriate technologies among all stakeholders.
5. Improve the instructional uses of technology through research and evaluation.

MBRE conducted its 10th annual survey of technology in Maryland public schools in March 2007. Survey results reveal that technology infrastructure has made significant progress: statewide, the student-to-computer ratio stands at 3.4:1 (3.4 students for every 1 computer available for classroom use). Also, 98% of all classrooms statewide have Internet connectivity, as shown in Figure 1.

Figure 1. Map of Maryland Classrooms with Internet Access (%)



Although the hardware and software components of technology have increased, according to MBRE, “technology is not being used effectively for higher level, analytical and problem-solving activities, where research and experts agree that education can derive the most compelling benefits for improved learning” (MBRE, 2005).

Obstacles

Research to date focuses on identifying the factors that obstruct the use of GIS in the classroom. This slight adoption of using GIS in the classroom is due to several barriers that have hindered administrators and teachers in applying GIS as a tool into lesson plans. Researchers have identified various major barriers in the use of GIS in the K-12 classroom (Baker, 2002; Gatrell, 2001; Kerski, 2003; Wiegand, 2003). Four common barriers to the diffusion of GIS into

classrooms are present in the literature: (1) technology; (2) GIS lesson planning; (3) time constraints; and (4) education and training opportunities.

A survey titled “GIS in Education Survey” was conducted in January 2001 by Dr. John M. Morgan, III of Towson University. The survey’s purpose was to determine some specific aspects of GIS technology use in Maryland’s schools. Over half of the respondents (N=343) were using GIS technology in their classrooms. However, almost all of the respondents, regardless of whether they are using or not using GIS in the classroom, said that they have limited hardware and software, little or no training available, and a lack of suitable instructional materials. Morgan’s survey confirms the four common barriers identified in the literature.

CHAPTER 3

Procedures and Methodology

Subjects

Science, environmental science and social studies teachers in the State of Maryland in grades 6-12 were chosen for the following reasons:

1. Science, environmental science, and social studies subjects include many different types of geographic or spatial information that can be related to GIS.
2. A national study was conducted on the use of GIS in secondary schools (Kerski, 2003), but not on a statewide level.
3. Grade levels 6-12 coursework includes more in-depth geography standards and more content related to GIS.
4. The population in the State of Maryland was selected because a teacher mailing list compiled by Dr. John M. Morgan, III, was readily accessible. Email addresses for middle and high school teachers were easily extracted from individual school science, environmental science, and social studies Web sites.

Instruments

The instrument used in this study is a self-administered, cross-sectional Internet survey, with the target population consisting of all known public and private science and social studies teachers in the State of Maryland who teach grades 6-12. The survey contained a total of forty-two questions and was divided into twelve separate sections. Logic is built in to the survey, which allows

respondents to skip certain sections, depending on their answers. These sections are:

1. General Information;
2. Classroom Technology Use;
3. Have Computers in the Classroom;
4. Don't Have Computers in the Classroom;
5. Use of GIS in the Classroom;
6. Not Currently Using GIS;
7. Currently Using GIS – Teacher Education;
8. Currently Using GIS – Details;
9. Technical Support;
10. Have Technical Support;
11. GIS Benefits/Constraints, and;
12. Prize Drawing.

Each section and its purpose are described in the following paragraphs. The logic built in the survey is shown in Figure 2 on page 17.

The first section, General Information, asked nine basic questions about the participants' teaching environment and experience. The questions ask about the type of school, enrollment at the school, average class size, grade levels and subjects taught, length of teaching, and the school district and department in which the participants teach.

The second section, Classroom Technology Use, asks three questions about the respondents' use of technology in the classroom. The questions ask if

the participants teach geographic concepts and, if so, the teaching methods used, if there are computers in the classroom, and if the teachers use technology in the classroom as a teaching aid.

The third section, Have Computers in the Classroom, is directed to teachers who responded that they have computers in their classrooms, and asks three basic questions regarding the computers being used in the classroom. The questions relate to the student/computer ratio in the classroom, the operating system being used, and whether or not the computers are connected to the Internet.

The fourth section, Don't Have Computers in the Classroom, is directed to teachers who responded that they do not have computers in their classrooms, and asks two questions about the use of computer labs in their schools. The questions ask if there is a computer lab in their school and if the teachers use the computer lab to teach lessons.

The fifth section, Use of GIS in the Classroom, asks questions about the use of GIS in the classroom, if they have heard of GIS, and if they are currently using GIS technology.

The sixth section, Not Currently Using GIS, is directed to respondents who are not currently using GIS. They are asked to describe why they are not using GIS technology, and to rate several constraints on the use of technology in the classroom, including GIS.

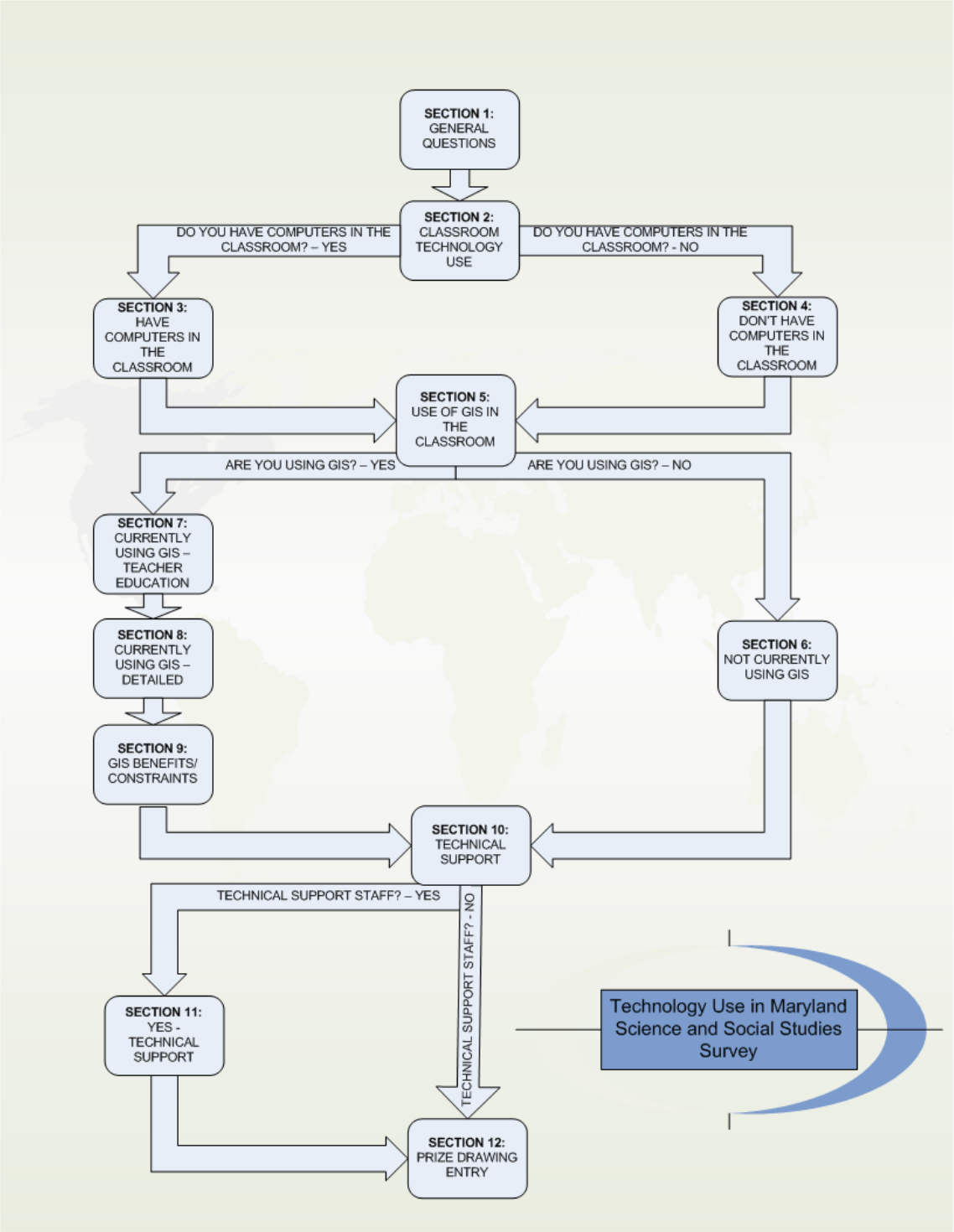
The seventh, eighth and eleventh sections, Currently Using GIS – Teacher Education and Details and GIS Benefits/Constraints, are directed to respondents

who are currently using GIS. The questions ask about their own education, more detailed information about how they use GIS in the classroom, and GIS benefits and constraints. This includes how they learned to use GIS, the total number of hours spent in formal GIS training, and use of GIS on their own.

The ninth and tenth sections, Technical Support and Have Technical Support, ask questions about whether or not the respondents' schools have a technical staff member. If yes, respondents are then asked about the amount of support they receive from the technical support staff member, and the amount of support they receive specifically for GIS.

The last section, Prize Drawing, is an optional section. The respondents could choose to enter their full name, email address, and school name for a chance to be entered into a drawing for several prizes.

Figure 2. Survey Flow and Logic



A census was conducted for the potential to render more precise estimates of population characteristics, as well as more information for addressing how GIS is being utilized in Maryland schools. The survey questionnaire produced both qualitative and quantitative data.

The study was completed in three steps: 1) develop and pre-test the survey; 2) conduct an Internet survey; and 3) perform the data analysis. The survey was developed using a survey tool and was pre-tested on selected teachers and administrators to achieve the best survey instrument possible with the feedback provided.

Collection of Data

A survey pre-test was forwarded to six teachers in the State, which helped to test the clarity of the questions and the questionnaire format. Based on the results of the pre-test, changes were made to the questionnaire. In order to email a request for teachers to complete the survey, a three-step campaign was undertaken, with the following approach:

1. A telephone meeting was set up with the Maryland State Department of Education (MSDE), which allowed the dissemination of the survey through MSDE's listservs, ultimately obtaining MSDE support of the project.
2. The curriculum coordinators and the heads of each science and social studies department in each county were contacted through MSDE, which helped with obtaining their support in disseminating the survey.

3. The mailing list compiled by Dr. John M. Morgan, III, for the annual Towson University GIS (TUgis) Conference was used, as well as a list compiled from each school's Web site via the school's academic department (science or social studies).

Constant Contact® software (/www.constantcontact.com) was used to store the email addresses. SurveyMonkey.com (Survey Monkey™, 2004) was the medium used to conduct the survey. The Survey Monkey™ Web site helps design a survey, collect the responses, and analyze the results. The use of this site helped to lower costs and was more efficient for organizational purposes.

