North, South, East, West: Could You Pass a Spatial Test?

A Study of Six Elementary Classrooms

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Chapter 1: Introduction
“I like geography. I like to know where places are.”- Tom Felton (a British actor who played a lead role in the Harry Potter films). Although the students did not have geography classes at Hogwarts, Draco Malfoy still took an interest. Maybe he was part of the Muggle world all along. Unlike the United States, public schools in the United Kingdom incorporate geography as a distinct discipline in the secondary school curriculum. This gives students interested in pursuing geographic careers a distinct advantage over their counterparts in other countries. A contrasting example can be found in the much less developed nation of the Philippines, and in many other countries throughout the world. In these places geography is either taught as a core subject or it is intertwined with other courses.

**United Kingdom**

According to the Royal Geographical Society and Institute of British Geographers (2013), some countries, like England, introduce geography classes when students enter school, typically around the age of five. Early geography classes begin with basic material. As children learn to think spatially and begin to understand some of the underlying concepts of the subject, the material gets increasingly sophisticated and more complex concepts are introduced.

In England, the National Curriculum is compiled by the Department of Education and Employment. The Curriculum includes three key stages of learning goals. Students in stage one learn about geographical descriptions and the importance of fieldwork. In stage two, students learn about thematic studies. In stage three, students study topics such as geographical methodology and developmental studies (Royal Geographical Society and Institute of British Geographers 2013). As of 2012, the number of students in the U.K. studying geography in secondary education reached 187,000, making it the ninth most popular subject. From 2011 to
2012, students opting to take a class in geography increased by 3.5 percent. When students graduate high school in the U.K., they have a much stronger foundation in geography than students schooled in the United States. Over the course of their secondary education, British students have approximately nine years of geographic education.

The QS World University Ranking (2013) identifies the top universities in the world for specific disciplines depending on number of citations and reputations. According to this ranking, nineteen U.K. universities are within the top fifty for geography, with the University of Oxford ranked as number one. The United States has eight of their universities within the top fifty for geography, with the University of California-Berkeley ranked as number four. It is not surprising the U.K. is ranked higher than the U.S. due to their extensive geographic education program.

In the U.K., geographical knowledge is highly valued in the secondary education system, universities, and the workplace. At the university level more than eighty institutions in the U.K. offer degrees pertaining to geography, and more than 30,000 students are studying geography at universities in the U.K. According to the Royal Geographical Society (2013), geography graduates are far more likely to be employed compared to their peers. In 2012, a survey was conducted by the Higher Education Career Services Unit and Jane Howie (2013) to determine what geography students in the U.K. do after their graduation. In total, 2,105 out of 2,565 U.K. geography graduates responded to the survey. Six months after graduation, 45 percent of U.K. graduates surveyed are employed with full-time geography jobs in the United Kingdom. Of the surveyed graduates, 19.7 percent are engaged in further study, training or research showing promise for a future career.
Philippines

In the Philippines, the Commission on Higher Education (CHED) works in close contact with the country’s president. The administration staff for CHED includes a chairman and four commissioners each serving four year terms. CHED is divided into three sections, each section focusing on different levels of education. The sections include: tertiary, graduate, basic, and technical education. The Department of Education is classified as basic education which includes elementary, middle and high school students.

The Department of Education is responsible for creating and improving programs to meet the needs of Filipino students. In 2002, a study conducted by CHED stated Filipino students’ abilities involving literacy were lacking. Students were not attaining functional literacy, meaning they struggled with various topics including making critical and informed decisions, linguistic fluency, competence and cognitive skills. The Commission on Higher Education recommended to members of the Department of Education that the school day and national curriculum be restructured. The proposal was accepted the same year (Lopez 2008). The new school day would consist of fewer classes and more time focused on five core subjects: math, English, Filipino, science, and Makabaya, a group of subject areas that includes music, art, social studies, and home economics (Commission on Higher Education).

The new Filipino curriculum known as the revised Basic Education Curriculum, or BEC, incorporates Makabayan in a 100 to 200 minute period. With the development of the BEC, core classes no longer had their own time slots and each was designated to share time with other subjects. Initially geography was taught for an average of seventy minutes each day during the learning area, Civics and Culture. Due to the new curriculum, geography began competing for
minimal class time during Makabayan. Like the United States, the Philippines intertwine geography with other core subjects including social studies (within Makabaya).

The struggling education system in the Philippines is a reflection of the government’s lack of resources and finances. In 2004, the Philippines spent only 3.5 percent of its gross domestic product on education compared to 7.9 percent in Malaysia (Lopez 2008). Malaysia is currently a middle income country looking to achieve a high income status within the next eight years. Due to the exports of various resources including gas, oil and rubber to other countries the economy is very profitable. The financial situation in Malaysia allows for more money to be spent on education, meaning fewer students per class and ample supplies for classrooms (Central Intelligence Agency 2013).

In contrast, Filipino teachers are unable to afford new books and materials to update their lessons. This can lead to obsolete and possibly erroneous information being taught to their students. Currently sixth grade students and teachers use a single text entitled: Pilipino Ako, Pilipinas Ang Bayan Ko. The textbook was first published in 1999 and has yet to be updated, meaning students are being taught potentially incorrect and irrelevant material. The average classroom size is between fifty to sixty school children with an average of one text book for every six students. Many teachers are unable to effectively teach geographic concepts due to lack of materials such as maps and globes (Lopez 2008).

In a study conducted by students of the University of the Philippines, sixth grade students from three different Filipino schools were required to take a test involving geographic concepts they learned in first and second grade. The test was divided into five topics that include: knowledge of the Earth, oceans and continents, map directions, landforms, water
bodies, and map grids. The purpose of the test was to determine the ability of students at each institution (private or public). Public school students scored an average of forty-one out of fifty and students in private schools scored an average of forty-five out of fifty. (Lopez 2008). The varying scores could be due to any number of factors, specifically the wealth of a private school in comparison to a public school. By having more money, private schools provide current resources and have more staff leading to for smaller class sizes.

**United States of America**

In November 1988, the Council of Chief State School Officers surveyed forty-one U.S. states’ and territories’ education departments about their requirements for geographic education. Every state indicated instruction in geography is required in elementary schools (Haas 1989). When asked how geographic education could be improved, teachers responded overwhelmingly that new curricula and increased opportunities for teacher workshops were imperative for geographic education’s success. Nationally, teacher workshops would include bringing together geographic resources, teachers and professional geographers in order to provide accurate geographic instruction. At the state level, teacher workshops would include bringing together state departments of education, private corporations, state geographic alliances and the National Geographic Society to improve teachers’ geographic knowledge on a more one-on-one basis (Haas 1989).

The Geography for Life standards were first introduced in 1994 and revised in 2012. The standards are implemented to varying degrees across the nation and include specific guidelines for every grade level. The Association of American Geographers (AAG), the National Council for Geographic Education (NCGE), the American Geographical Society (AGS), and the National
Geographic Society worked together to create these nationally recognized standards. According to Geography for Life, Second Edition (2012), “the goal of teaching geography is [to] equip students with the knowledge, skills, and perspectives to ‘do’ geography. Reaching this goal requires that students learn how to use geographic thinking and information to make well-reasoned decisions and to solve personal and community problems...Geography connects students to world events, problems, and decisions throughout their lives.”

The U.S. does not have a geography class requirement for middle or high school. American schools teach geography as part of their social studies or science curriculum. Often there is not ample time within a school day for extra activities aside from mathematics, reading, writing, science, and social studies. All teachers, geographically trained or not, provide students with knowledge regarding various locations, weather and history, which are important aspects of geography.

In order to become a teacher in New Hampshire, candidates are required to have a Bachelor’s Degree in Education as well as a New Hampshire teacher certification. Teachers are required to show skills and knowledge on material they will be teaching to students at varying grade levels (Appendix A). Although educators are not required to have official training on teaching geography, geographic concepts are expected to be taught to students within the social studies curriculum. In New Hampshire, elementary educators are required to have knowledge of world geography which includes its effects on physical, political, economic and human systems. Unless educators have taken courses in geography at the college level or majored in the topic they do not have formal training in geography. Instead, they read the textbook provided, just as their students do.
Students in the U.S. take the National Assessment of Educational Progress (NAEP) test in fourth, eighth, and twelfth grade. The results shown in the Nation’s Report Card are derived from samples of the population who completed the NAEP test. Ten assessment topics have been conducted periodically since 1969. NAEP is run by the National Center for Education Statistics (NCES) which is part of the U.S. Department of Education. According to the U.S. Department of Education (2010), the results of the Nation’s 2010 Report Card reveals U.S. students are lacking an understanding of geographic concepts. “Only 23 percent of fourth-graders, 30 percent of eighth-graders and 21 percent of twelfth-graders knew enough to be considered ‘proficient’ or ‘advanced’ on the national exam” (Banchero 2011, 1). ‘Proficient’ means students have a solid understanding of challenging material and performed well academically, while ‘advanced’ means students gave a superior academic performance.

Some educators and administrators believe these low test scores are partly due to students’ fascination and obsession with technology. Educators also blame the exclusion or minimal usage of social sciences during the school day (Banchero 2011). According to the NAEP test results, one portion that many students struggled with is map reading skills. Today, many students listen to a GPS receiver recite instructions rather than reading an atlas or map. A GPS is a form of voice navigation which provides drivers with precise step by step instructions to a specified destination without having to look at a map, although one is usually provided.
National Geographic

Geographic education is minimal not only in the United States but in numerous countries throughout the world. Each year National Geographic produces three magazines for varying ages including: National Geographic Little Kids, National Geographic Kids and National Geographic Traveler. Having various magazines allows everyone to experience geographic concepts regardless of age. Not only is National Geographic a magazine publisher, but a prominent resource teachers use throughout the United States. Their website provides teachers with geographic lesson plans and videos to aide in educational activities. National Geographic is known for promoting events such as Geographic Awareness Week (GAW) and the National Geography Bee to stimulate students and teachers interest in the subject.