In an effort to increase participation in the survey, a random drawing was held for ten teachers after the survey was completed. All survey respondents had the option to enter their names and email addresses for a chance to win a prize provided by Environmental Systems Research Institute (Esri) (http://www.esri.com/), Towson University Department of Geography and Environmental Planning, and the Center for GIS at Towson University.

Esri is the largest manufacturer and seller of GIS software in the world. Esri's support comprised both software and training and included:

- 1st place package: $300.00 of free virtual campus training & *A-Z GIS Dictionary* ($30 Value) – total value of $330.00.
- 2nd place package: A book package containing *Our World GIS Education: Thinking Spatially Using GIS* ($50 Value), *Mapping Our World Using GIS* ($50 Value), *Analyzing Our World Using GIS* ($50 Value), *and Making Spatial Decisions Using GIS* ($50 Value) – total value of $200.00.

Towson University Department of Geography and Environmental Planning provided the following:

- 3rd place package: Free full registration to the 24th Annual Towson University Geographic Information Sciences Conference (TUgis 2011) or free registration to a 2011 TUgis post-conference workshop – total value of $125.00.

The Center for GIS at Towson University (CGIS) (http://cgis.towson.edu/) provided the following:

- 4th – 10th place packages: One paper map of the Maryland Landsat 7 Color Composite and one paper map of Impervious Surfaces in Maryland.

Data Analysis

To answer the research questions, the survey results were analyzed in the following manner. Raw data collected from the survey were downloaded to a Microsoft Excel spreadsheet. When needed, data responses were assigned a numeric code for use within SPSS analytic software (http://www.spss.com/). Descriptive statistics were used to summarize and describe the responses. More specifically, means, frequencies, and two-way cross tabulations were calculated.

Response frequency distributions and percentages for each question were calculated to. To reveal statistical patterns, cross tabulation tables were created to show relationships and/or contrasts between two different survey questions. Chi-square statistics were run on mutually exclusive categories to show if two groups have significantly different answers. For example, a comparison was

made between adopters and nonadopters of GIS in the classroom with the type of school in which they teach. Five-point scale questions (Likert scale) were summarized as the percentage of respondents who fall into each category as well as the rating average. This helped to create an index for measuring results. The median value was used to indicate the center or mid-point of the distribution and the inter-quartile range was used as an indication of variability in the data.

CHAPTER 4

Analysis of Data

The pilot test and results of the survey are discussed throughout this section. An overview of the findings and suggestions for further research opportunities are discussed in Chapter 5: Summary and Conclusions.

Pilot Test

Prior to distribution, collection, and analysis of the survey, a draft survey was developed and a pilot test conducted. Six teachers were chosen for the pilot test to provide feedback on the survey. The teachers were selected by Dr. Todd Kenreich (thesis committee advisor), who has a professional relationship with each teacher. The pilot test was distributed via www.surveymonkey.com on Wednesday, January 17, 2007. Respondents were allowed four days to complete the survey. Respondents were requested to regard the pilot survey as the final version of the instrument, and to provide feedback on several items, including the following:

- How long did it take you to complete the survey?
- Identify any difficulties you may have had when taking the survey, such as lack of clarity in a question.
- Do you have any suggestions or comments on the format of the survey?

The average time to complete the survey was five minutes. Four of the six self-selected teachers responded, a rate of 66.7%. Several modifications were made to the survey as a result of the feedback received. The pilot test enabled a

thorough examination of the survey format; suggested changes were incorporated in the survey prior to its full distribution. Although several difficulties were noted by the pilot test participants, their comments and suggestions also included responses such as, “the format looks great,” and “the survey is very user-friendly – good luck!”

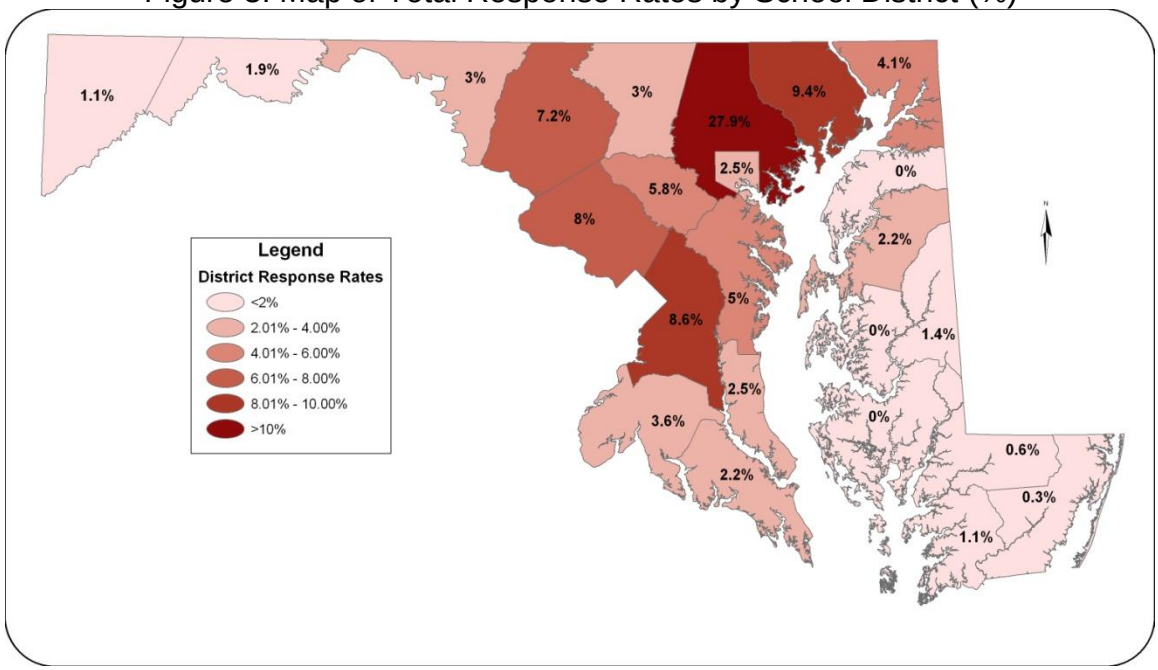
Description of Respondents and Survey Results

A total of 5732 teachers were contacted via a mass emailing. This effort yielded 395 responses. This represents a response rate of 6.9%. Of the 395 responses returned, 1 was not sufficiently completed, and 32 were from respondents outside of Maryland. After excluding these responses, the sample size was reduced to 362 which represents 6.3% of the total known population of middle and high school science, environmental science, and social studies teachers in Maryland.

Teacher Demographics. The majority of teachers (82.6%; n=299) teach in Maryland’s public education system. Approximately half teach at middle school level (41.7%, n=151); the remainder teach at high school level (54.7%, n=198).

The five school systems with the highest teacher response rates were Baltimore County, Harford County, Prince George’s County, Montgomery County, and Frederick County. Responses were not received from any teachers in Dorchester County, Kent County and Talbot County (Figure 3).

Figure 3. Map of Total Response Rates by School District (%)



The respondents were asked to specify the approximate enrollment of the school in which they teach. The majority of the enrollment is above 500 students (Table 1).

Table 1: Approximate Enrollment

What is the approximate enrollment at your school?		
Answer Options	**Response Percent**	**Response Count**
Less than 250	1.70%	6
250 – 499	10.20%	37
500 – 999	33.70%	122
1000 – 1999	40.30%	146
2000 – 2999	11.30%	41
3000 or more	2.80%	10

The average class size for the majority of the teachers (70.4%) is 21-29 students. Of the 362 respondents, 49.7% teach in the science department, 43.9% teach in the social studies department, and 2.5% teach in the environmental science department. The remaining 3.9% chose “Other” and

specified technology, science and social studies, career and technology, special education, and teacher mentor as the department (Table 12).

The majority of respondents chose “Other” when asked about the subject(s) they teach. Of the 97 different responses, US history, physical science, and environmental science were the next top responses. Of the 362 respondents, 26.5% have been teaching for 20 or more years, and 24.3% for 6-9 years. Teachers who responded are highly educated, with Master’s Degree or equivalent being the highest level of education completed (67.1%; Table 2).

Table 2. Level of Education

What is the highest level of education you have completed?		
Answer Options	**Response Percent**	**Response Count (n=362)**
Bachelor's degree	20.99%	76
Master's degree or equivalent	72.65%	263
Doctoral degree or equivalent	6.35%	23

Technology in the Classroom. Three quarters of respondents have computers in their classrooms (75.6%), and almost all respondents use technology in their classrooms as a teaching aid (91.6%).

Wall maps, videos, atlases, globes, and CD-ROMs are the top five choices identified by respondents as the types of materials used to teach geographic concepts. The use of GIS software to teach geographic concepts was rated lowest (9.8%; Table 3). There were 92 respondents who chose “Other” and specified that they use textbook readings, map activities, graphing calculators, transparencies, PowerPoint, and other types of materials.

Table 3. The Use of GIS Software to Teach GIS Concepts

To teach geographic concepts, I use (select all that apply):		
Answer Options	**Response Percent**	**Response Count (n=357)**
CD-ROM	33.60%	120
Video	54.60%	195
Atlases	50.70%	181
Wall Maps	67.50%	241
Globes	45.10%	161
Aerial Photos	33.90%	121
GIS Software	9.80%	35
Internet Map Services (IMS) Viewer	28.60%	102
Other (please specify)	25.80%	92

Of the respondents who have computers in their classroom, 99.3% are connected to the Internet. Only two respondents do not have Internet connectivity. Of the respondents who do not have computers in their classrooms, 97.2% have a computer lab(s) in their school, and 73.4% use the computer lab to teach lessons.

Technical and Administrative Support. A majority of respondents (89.3%; n=302) have a technical support staff member at their schools, and more than 70% are receiving some or much support for technology use in their classrooms. However, more than 90% of the teachers with technical staff members at their school are not receiving any support for GIS. Similarly, approximately 90% are also not receiving any support and/or encouragement from their administrators for using GIS in the classroom.

Classroom Users of GIS

Of the total number of respondents, 67.7% have heard of GIS (Table 4), but only 13.2% are currently using GIS technology in their classes (

Table **5**).

Table 4. Heard of GIS

Have you heard of GIS?		
Answer Options	**Response Percent**	**Response Count (n=356)**
Yes	66.90%	238
No	33.10%	118

Table 5. Use of GIS

Are you currently using GIS technology (i.e., mapping software, digital image processing software, Computer Aided Design (CAD) software, Global Positioning System (GPS)) in your classes?		
Answer Options	**Response Percent**	**Response Count (n=356)**
Yes	13.20%	47
No	86.80%	309

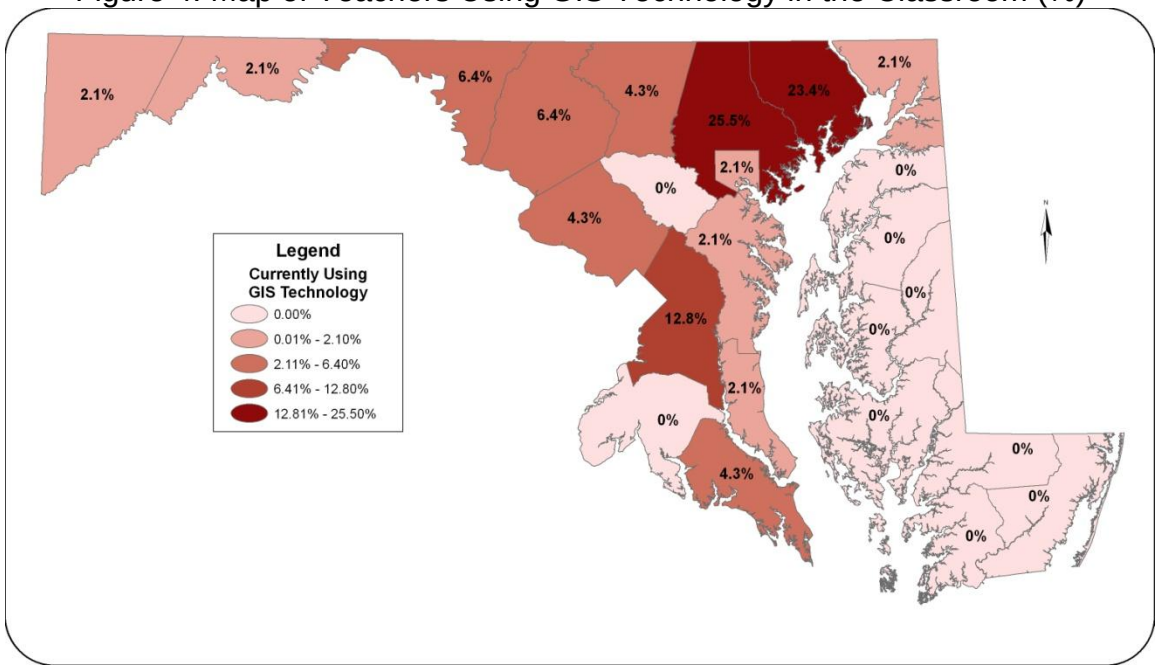
The following sections describe general characteristics about GIS users, such as their education level, department, and subjects taught; specific information about how the teacher learned to use GIS; and benefits and constraints of GIS.

GIS Adopters: Teacher Demographics**.** The majority (74.5%; n=35) of respondents who are currently using GIS technology in the classroom teach in Maryland's public education system, and 59.6% (n=28) teach at the high school level. Of the respondents currently using GIS in the classroom, 19.1% (n=9) teach in private schools; 2.1% teach in technical/vocational schools, magnet schools, and a technical/vocational curriculum office; 27.7% (n=13) teach in a middle school; and 12.8% (n=6) teach in an outdoor education center, K-12

school, or serve as a supervisor. The top five school districts with the highest percentage of respondents using GIS technology in that district are (Figure 4):

- Baltimore County: 25.5% (n=12);
- Harford County: 23.4% (n=11);
- Prince George's County: 12.8% (n=6);
- Frederick County: 6.4% (n=3);
- Washington County: 6.4% (n=3).

Figure 4. Map of Teachers Using GIS Technology in the Classroom (%)



Of the 362 respondents, 46.8% (n=22) teach in the science department; 29.8% (n=14) teach Social Studies; and 12.8% (n=6) teach environmental science. Five respondents selected "Other" and specified departments such as career and technology, and biotechnology programs. Most of the respondents teach the subjects of environmental science (36.2%; n=17); earth science (19.1%; n=9); social studies (14.9%; (n=7); and US History (14.9%; n=7). Other

responses included geography, chemistry, biology, physics, and outdoor education.

Most of the respondents are highly educated and experienced: 61.7% of teachers using GIS technology in the classroom have a master's degree or equivalent; 31.9% (n=15) of teachers using GIS technology in the classroom have been teaching for 20 or more years. These teachers have had more time to plan lessons that incorporate GIS and/or more opportunities to receive training, whether the training is from a higher level course, another teacher, or a summer teaching program. The average class size of teachers using GIS is 21-29 students (68.1%; n=32).

Teacher GIS Education. About half of the respondents (48.9; n=22) first learned to use GIS by training themselves; 24.4% (n=11) learned by attending a teacher in-service day, 24.4% at a conference, and 24.4% from another teacher (Table 6). Use of GIS continues to expand and might not have been part of an undergraduate degree program when these teachers began their careers.

Table 6. How Teachers First Learned to use GIS

Q22. How did you first learn to use GIS? (Click all that apply).		
Answer Options	**Response Percent**	**Response Count**
I trained myself	47.80%	22
Teacher in-service day	23.90%	11
At a conference	23.90%	11
By another teacher	23.90%	11
Other (please specify)	23.90%	11
Via the Internet	13.00%	6
An undergraduate or graduate course in GIS	8.70%	4
By a GIS user outside of the educational community	6.50%	3
TUGIS Conference	4.30%	2
National Science Teachers Association	4.30%	2
National Council for Geographic Education	2.20%	1

The data suggest that the number of GIS classes or training available may be inadequate and that teachers do not have an adequate amount of classroom and hands-on experience with GIS. About half of respondents have spent no hours in formal GIS training classes (46.7%, n=21). However, 80.0% (n=36) responded that they are able to use GIS on their own.

Question 24 asked the respondents to rate how useful certain resources were in helping them to learn GIS. Several resources were listed; respondents were asked to rate their response to the following level of measurement categories:

- None
- Some

- Very much

Respondents expressed that another teacher helped “very much” but that the Internet, college courses, books, magazines, newspapers, curriculum materials, and conferences did not help. Hands-on training with someone else appears to be the most effective resource in learning GIS. The resource would be available to answer questions and guide them through the software, preparing lesson plans, and troubleshooting.

Benefits and Constraints. Several questions focused on determining teachers’ views on the benefits and constraints of using GIS in the classroom, as follows:

- Question 39: How much does your use of GIS result in these benefits?
- Question 40: How much is your use of GIS hindered by the following constraints?
- Question: 41: Please rate the following barriers in the use of GIS in the classroom, where 1 = Most hindering and 4 = Least hindering.

Respondents who are currently using GIS in the classroom were asked how the use of GIS produces specific benefits. To gauge the level of agreement about benefits of the use of GIS technology in their classrooms, a Likert scale question was asked (Question #39). Several statements were given. The respondents were asked to rate their responses according to the following measurements (Table 7):

- Never;
- Almost never;

- Neutral
- Almost always
- Always.

The following table summarizes teacher responses using modal values.

Table 7. Use of GIS and Benefits

How much does your use of GIS result in these benefits? (n=29)						
Answer Options	**Never**	**Almost never**	**Neutral**	**Almost always**	**Always**	**Mode**
Enhances Learning	0	0	2	21	6	4
Provides exploratory tool for data analysis	1	0	7	15	6	4
Offers team learning environment	2	0	13	14	0	4
Provides real-world relevance to subject	1	0	3	15	10	4
Enhances motivation and student interest	0	0	3	17	9	4
Helps teach national, state, or district standards	6	2	13	6	2	3
Provides employment skills	4	1	16	5	3	3
Provides integration of different subjects	2	2	10	10	5	3
Provides opportunities to partner with the community	5	3	10	9	1	3

"Almost always" was the most frequent response to the following benefits.

- Enhances Learning
- Provides exploratory tool for data analysis
- Offers team learning environment
- Provides real-world relevance to subject
- Enhances motivation and student interest

The current generation of students is technologically savvy. By incorporating GIS into the science and social studies classrooms, teachers offer their students a new, different technology to learn. Once learned, GIS encourages student engagement and problem-based learning.

Respondents who are currently using GIS in the classroom were asked how the use of GIS is hindered by specific constraints. To gauge the level of agreement about constraints on the use of GIS technology in their classrooms, a Likert scale question was asked (question #40). Several statements were given. The respondents were asked to rate their responses according to the following measurements (Table 8):

- Never;
- Almost never;
- Neutral;
- Almost always
- Always.

The following table summarizes teacher responses using modal values.

Table 8. Use of GIS and Constraints

How much is your use of GIS hindered by the following constraints? (n=29)						
Answer Options	Never	Almost never	Neutral	Almost always	Always	Mode
Lack of time to develop lessons incorporating GIS	2	3	7	8	10	5
Complexity of software	3	7	12	6	2	3
Cost of hardware and software	4	1	10	9	6	3
Computers not accessible to my students	7	5	7	7	4	3
Computers not capable of handling GIS	4	7	13	3	3	3
Little administrative support for training	2	3	18	3	4	3
Class periods too short to work on GIS-based projects	5	5	15	2	3	3
Lack of useful or usable data	5	6	13	5	1	3
Lack of geographic skills among students	2	5	12	10	1	3
Variable skill levels among students	2	4	14	7	3	3
Does not fit in the curriculum	7	6	10	6	1	3

Teachers believe that the lack of time to develop lessons incorporating GIS is the paramount constraint to implementing GIS in the classroom. Since GIS is not currently included in the curriculum, teachers are spending more time planning curricular-based activities. The planning time that they do have is mostly spent on grading papers, conducting parent conferences and making phone calls, and performing other administrative activities during the school year.

Respondents were asked to rate several barriers in the use of GIS in the classroom, where 1 is the most hindering and 4 is the least hindering. Teachers rated technology understanding and availability, GIS lesson plan availability, and time constraints for planning as the most hindering barriers with a modal statistic of 1, or most hindering. Also, teacher education and training opportunities were rated as a significant hindering barrier, with a modal statistic of 2.

The following table, Table 9, summarizes teacher responses using modal values.

Table 9. Perceived Barriers in the Use of GIS

Q41. Please rate the following barriers in the use of GIS in the classroom, where 1 = Most hindering and 4 = Least hindering.					
Answer Options	**Most Hindering (1)**	**→2**	**→3**	**Least Hindering (4)**	**Mode**
Technology understanding and availability	**126**	20	31	57	1
GIS lesson plan availability	**75**	69	66	54	1
Time constraints for planning	**84**	74	47	59	1
Teacher education/training opportunities	77	**88**	57	43	2

Non-Users of GIS

Over three-quarters of the 362 respondents (86.8%) do not use GIS technology in the classroom. Question 20 specifically asks the teachers to explain why they do not use GIS technology. The top five responses are:

- Not familiar with GIS: 41.9% (n=125);
- Limited GIS Training: 37.9% (n=113);
- Lack of GIS lesson plans: 31.2% (n=93);

- Limited Budget: 29.9% (n=89), and
- Lack of time to plan lessons: 28.2% (n=84).

The majority of respondents are not familiar with GIS, may not even know what G-I-S stands for, have limited GIS training, lack available GIS lesson plans and lack time to plan lessons on GIS, and lack adequate budget to apply to using GIS.

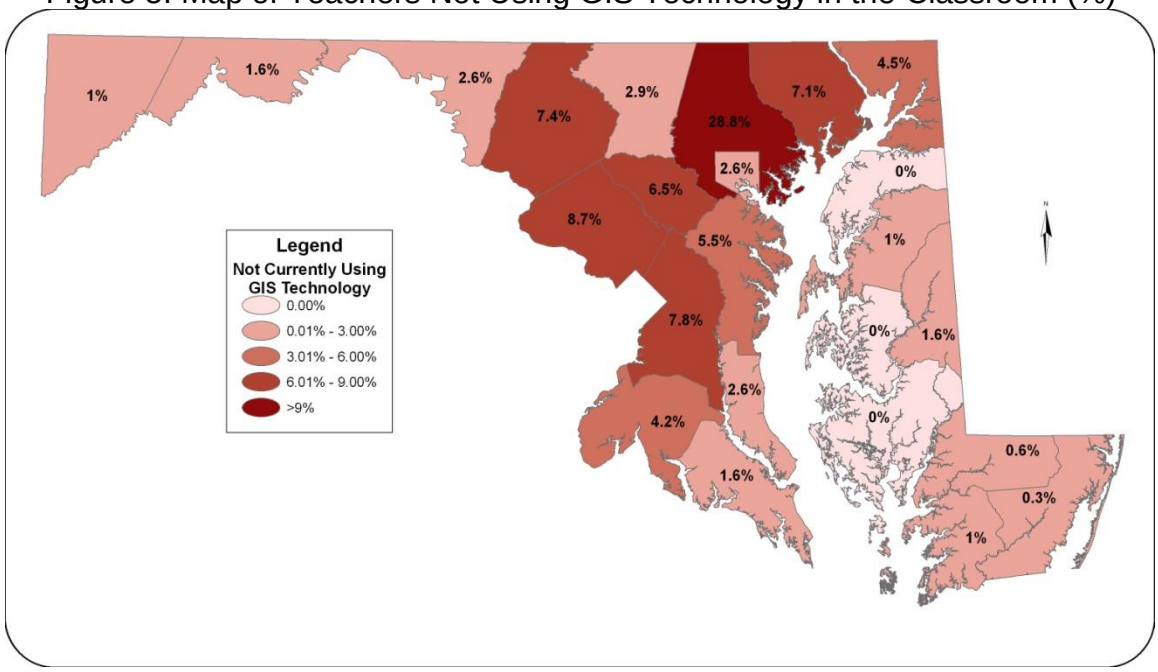
The following sections describe general information about the non-adopters, such as their education level, departments, subjects taught, and constraints of using GIS.

GIS Non-adopters: Teacher Demographics. The majority of respondents who are not currently using GIS technology in the classroom (83.8%; n=259) teach in Maryland's public education system; 54.5% (n=168) teach at the high school level; 12.6% (n=39) teach in a private school, and 0.3% teach in technical/vocational schools, magnet schools, or the technical/vocational curriculum office. Of the respondents not currently using GIS in the classroom, 43.7% (n=135) teach middle school, and 1.9% (n=6) teach in a K-8 school, K-12 school, or serve as an administrator. The top five school districts with the highest percentage of respondents not using GIS technology in that district are (Figure 5):

- Baltimore County: 28.8% (n=89);
- Montgomery County: 8.7% (n=27);
- Prince George's County: 7.8% (n=24)

- Harford County: 7.1% (n=22)
- Howard County: 6.5% (n=20).

Figure 5. Map of Teachers Not Using GIS Technology in the Classroom (%)



Of the respondents who are not currently using GIS technology in the classroom, 50.2% (n=155) teach in the science department at their school; 46.6% (n=144) teach Social Studies; and 1.0% (n=3) teach environmental science. Seven respondents selected “Other” then listed their departments as science and social studies, and technology. Most of the respondents teach the subjects of US history (20.7%; n=64), physical science (20.4%; n=63), world history (18.8%; n=58), earth science (18.1%; n=56), and social studies (17.2%; n=53). Other responses include oceanography, horticulture, biology, physics, and forensic science.

Most of the respondents are highly educated and experienced: 68.3% of respondents that are not using GIS technology in the classroom have a master's degree or equivalent; 25.2% (n=78) have taught for 20 or more years, with the average class size of 21-29 students (70.6%; n=218).

Technical & Administrative Support. Of the respondents who are not currently using GIS technology in the classroom, 90.5% (n=268) have a technical support staff member in their school; 73.4% (n=201) have some or much support from this person for general technology use; and only 26.6% (n=73) have little or no support. When asked how much support they receive from the technical staff member for GIS, 97.4% (n=259) responded that they receive little or no support for GIS. When asked how much support they receive from their administrators for using GIS, 92.8% (n=243) responded that they receive little or no support for GIS. Anecdotally, conversations with several administrators and supervisors reflect their lack of knowledge about GIS, suggesting that teachers are not receiving support because administrators perhaps don't realize that there is a need for support.

Constraints. To gauge the level of agreement about constraints on the use of technology in their classrooms, including the use of GIS, a Likert scale question was asked (question #21). Several statements were given. The respondents were asked to rate their response according to the following measurements.

- Strongly disagree
- Somewhat disagree

- Neither agree nor disagree
- Somewhat agree
- Strongly agree

The following table, Table 10, summarizes teacher responses using modal values.

Table 10. Constraints of Technology Use in the Classroom

Rate the following constraints on the use of technology in your classroom, including the use of GIS (n=298).						
Answer Options	**Strongly disagree**	**Somewhat disagree**	**Neither agree nor disagree**	**Somewhat agree**	**Strongly agree**	**Mode**
I am not familiar with GIS.	29	62	28	60	119	5
I have a limited budget.	15	14	54	79	136	5
I have limited hardware availability.	29	42	66	91	70	4
I have limited software availability.	19	27	71	92	89	4
I have limited instructional time.	11	26	49	121	91	4
I have a lack of time to plan lessons.	19	33	76	93	77	4
I have no need or interest in GIS.	56	53	122	45	22	3
There is limited GIS training available.	12	15	105	71	95	3
There is limited technology training available.	27	55	91	80	45	3
There is a lack of GIS lesson plans.	6	8	127	79	78	3

"Strongly agree" was the most frequent response to the statements "I am not familiar with GIS" and "I have a limited budget." Respondents also indicated that they have a limited budget that constrains them from using GIS in the

classroom. Commercial GIS licensing and maintenance is costly. “Somewhat agree” was the most frequent response to the following statements.

- “I have limited hardware availability”
- “I have limited software availability”
- “I have limited instructional time”
- “I have a lack of time to plan lessons.”

GIS software is complex and requires significant system resource, such as memory and disk space, both locally and on central servers. GIS also performs better on computers with greater memory capacity. Survey responses imply that the computers in schools and classrooms are limited in availability and most likely insufficient to house GIS software appropriately.

Teachers also agree they have limited instructional and lesson planning time, especially relative to the mandatory content that must be covered in the curriculum. There is little time to teach something extra, or new.

“Neither agree nor disagree” was the most frequent response to the following statements.

- “I have no need or interest in GIS”
- “There is limited GIS Training”
- “There is limited technology training available”
- “There is a lack of GIS Lesson plans”

The response is not surprising, since most had previously stated that they are not familiar with GIS. Teachers would not know if they need or are interested in GIS if they do not know the meaning and value of GIS. They also would not

know if there is GIS and technology training available or if there are GIS lesson plans available to incorporate into their study units.

Analysis of Survey Data and Information

Questions arise as to whether there are associations between factors such school type or academic departments and the adoption or non-adoption of GIS for classroom instruction. Contingency table analysis using the chi-squared (χ^2) statistic was used for this purpose.

Chi-square analysis was used to assess whether a place of employment was associated with classroom use of GIS. No significant association between the place of employment (public vs. private schools) of teachers and adopters and nonadopters of GIS was observed (Chi-square value = 2.86; P=0.239).

A significant association was observed between school type (middle and high school) and adopters and nonadopters of GIS (Table 11, Chi-square value = 16.9; P=0.000). Fewer teachers than expected use GIS in middle and high schools; whereas more teachers than expected use GIS in K-12 schools, technical, and charter schools.

Table 11. Secondary School Type and Use of GIS

Secondary School Type	Use	Don't Use	Total
Middle	13 27.7%	135 43.7%	148 41.6%
High	28 59.6%	168 54.4%	196 55.1%
Other	6 12.8%	6 1.9%	12 3.4%
Total	47 100.0%	309 100.0%	356 100.0%
Pearson's Chi-Square X^2=16.902 P=.000			

Table 12. Departments in which the Respondents Teach

In what department do you teach?		
Answer Options	**Response Percent**	**Response Count (n=362)**
Social Studies	43.90%	159
Science	49.70%	180
Environmental Science	2.50%	9
Other	3.90%	14

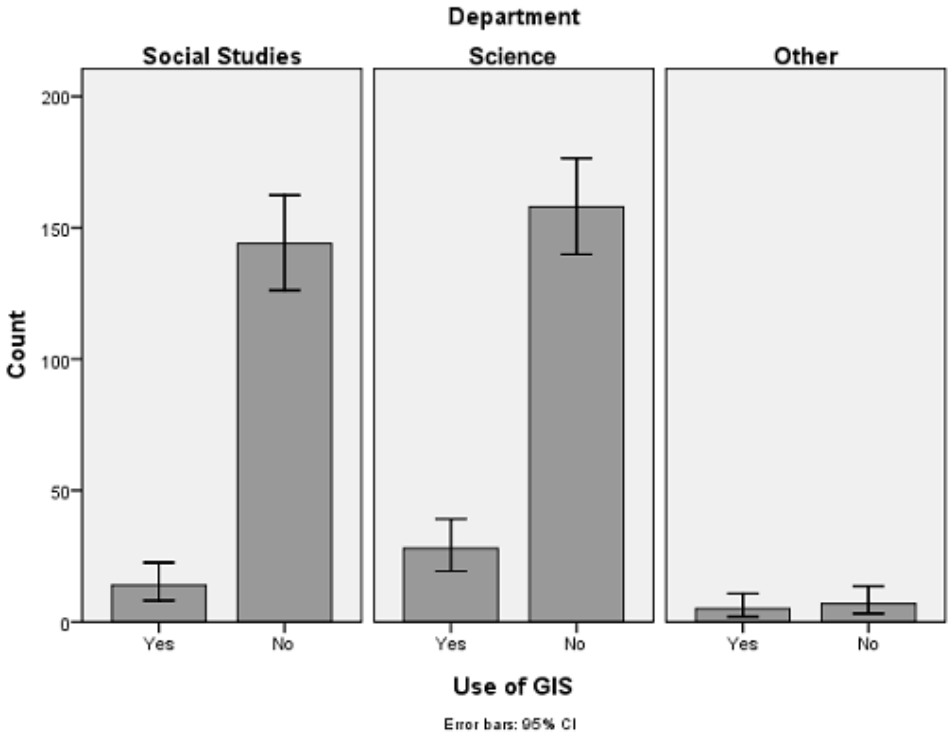
A chi-square test was performed to determine if there is a significant association between the type of department and the adoption of GIS (Table 13). Assuming that the three groups are equivalent, chi-square measures how much they depart from equivalency. The results of this analysis indicate that a lower than expected number of teachers use GIS in science and social studies departments, and that the number of teachers in other departments using GIS is greater than expected.

Table 13. Department and Use or Non-use of GIS

Department	Use	Don't Use	Total
Social Studies	14 29.8%	144 46.6%	158 44.4%
Science	28 59.6%	158 51.1%	186 52.2%
Other	5 10.6%	7 2.3%	12 3.4%
Total	47 100.0%	309 100.0%	356 100.0%
Pearson Chi-Square X^2=11.64 P=.003			

Further analysis reveals no significant associations, because there are fewer teachers not using GIS in other departments than there are in science and social studies departments (Figure 6).

Figure 6. Error bar Graph



Two research questions were posed for this project.

1. Do teachers have a lack of training and educational background in geography and GIS?
2. Why are teachers not using GIS in their classrooms?

To answer these research questions, several sections of the survey specifically addressed teacher training and knowledge of GIS as well as constraints of using GIS technology in the classroom.

The first research question —do teachers have a lack of training and educational background in geography and GIS?—was answered by the survey results. Teachers do have a lack of training and educational background in geography and GIS. Of the 362 respondents, 86.8% are not using GIS. Nearly half of the 357 respondents (66.9%; n=238) are not familiar with the technology.

The top response to the question asking teachers to explain why they are not using GIS technology is “not familiar with GIS” (41.9%, n=125). Also, “strongly agree’ was the most frequent response to the statement, “I am not familiar with GIS.” Teachers do not have the training or educational background in GIS.

The second top response to the question asking teachers to explain why they are not using GIS technology was “limited GIS training” (37.9%; n=113). GIS training should be made available to teachers either as part of their undergraduate degree program or through other training opportunities, such as in-service training or other professional development opportunities. GIS training may be available, but teachers are not taking the training because they may not know about GIS or understand how it can enhance teaching their content area.

The second research question —why are teachers not using GIS in the classroom?—was answered by the survey results. Lack of easy-to-use software, digital geospatial data, teacher training, and educational pedagogy, particularly curriculum key to state standards prevents teachers from utilizing GIS as an educational tool. Respondents were asked to rate several barriers to the use of GIS, and the most frequent responses were that “technology understanding and availability” (46%, n=126) and “GIS lesson plan availability” (27.4%, n=75) are some of the “most hindering” barriers. Lack of GIS lesson plans was also a top response to the questions asking respondents why teachers are not using GIS in the classroom and what the observed constraints are of users of GIS (32.6%, n=14).

When asked if using GIS “helps teach national, state, or district standards”, if there is a “lack of useful or usable data”, that there is “complexity of the software”, or that GIS “does not fit in the curriculum”, teachers responded neutrally (mode=3). Teacher results are based on their lack of knowledge of the resources needed to operate GIS software.

Summary

In conclusion, 86.8% of the respondents are not currently using GIS in their classroom due to several constraints. Teachers agree that there is a need for or interest in GIS, but constraints hinder them from using GIS as a tool. They are not familiar with GIS, and they agree that hardware and software availability, budget, GIS and technology training available, and instructional time are all limited. They agree that they lack GIS lesson plans and time to create new lesson plans. All of these constraints combined hinder teachers from using GIS technology as a teaching tool in their classrooms.

The teachers who are currently using GIS in the classroom recognize several benefits from the technology:

- enhances learning, motivation, and student interest;
- provides an exploratory tool for data analysis;
- provides employment skills;
- offers a team learning environment;
- provides real-world relevance to subjects;
- provides integration of different subjects.

However, the teachers do not believe that using GIS in the classroom provides opportunities to partner with the community or helps to teach national, state, or district standards.

Teachers currently using GIS in the classroom also recognize the following constraints that inhibit use of the technology:

- cost of hardware and software;
- lack of time to develop lessons incorporating GIS;
- little administrative support for training;
- lack of geographic skills among students
- variable technical skill levels among students
- unclear placement of GIS in the curriculum.

Respondents do not regard complexity of software, inaccessibility of a computer to students, inadequacy of a computer to utilize GIS software, inadequate length of class periods for working on GIS-based projects, and lack of useful or usable data constraints their use of GIS. As stated previously, a general lack of knowledge about GIS may be influencing teacher responses to these questions.

CHAPTER 5

Summary and Conclusions

The purpose of this research was to collect information directly from science, environmental science, and social studies teachers in the State of Maryland to determine how GIS is being utilized in schools. Literature research was conducted to provide background information. A survey was sent to science, environmental science, and social studies teachers in the State of Maryland in grades 6-12 to measure the use of GIS in the classroom. The paragraphs that follow will provide a brief summary of the procedures, as well as summary of the findings, conclusions, discussions and implications, and recommendations for further study.

Summary of Procedures

A self-administered, cross-sectional Internet survey questionnaire was sent to science and social studies teachers in the State of Maryland who are teaching grades 6-12. Ten respondents were chosen randomly and were given a prize package comprising books (A-Z GIS Dictionary and the Our World GIS Education book series), GIS training, and/or maps (Maryland Landsat 7 Color Composite and Impervious Surfaces in Maryland). The survey was compiled with information from a literature review, as well as information from a national study completed by Joseph Kerski, and a local study completed by Dr. John M. Morgan, III. (Kerski, 2003; Morgan, 2004). The pilot survey was distributed and modifications were then made to the final survey. The survey was distributed to

a list of science, environmental science, and social studies teachers in the State of Maryland in grades 6-12. The population in the State of Maryland was selected because a teacher mailing list compiled by Dr. John M. Morgan, III, was readily accessible. Email addresses for middle and high school teachers were easily extracted from individual school science, environmental science, and social studies Web sites.

A total of 5732 teachers were surveyed, and 395 responses were returned. Of the 395 responses returned, 1 was not sufficiently completed, and 32 were from respondents outside of Maryland. After excluding these responses, the sample size was 362, a response rate of 6.3%,

The analysis consisted of the following two processes: 1) dissemination and collection of the survey, and 2) analysis of the results. The results of the analysis were compiled into tables. Some tables include cross-tabulations to help determine the validity of the research questions. Due to the categorical and non-normal nature of the data collected from the survey, descriptive statistics were used to summarize and describe the responses. Response frequencies, percentages, cross-tabulations, and modal statistics were used to reveal statistical patterns, relationships, and contrasts.

Summary of Findings

67.7% of respondents have heard of GIS; however, only 13.2% of respondents are currently using GIS technology in their classes. Most adopters of GIS in the classroom teach in Maryland's public education system at the high

school level. More teachers in the science department use GIS (59.6%, n= 28) than in the social studies department (12.8%, n=6). Most of the respondents teach the subjects of environmental science, 36.2% (n=17), earth science, 19.1% (n=9), social studies, 14.9% (n=7), and US History (14.9%, n=7).

Adopters of GIS in the classroom are highly educated and have been teaching for a significant number of years: 61.7% of teachers who use GIS technology in the classroom have earned a master's degree or equivalent, and 31.9% (n=15) of teachers who use GIS technology in the classroom have been teaching for 20 or more years.

The majority of teachers who responded to the survey are not using GIS technology (86.8%) and have not received any formal training on its use in education. The nonadopters of GIS are not familiar with GIS (41.9%, n=125), and/or may not even know what G-I-S means.

There are many constraints that both users and non-users of technology and GIS in the classroom indicated. The majority of respondents indicated the following constraints:

- limited hardware availability;
- limited software availability;
- cost of hardware and software;
- limited budget;
- limited GIS training available;
- limited technology training available;
- limited instructional time;
- lack of GIS lesson plans available;
- lack of time to plan lessons; and
- little administrative and technical support for training.

These constraints are consistent with prior studies and researches conducted over the past decade (Baker, 2002; Gatrell, 2001; Kerski, 2003; Wiegand, 2003). As discovered in the National Survey conducted by Joseph Kerski in 2003, the top constraints in Maryland are: lack of time to plan lessons, and limited GIS training. Teachers must complete a considerable amount of work during the school day; they have little time to plan new lessons. They consider the technology to be complex and hard to fit into their schedules. Also, understanding how to install and operate software is critical to the success of using GIS; teachers indicate that they lack technical staff support. Therefore, technical and administrative staff members in the schools would play an important role in actively in promoting and supporting the use of GIS.

Teachers indicated that the following benefits result from their use of GIS in the classroom:

- results in enhancing learning;
- provides an exploratory tool for data analysis;
- provides employment skills;
- offers a team learning environment;
- provides real-world relevance to subjects;
- integrates different subjects; and
- enhances motivation and student interest.

They also indicated that their use of GIS:

- does not provide opportunities to partner with the community; and
- does not result in helping to teach national, state, or district standards.

Conclusions

Based upon the findings and within the limitations of this study, most teachers in the State of Maryland are not utilizing geographic information system technology—GIS—in the classroom. Many have not heard of GIS, don't have a broad enough understanding of the technology to realize its benefits, do not have adequate time to plan lessons, do not have adequate instructional time to incorporate the technology, and do not have adequate budgets. A minimal number of teachers are using GIS in Maryland's classrooms. Of the teachers using GIS, most teach high school science in Maryland's public education school system and are teaching themselves how to use GIS.

The following conclusions are based upon the findings of this survey:

1. Add GIS to the curriculum so it can be taught with required content to reduce the perceived barrier of a lack of instructional time. GIS can be time-consuming, but recent advances in performance of the technology and availability of lesson plans using GIS are decreasing the time needed to plan and incorporate GIS. Esri's ArcLessons is an example of a Web site for teachers to share lessons for using GIS in the classroom. Ideally, GIS would be added to the curriculum so it can be taught alongside the other required content.
2. Incorporate GIS into in-service training and other opportunities, such as summer programs, so teachers can gain enough awareness and knowledge of the software to begin understanding its benefits and

importance. For example, lesson plans are available and easily accessible to teachers to use in their classes, but many don't know they exist. Overall, holding general informational sessions for teachers will help them learn the many resources and free software packages available. Also, teachers must begin learning how to use GIS with a free, easy-to-use software package such as My World GIS™, ArcGIS Explorer, and/or Google Earth. Teachers with limited budgets and little funding set aside for GIS software can still use GIS in the classroom cost effectively. Several free GIS software packages are available for teachers that are more manageable and easier to learn than commercial GIS packages. These packages have a smaller learning curve associated with the technology but still offer adequate processing and tool availability. Students can also download these types of software packages for home use. They can then move to more robust software packages such as Esri's ArcGIS desktop software.

3. While in-service training is an immediate step to address concerns about teachers' capacity to use GIS in the classroom, pre-service training is another important step. Adding GIS in pre-service teacher education programs would develop a new generation of teachers with awareness of GIS. For example, science methods professors and social studies methods professors could provide pre-service teachers with an introduction to GIS and its uses in the classroom. This

early introduction might increase the probability that the pre-service teachers would later use GIS in the classroom and seek out more in-service training related to GIS.

4. IT staff and administrators need to promote and play a supportive role to teachers attempting or currently integrating GIS in the classroom. The Maryland State Superintendent of Schools, Nancy S. Grasmick, stated, "It is imperative that principals possess technology skills and see technology literacy for students and staff as a priority. Our students face a very competitive environment in today's global society and technology literacy is central to their future success."

Discussion and Implications

In 2004 the U.S. Department of Labor identified geospatial technology as one of the most important high-growth industries in the 21st century. The *High Growth Job Training Initiative* "is a strategic effort to prepare workers to take advantage of new and increasing job opportunities in high growth, high demand and economically vital sectors of the American economy (www.doleta.gov)." According to the Department of Labor, this initiative includes geospatial technology as one of 14 sectors that are projected to add substantial numbers of new jobs to the economy. The Department of Labor's Employment and Training Administration (ETA) has invested over $8,367,110 in the geospatial industry, including six High Growth Job Training Initiative grants totaling $6,438,653 and one multi-industry Community-Based Job Training Grant totaling $1,928,457.

The ETA determined that there are three workforce challenges to geospatial technology: skills, competencies and training; image and outreach to the public; and pipeline (filling current and projected job vacancies). The most important of these challenges in Maryland is the need to build basic spatial literacy. One of the solutions proposed in the current study is to develop a geospatial curriculum in schools and to deploy core training in K-12 and community colleges (www.doleta.gov).

Based on the current survey results, Maryland should increase the use and teaching of GIS in K-12 schools to better accommodate the needs of the growing geospatial technology sector. Developing more qualified instructors and adding GIS and/or geospatial technology to the curriculum in K-12 schools will communicate the importance of and the growing need for developing geospatial skills.

The State of Maryland and Esri are currently discussing the possibility of a statewide enterprise license agreement (ELA) for Maryland. According to Esri, “an ELA contract allows you to make annual payments to Esri for a three-year period in exchange for a package of software, maintenance, services and training. ELAs permit deployment of unlimited quantities of selected Esri products over the term of the agreement (Esri, 2010).” The Maryland State Department of Education also has expressed interest in pursuing a separate ELA with Esri within Maryland state education for all K-12 schools. ELAs generally help organizations save money each year, expand the software to teachers, students, and administrators, and help reduce the overhead of license procurement. With

a statewide or district-wide license, K–12 schools in Maryland would be able to use Esri software for teaching, research, or administrative purposes.

While there are many benefits to a statewide or district wide ELA, there are other software packages available that are easier to use and less expensive or free, such as My World GIS™, ArcGIS Explorer, and Google Earth. The current research found that teachers have limited time to plan lessons and limited instructional time, as well as limited budgets. Learning to use software specifically developed for education will result in an easier learning curve and a shorter amount of time learning to use and teach it in the classroom. Also, budgets will not be interrupted since most of these types of software are free. (The ELA with Esri would most likely install ArcGIS on all desktops in the Maryland State Department of Education system; the potential exists for significant resistance by IT staff for loading ArcGIS because of its size.)

Emphasis must be placed less on in-depth learning of the software and more on enabling teachers to develop lesson plans that incorporate the technology. Significant amounts of free geospatial data and information are readily available. Teachers can access, load, view, and analyze data in free, easy-to-use software packages then create lessons that utilize this approach. Students can engage in the learning activities and homework from home on their own computers. Using software that is easy to learn and free may help stimulate teachers to take the next step and move toward using the more complex ArcGIS package in the classroom in the future.

National Geographic and Esri created the GeoMentor Program. This program “helps people who know and use geography in their professional lives join forces with educators who want to incorporate activities that teach geography and geospatial technology into the daily curriculum of students from elementary through college levels (Esri, 2009).” Eric Cromwell, an environmental science teacher and coordinator of Accelerated Learning Programs at Harford County Public Schools in Maryland, uses, promotes, and encourages the use of GIS in the classroom. He is an active GeoMentor and challenges and encourages other professionals to become GeoMentors as well. At the 2009 Esri International Users conference plenary session, Cromwell said during his closing remarks, “my charge to you is this: first, believe in the kids. Believe that they can use these tools [GIS]. Second, find teachers willing to say ‘I don't know' in front of the kids. That's frightening. Find teachers willing to go beyond what is written on the test (Esri, 2009).” GeoMentors in Maryland can help teachers overcome many of the obstacles and barriers to the use of GIS that the survey results reveal.

The Homeland Security and Emergency Preparedness Magnet Program at Joppatowne High School in Harford County, Maryland have an Information/Communications Technology pathway that utilizes GIS. The courses required include introduction to Geographic Information Systems and Remote Sensing, Skill-Based Training for Geographic Information Systems and Remote Sensing, and a capstone course that involves each student completing a GIS Technician Certification and taking part in job shadowing opportunities (www.hcps.org, 2010). The Community College of Baltimore County offers the

students who successfully complete the GIS Technician Certification three credits. 17 students graduated from this program in 2010.

Recommendations for Further Study

The purpose of this research was to collect information directly from science, environmental science, and social studies teachers in the State of Maryland to determine if and how GIS is being utilized in schools. The following recommendations encourager further study on the topic; additional research is needed to promote and increase the use of GIS throughout Maryland's schools.

This study surveyed only teachers at one point in time during one school year. A longitudinal study would result in a greater understanding of the ways GIS is being used in the classroom over a longer term and would reveal patterns or alterations in the use of GIS over time. Also, re-surveying the same population of teachers over time will show whether or not non-adopters have begun using GIS in the classroom and if GIS adopters have stopped using GIS in the classroom.

The survey instrument should be modified so the questions are clearer; precisely focused questions will help to better answer the research questions.

A more accurate, up-to-date list of science and social studies teachers in the State of Maryland is also needed to increase the response rate. A list from MSDE would most likely contain the most current teacher data; a list from Esri of its software subscribers would provide the names of teachers in Maryland who are using GIS software. Alternatively, the survey could be forwarded to science and social studies supervisors for distribution to teachers.

Questions can be incorporated into the survey that requests the undergraduate degree of the respondent, as well as the number and/or types of geography courses they have taken in the past. The intent is to more thoroughly answer the research question asking if teachers lack training and/or educational background in geography and GIS.

APPENDICES

Appendix A – Survey Categories and Questions

Survey: Technology Use in Maryland Science and Social Studies

General Information
Q1. What is the type of your school?
Q2. In which district do you teach?
Q3. Are you currently teaching at a middle or high school?
Q4. What is the approximate enrollment at your school?
Q5. In what department do you teach?
Q6. What subject(s) do you teach? (Select all that apply).
Q7. How long have you been teaching?
Q8. What is your average class size?
Q9. What is the highest level of education you have completed?

Classroom Technology Use
Q10. Do you have computers in your classroom?
Q11. Do you use technology in your classroom as a teaching aid?
Q12. To teach geographic concepts, I use (select all that apply):

Have Computers in the Classroom
Q13. What is the approximate student/computer ratio for your classes?
Q14. Does your classroom have computers connected to the Internet?
Q15. What operating system(s) is on your classroom computer(s)?

Don't have computers in the Classroom
Q16. Do you have a computer lab(s) in your school?
Q17. Do you use a computer lab in your school to teach lessons?

Use of GIS in the Classroom
Q18. Have you heard of GIS?
Q19. Are you currently using GIS technology (i.e., mapping software, digital image processing software, Computer Aided Design (CAD) software, Global Positioning System (GPS)) in your classes?

Not Currently Using GIS
Q20. Describe why you are not currently using GIS technology in your classes. (Click all that apply).
Q21. Rate the following constraints on the use of technology in your classroom, including the use of GIS.

Currently Using GIS - Teacher Education
Q22. How did you first learn to use GIS? (Click all that apply).
Q23. How many total hours have you spent in formal GIS training classes?
Q24. How useful were the following in terms of helping you learn GIS?
Q25. Are you able to use GIS on your own?

Currently Using GIS - Detailed
Q26. In which grade level(s) do you use GIS? (Click all that apply).
Q27. What type(s)/brand(s) of GIS or related software are you using?
Q28. When did you obtain your first copy of GIS or related software?
Q29. When did you begin using GIS in your classroom?
Q30. Which choice best describes your use of GIS in your classroom this year?
Q31. How many teachers at your school are using GIS, including yourself?
Q32. How many hours per week are you spending, on average, outside of class time on GIS?
Q33. What digital geographic data do you use with the GIS or related software (i.e., Imagery, Census data, Digital Elevation Model)? Please describe.
Q34. Which of the following do you consider as contraints to your use use of GIS in your classes. (Click all that apply).

Technical Support
Q35. Does your school have a technical support staff member?

Yes Technical Support
Q36. How much support do you receive from the technical support staff member for technology use in the classroom?
Q37. How much support do you receive from the technical support staff member for GIS?
Q38. How much support and/or encouragement do you receive from your administrators for your use of GIS?

GIS Benefits/Constraints
Q39. How much does your use of GIS result in these benefits?
Q40. How much is your use of GIS hindered by the following constraints?
Q41. Please rate the following barriers in the use of GIS in the classroom, where 1 = Most hindering and 4 = Least hindering.

Prize Drawing
Q42. OPTIONAL: Please list your name, email address and the name of your school if you would like to be entered into a drawing for the above prizes:

Appendix B – Survey Email

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Survey - Technology in Science and Social Studies Classes
~~~~~~

Dear Participant

My name is Ashley M. Lesh and I am a graduate student in the Department of Geography and Environmental Planning at Towson University. As part of the research for my master's thesis, I am conducting a survey to determine technology use in science and social studies classes in the State of Maryland, particularly the use of Geographic Information Systems (GIS).

Participation in this study is voluntary. This survey should take approximately 5 minutes to complete. All information collected during the study will be kept strictly confidential, and your employment status will not be affected by choosing to participate or not to participate.

If you have questions about this survey, please contact me at 410-704-2081, alesh@towson.edu, my faculty advisor, Dr. John M. Morgan, III at 410- 704-2964, jmorgan@towson.edu or the Chairperson of Towson University's Institutional Review Board for the Protection of Human Participants, Dr. Patricia M. Alt, at 410-704-2236 (Exemption Number: 07-0X67). A copy of my completed thesis will be available on request. Please send an email to alesh@towson.edu to request a copy.

Please follow the link below to complete the survey.
http://www.surveymonkey.com/s.as p?u=77472988017

As a way to thank you for your participation, you are invited to enter a drawing at the end of the survey for the following prizes:

Environmental Systems Research Institute (ESRI) (http://www.esri.com/) is providing:

- $300.00 of free virtual campus training & Mapping our World with a CD of ArcView 9.0 ($80.00 Value).
- A book package containing Cartographic Extraordinaire ($80.00 Value) , GIS in Schools ($20.00 Value) & Mapping our World with a CD of ArcView 9.0 ($80.00 Value).

The Towson University Department of Geography and Environmental Planning is providing:

- One free, full conference registration to the 2007 TUgis conference or a free

registration for the TUgis Post Conference Workshop titled “Introduction to GIS for K-12 Teachers” ($125.00 Value). For information, visit (http://tugis.towson. edu/).

The Center for GIS at Towson University (CGIS) (http://cgis.towson.ed u/) is providing:

- 25 teachers will receive one paper map of the Maryland Landsat 7 Color Composite and one paper map of Impervious Surfaces in Maryland ($25.00 Value).

The drawing for these prizes will be held on Friday, March 2, 2007 (the conclusion of the survey).

Thank you for participating!

Ashley M. Lesh
Graduate Student

P.S. If you know a teacher who is using GIS in their classroom, I would appreciate it if you would forward this email to them using the link below.

Contact Information
~~~~~~
email: alesh@towson.edu
phone: 410-704-2081
~~~~~~

Appendix C – IRB Approval

TOWSON
UNIVERSITY

EXEMPTION NUMBER: 07-0X67

To: Ashley Lesh

From: Institutional Review Board for the Protection of Human Subjects, Patricia Alt, Chair

Date: Tuesday, January 16, 2007

RE: Application for Approval of Research Involving the Use of Human Participants

Office of University
Research Services

Towson University
8000 York Road
Towson, MD 21252-0001

t. 410 704-2236
f. 410 704-4494

Thank you for submitting an application for approval of the research titled, *Utilization of Geographic Information Systems Technology in Middle and High Schools in the State of Maryland*

to the Institutional Review Board for the Protection of Human Participants (IRB) at Towson University.

Your research is exempt from general Human Participants requirements according to 45 CFR 46.101(b)(2). No further review of this project is required from year to year provided it does not deviate from the submitted research design.

If you substantially change your research project or your survey instrument, please notify the Board immediately.

We wish you every success in your research project.

CC: John Morgan,III
File

Appendix D – Entire Survey Results

Q1. What is the type of your school?		
Answer Options	**Response Percent**	**Response Count**
Public	82.60%	299
Private	13.50%	49
Technical/Vocational	0.60%	2
Magnet	2.80%	10
Other (please specify)	0.60%	2
	answered question	362
	skipped question	0

Q2. In which district do you teach?		
Answer Options	**Response Percent**	**Response Count**
Allegany County	1.90%	7
Anne Arundel County	5.00%	18
Baltimore County	27.90%	101
Baltimore City	2.50%	9
Calvert County	2.50%	9
Caroline County	1.40%	5
Carroll County	3.00%	11
Cecil County	4.10%	15
Charles County	3.60%	13
Dorchester County	0.00%	0
Frederick County	7.20%	26
Garrett County	1.10%	4
Harford County	9.40%	34
Howard County	5.80%	21
Kent County	0.00%	0
Montgomery County	8.00%	29
Prince George's County	8.60%	31
Queen Anne's County	0.80%	3
Saint Mary's County	2.20%	8
Somerset County	1.10%	4
Talbot County	0.00%	0
Washington County	3.00%	11
Wicomico County	0.60%	2
Worcester County	0.30%	1
Other (please specify)	0.00%	0
	answered question	362
	skipped question	0

Q3. Are you currently teaching at a middle or high school?		
Answer Options	**Response Percent**	**Response Count**
Middle	41.70%	151
High	54.70%	198
Other (please specify)	3.60%	13
	answered question	362
	skipped question	0

Q4. What is the approximate enrollment at your school?		
Answer Options	**Response Percent**	**Response Count**
Less than 250	1.70%	6
250 – 499	10.20%	37
500 – 999	33.70%	122
1000 – 1999	40.30%	146
2000 – 2999	11.30%	41
3000 or more	2.80%	10
	answered question	362
	skipped question	0

Q5. In what department do you teach?		
Answer Options	**Response Percent**	**Response Count**
Social Studies	43.90%	159
Science	49.70%	180
Environmental Science	2.50%	9
Other (please specify)	3.90%	14
	answered question	362
	skipped question	0

Q6. What subject(s) do you teach? (Select all that apply).		
Answer Options	**Response Percent**	**Response Count**
Earth Science	18.30%	66
General Science	10.80%	39
Environmental Science	18.30%	66
Physical Science	19.70%	71
Life Science	11.40%	41
Computer	1.10%	4
Chemistry	15.50%	56
Biology	15.00%	54
GIS	1.10%	4
Geography	9.10%	33
Social Studies	16.90%	61
US History	19.70%	71
World History	16.90%	61
World Cultures	7.50%	27
Government	13.30%	48
Human Geography	3.60%	13
Other (please specify)	26.90%	97
	answered question	361
	skipped question	1

Q7. How long have you been teaching?		
Answer Options	**Response Percent**	**Response Count**
Less than 3 years	7.70%	28
3 – 5 years	15.70%	57
6 – 9 years	24.30%	88
10 – 14 years	14.40%	52
15 – 19 years	11.30%	41
20 or more years	26.50%	96
	answered question	362
	skipped question	0

Q8. What is your average class size?		
Answer Options	**Response Percent**	**Response Count**
Less than 10 students	0.30%	1
11 - 20 students	18.00%	65
21 - 29 students	70.40%	255
30 or more students	11.30%	41
	answered question	362
	skipped question	0

Q9. What is the highest level of education you have completed?		
Answer Options	**Response Percent**	**Response Count**
Bachelor's degree	20.40%	74
Master's degree or equivalent	67.10%	243
Doctoral degree or equivalent	6.40%	23
Other (please specify)	6.10%	22
	answered question	362
	skipped question	0

Q10. Do you have computers in your classroom?		
Answer Options	**Response Percent**	**Response Count**
Yes	75.60%	270
No	24.40%	87
	answered question	357
	skipped question	5

Q11. Do you use technology in your classroom as a teaching aid?		
Answer Options	**Response Percent**	**Response Count**
Yes	91.60%	327
No	8.40%	30
	answered question	357
	skipped question	5

Q12. To teach geographic concepts, I use (select all that apply):		
Answer Options	**Response Percent**	**Response Count**
CD-ROM	33.60%	120
Video	54.60%	195
Atlases	50.70%	181
Wall Maps	67.50%	241
Globes	45.10%	161
Aerial Photos	33.90%	121
GIS Software	9.80%	35
Internet Map Services (IMS) Viewer	28.60%	102
Other (please specify)	25.80%	92
	answered question	357
	skipped question	5

Q13. What is the approximate student/computer ratio for your classes?		
Answer Options	**Response Percent**	**Response Count**
Less than 3:1	22.80%	61
3:1	10.80%	29
5:1	15.70%	42
10:1	7.80%	21
15:1	9.70%	26
More than 15:1	33.20%	89
	answered question	268
	skipped question	94

Q14. Does your classroom have computers connected to the Internet?		
Answer Options	**Response Percent**	**Response Count**
Yes	99.30%	266
No	0.70%	2
	answered question	268
	skipped question	94

Q15. What operating system(s) is on your classroom computer(s)?		
Answer Options	**Response Percent**	**Response Count**
Macintosh	8.60%	23
Windows 95/98	7.80%	21
Windows 2000	23.50%	63
Windows XP	56.00%	150
Windows NT	4.10%	11
Unix	0.40%	1
I don't know	4.90%	13
	answered question	268
	skipped question	94

Q16. Do you have a computer lab(s) in your school?		
Answer Options	**Response Percent**	**Response Count**
Yes	97.20%	347
No	2.80%	10
	answered question	357
	skipped question	5

Q17. Do you use a computer lab in your school to teach lessons?		
Answer Options	**Response Percent**	**Response Count**
Yes	73.40%	262
No	26.60%	95
	answered question	357
	skipped question	5

Q18. Have you heard of GIS?		
Answer Options	**Response Percent**	**Response Count**
Yes	66.90%	238
No	33.10%	118
	answered question	356
	skipped question	6

Q19. Are you currently using GIS technology (i.e., mapping software, digital image processing software, Computer Aided Design (CAD) software, Global Positioning System (GPS)) in your classes?		
Answer Options	**Response Percent**	**Response Count**
Yes	13.20%	47
No	86.80%	309
	answered question	356
	skipped question	6

Q20. Describe why you are not currently using GIS technology in your classes. (Click all that apply).		
Answer Options	**Response Percent**	**Response Count**
No need or interest	14.40%	43
Not familiar with GIS	41.90%	125
Does not fit in the curriculum	39.30%	117
Limited hardware	21.10%	63
Limited software	25.80%	77
Limited budget	29.90%	89
Limited GIS training	37.90%	113
Limited instructional time	26.20%	78
No classroom computer	7.00%	21
No local data	2.70%	8
Lack of GIS lesson plans	31.20%	93
Lack of time to plan lessons	28.20%	84
Other (please specify)	12.40%	37
	answered question	298
	skipped question	64

Q21. Rate the following constraints on the use of technology in your classroom, including the use of GIS.							
Answer Options	**Strongly disagree**	**Somewhat disagree**	**Neither agree nor disagree**	**Somewhat agree**	**Strongly agree**	**Rating Average**	**Response Count**
I have no need or interest in GIS.	56	53	122	45	22	2.74	298
I am not familiar with GIS.	29	62	28	60	119	3.6	298
I have limited hardware availability.	29	42	66	91	70	3.44	298
I have limited software availability.	19	27	71	92	89	3.69	298
I have a limited budget.	15	14	54	79	136	4.03	298
There is limited GIS training available.	12	15	105	71	95	3.74	298
There is limited technology training available.	27	55	91	80	45	3.2	298
I have limited instructional time.	11	26	49	121	91	3.86	298
There is a lack of GIS lesson plans.	6	8	127	79	78	3.72	298
I have a lack of time to plan lessons.	19	33	76	93	77	3.59	298
					answered question		298
					skipped question		64

Q22. How did you first learn to use GIS? (Click all that apply).		
Answer Options	**Response Percent**	**Response Count**
Teacher in-service day	23.90%	11
I trained myself	47.80%	22
At a conference	23.90%	11
By another teacher	23.90%	11
Via the Internet	13.00%	6
An undergraduate or graduate course in GIS	8.70%	4
By a GIS user outside of the educational community	6.50%	3
TUGIS Conference	4.30%	2
National Science Teachers Association	4.30%	2
National Council for Geographic Education	2.20%	1
Other (please specify)	23.90%	11
	answered question	46
	skipped question	316

Q23. How many total hours have you spent in formal GIS training classes?		
Answer Options	**Response Percent**	**Response Count**
None	47.80%	22
1 - 19	34.80%	16
20 - 39	6.50%	3
40 - 59	4.30%	2
60 - 79	4.30%	2
80 or more	2.20%	1
	answered question	46
	skipped question	316

Q24. How useful were the following in terms of helping you learn GIS?					
Answer Options	**None**	**Some**	**Very Much**	**Rating Average**	**Response Count**
Another teacher	12	12	22	2.22	46
Internet	19	18	9	1.78	46
College courses	39	4	3	1.22	46
Books, magazines, newspapers	32	11	3	1.37	46
Curriculum materials	31	12	3	1.39	46
Conferences	24	14	8	1.65	46
				answered question	46
				skipped question	316

Q25. Are you able to use GIS on your own?		
Answer Options	**Response Percent**	**Response Count**
Yes	78.30%	36
No	21.70%	10
	answered question	46
	skipped question	316

Q26. In which grade level(s) do you use GIS? (Click all that apply).		
Answer Options	**Response Percent**	**Response Count**
Grade 6	16.30%	7
Grade 7	23.30%	10
Grade 8	4.70%	2
Grade 9	16.30%	7
Grade 10	18.60%	8
Grade 11	46.50%	20
Grade 12	44.20%	19
Other (please specify)	7.00%	3
	answered question	43
	skipped question	319

Q27. What type(s)/brand(s) of GIS or related software are you using?		
Answer Options	**Response Percent**	**Response Count**
ArcView	39.50%	17
ArcExplorer	4.70%	2
GPS Units / software	39.50%	17
MyWorld	9.30%	4
CAD	0.00%	0
ArcInfo	0.00%	0
ArcEditor	0.00%	0
Web-based Mapping Application	27.90%	12
ArcVoyager	11.60%	5
Other (please specify)	25.60%	11
	answered question	43
	skipped question	319

Q28. When did you obtain your first copy of GIS or related software?		
Answer Options	**Response Percent**	**Response Count**
Before 1995	2.30%	1
1995 - 2000	16.30%	7
2000 - 2005	32.60%	14
2005 - present	23.30%	10
I do not remember	18.60%	8
I don't know - the software was already at my school	7.00%	3
	answered question	43
	skipped question	319

Q29. When did you begin using GIS in your classroom?		
Answer Options	**Response Percent**	**Response Count**
Before 1995	2.30%	1
1995 - 2000	14.00%	6
2000 - 2005	32.60%	14
2005 - present	46.50%	20
I don't know	4.70%	2
	answered question	43
	skipped question	319

Q30. Which choice best describes your use of GIS in your classroom this year?		
Answer Options	**Response Percent**	**Response Count**
I do not use GIS at this time and have no plans to do so	4.70%	2
I am planning to use GIS	2.30%	1
I demonstrate GIS on a computer	20.90%	9
I prepare lesson materials using a GIS	4.70%	2
I use GIS in one lesson in one class	9.30%	4
I use GIS in one lesson in more than one class	9.30%	4
I use GIS in more than one lesson in one class	14.00%	6
I use GIS in more than one lesson in more than one class	34.90%	15
	answered question	43
	skipped question	319

Q31. How many teachers at your school are using GIS, including yourself?		
Answer Options	**Response Percent**	**Response Count**
None	9.30%	4
1 teacher	25.60%	11
2 teachers	9.30%	4
3 teachers	16.30%	7
More than 3 teachers	7.00%	3
I am not sure	32.60%	14
	answered question	43
	skipped question	319

Q32. How many hours per week are you spending, on average, outside of class time on GIS?		
Answer Options	**Response Percent**	**Response Count**
None	60.50%	26
1	25.60%	11
2	9.30%	4
3	2.30%	1
4	0.00%	0
5 or more	2.30%	1
	answered question	43
	skipped question	319

Q33. What digital geographic data do you use with the GIS or related software (i.e., Imagery, Census data, Digital Elevation Model)? Please describe.
Responses:
Baltimore County Government-supplied information
All of these that you list...
Imagery,
Elevation mostly
census data, Chesapeake Bay
Imagery
All kinds.
We looked at watershed data and flood data for an ecological project around our school
mostly imagery for the student understanding
GPS Chesapeake watershed
Imagery, Google earth, some census data(population by county, by year)

Satellite images from NOAA, other .gov sites. Last fall satellite images were published of the arctic ice cap. I had the kids use Image to define a scale, outline the ice cap, and compare the areas on the two images. I've used a Google Hybrid map of the campus to have the student's measure areas of the campus (tree covered, permeable, and impermeable surfaces.) I've used contour maps of the campus from MapCard for physics problems. How long is the cross country course? What is the elevation of a building on campus? How much energy is required to walk from one building to another. A car coasts down Falls road from the top of the hill; what is its speed at the bottom, etc.
The workshop that I attended taught us to use the My World program to graph stream data and determine stream health (iGIS).
imagery, census data, dems, county data, state data, USGS data, EPA BASINS data, Chesapeake Bay from Space data, and any other source I can find
imagery and demographic/census data
I DON'T KNOW WHAT GIS IS SO THESE QUESTIONS DON'T RELATE TO ME :)
Canned programs for the most part that were installed with the software.
elevation topographic mapping
Digital Elevation
I just let the system do its thing.
Imagery
don't know
Use census data for students to see growth patterns and elevation models to show geographical concepts such as human interaction with the land, etc.
don't know
none
Imagery and Census data
none
demographic data, imagery, mapping gps points
digital elevation, location of habitats
Aerial Images, ArcMap to create maps and make measurements concerning land use, Studying watersheds, Data about blue crab distribution to study life cycle
Many of my GIS lessons have been prepared by my college instructor or from workshops so they have the data layers already available. We use County data, state bioassessment, land cover, impervious surface data, aerial imagery.
none
Harford County GIS data base - ESRI Data & Maps that came with 9.0 - MD DNR MAMMS data on stream chemistry and biological indices - some census data - Some Environmental Health Data from MPT/JHU Bloomberg School of Public Health EnviroHealth Connections Summer Institute

I really want to learn this. I use Census Data from the US Census Bureau. I try to show students GIS type of information using Google Earth. I need more direction and help.
Maryland biological stream survey, Mapping and monitoring Maryland streams MDNR- digital imagery
population density, population movement, population change over time
Use the county's website to demonstrate the different layers.
Chesapeake bay grass populations
Google earth
??
We use landsat images, land cover maps, census data street maps, county maps, watershed data. We use data that ESRI includes with their software, data from Martin Shmits MD geodata Cd and data gathered by the people at MAMMS.
Harford County Govt GIS data
imagery and census data

answered question 43
skipped question 319

Q34. Which of the following do you consider as constraints to your use of GIS in your classes? (Click all that apply).		
Answer Options	**Response Percent**	**Response Count**
Limited hardware	34.90%	15
Limited software	27.90%	12
Limited budget	25.60%	11
Limited GIS training	51.20%	22
Limited instructional time	41.90%	18
No classroom computer	11.60%	5
Lack of GIS lesson plans	32.60%	14
Lack of time to plan lessons	51.20%	22
Other (please specify)	18.60%	8

answered question 43
skipped question 319

Q35. Does your school have a technical support staff member?		
Answer Options	**Response Percent**	**Response Count**
Yes	89.30%	302
No	7.40%	25
I am the technical staff member	3.30%	11
	answered question	338
	skipped question	24

Q36. How much support do you receive from the technical support staff member for technology use in the classroom?		
Answer Options	**Response Percent**	**Response Count**
No support for technology use	3.90%	12
Little support for technology use	24.50%	76
Some support for technology use	44.80%	139
Much support for technology use	26.80%	83
	answered question	310
	skipped question	52

Q37. How much support do you receive from the technical support staff member for GIS?		
Answer Options	**Response Percent**	**Response Count**
No support for GIS	91.10%	275
Little support for GIS	6.00%	18
Some support for GIS	2.30%	7
Much support for GIS	0.70%	2
	answered question	302
	skipped question	60

Q38. How much support and/or encouragement do you receive from your administrators for your use of GIS?		
Answer Options	**Response Percent**	**Response Count**
No support for GIS	78.20%	233
Little support for GIS	12.40%	37
Some support for GIS	6.40%	19
Much support for GIS	3.00%	9
	answered question	298
	skipped question	64

Q39. How much does your use of GIS result in these benefits?						
Answer Options	**Never**	**Almost Never**	**Neutral**	**Almost Always**	**Always**	**Mode**
Enhances Learning	0	0	2	21	6	4
Provides exploratory tool for data analysis	1	0	7	15	6	4
Offers team learning environment	2	0	13	14	0	4
Provides real-world relevance to subject	1	0	3	15	10	4
Provides integration of different subjects	2	2	10	10	5	4
Enhances motivation and student interest	0	0	3	17	9	4
Helps teach national, state, or district standards	6	2	13	6	2	3
Provides employment skills	4	1	16	5	3	3
Provides opportunities to partner with the community	5	3	10	9	1	3
				answered question	33	
				skipped question	329	

Q40. How much is your use of GIS hindered by the following constraints?						
Answer Options	**Never**	**Almost never**	**Neutral**	**Almost always**	**Always**	**Mode**
Lack of time to develop lessons incorporating GIS	2	3	7	8	10	5
Cost of hardware and software	4	1	10	9	6	3
Computers not accessible to my students	7	5	7	7	4	3
Computers not capable of handling GIS	4	7	13	3	3	3
Little administrative support for training	2	3	18	3	4	3
Class periods too short to work on GIS-based projects	5	5	15	2	3	3
Lack of useful or usable data	5	6	13	5	1	3
Lack of geographic skills among students	2	5	12	10	1	3
Variable skill levels among students	2	4	14	7	3	3
Does not fit in the curriculum	7	6	10	6	1	3
Complexity of software	3	7	12	6	2	3
				answered question	30	
				skipped question	332	

Q41. Please rate the following barriers in the use of GIS in the classroom, where 1 = Most hindering and 4 = Least hindering.					
Answer Options	**Most Hindering (1)**	**→2**	**→3**	**Least Hindering (4)**	**Mode**
Technology understanding and availability	**126**	20	31	57	1
GIS lesson plan availability	**75**	69	66	54	1
Time constraints for planning	**84**	74	47	59	1
Teacher education/training opportunities	77	**88**	57	43	2

answered question	274
skipped question	88

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