Giant Map

Every year National Geographic rents a variety of giant educational floor maps to participating K-8 schools and libraries throughout the country. The giant map provides an interactive learning space for children to explore a continent illustrated with the familiar cartographic design elements of National Geographic. In 2011, National Geographic deployed ten maps to various locations in the U.S.: three maps of Africa, three of Asia and four of North America. As of 2013, different maps have been added to the collection allowing the maps to alternate each year. Current maps include: South America, Africa, Asia, Europe, the Pacific Ocean and North America. Schools and libraries can request a specific continent or the Pacific Ocean for their use. In 2013, the continental map sent to New Hampshire was South America.
Study

Our study involves exploring students’ spatial abilities using the giant map. Use of the giant map was divided into three parts: a pre-test, an activity and a post-test. For our study we worked with fifth and sixth grade students within School Administrative Unit 29. The schools included in the study were Fuller Elementary in Keene, New Hampshire, Marlborough Elementary in Marlborough, New Hampshire and Nelson Elementary in Nelson, New Hampshire. Fuller Elementary is a K-5 school where we worked with their three fifth-grade classes. Marlborough Elementary is a K-8 school where we worked with one fifth-grade class and one sixth-grade class. Nelson Elementary is a K-6 school where we worked with their combined fifth/sixth grade class.

![Map of Keene, Nelson, and Marlborough with a New Hampshire inset.](image)
Demographics

Marlborough and Nelson do not have a public preschool program. The Marlborough Elementary School is K-8 meaning they do not have a separate middle school. Nelson students go to Keene Middle and High School starting in seventh grade. Marlborough students go to Keene High School starting in ninth grade. Keene High School’s total school enrollment is comprised of students from the towns of Keene, Marlborough, Nelson, Chesterfield, Harrisville, Westmoreland, Marlow and Surry.

Table 1 School Enrollment 2010-2011.

<table>
<thead>
<tr>
<th>Town</th>
<th>Preschool</th>
<th>Kindergarten</th>
<th>Elementary</th>
<th>Middle</th>
<th>High</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keene</td>
<td>70</td>
<td>204</td>
<td>968</td>
<td>595</td>
<td>1,558</td>
<td>3,395</td>
</tr>
<tr>
<td>Marlborough</td>
<td>0</td>
<td>15</td>
<td>180</td>
<td>0</td>
<td>0</td>
<td>195</td>
</tr>
<tr>
<td>Nelson</td>
<td>0</td>
<td>1</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>25</td>
</tr>
</tbody>
</table>

The New Hampshire Department of Education (2006) Rule “Ed 306.17” specifies a maximum allowable class size of 25 for grades 1 and 2, and 30 for higher grades. In 2011, there were no class sizes that exceeded the maximum allotted number of students. There was a wide range of class sizes within each school due to the population of the towns.

Table 2 Average Class Size by School in Public Elementary Schools, October 2011.

<table>
<thead>
<tr>
<th>Town</th>
<th>School</th>
<th>Grades 1 and 2</th>
<th>Grades 3 and 4</th>
<th>Grades 5 and 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keene</td>
<td>Franklin</td>
<td>15.8</td>
<td>17.8</td>
<td>18.5</td>
</tr>
<tr>
<td>Keene</td>
<td>Fuller</td>
<td>16.3</td>
<td>17.5</td>
<td>26.5</td>
</tr>
<tr>
<td>Keene</td>
<td>Jonathan M. Daniels</td>
<td>14</td>
<td>16</td>
<td>14.5</td>
</tr>
<tr>
<td>Keene</td>
<td>Symonds</td>
<td>18.7</td>
<td>17.5</td>
<td>16.7</td>
</tr>
<tr>
<td>Keene</td>
<td>Wheelock</td>
<td>16.7</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Marlborough</td>
<td>Marlborough</td>
<td>14.7</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>Nelson</td>
<td>Nelson</td>
<td>7.5</td>
<td>4</td>
<td>14</td>
</tr>
</tbody>
</table>
With a population of 23,476 as of 2012, Keene is a relatively large city in southwestern New Hampshire. It is the eleventh largest city in New Hampshire out of 234 towns (New Hampshire Employment Security 2012).

When broken down by age group, the demographics of Keene’s population (Figure 2) show that the largest sub-population group is between the ages of twenty and thirty-four. This is most likely because of the resident population of Keene State College. Due to the relatively large number of jobs in Keene compared to surrounding areas, many Keene residents work within the city limits. On average, Keene residents travel 5.8 minutes to work each day. The four largest employers in Keene could employ more than one-sixth of Keene’s population (Table
The median household income was $48,441 in 2011. In 2011, 7.2 percent of the city’s families lived below the poverty level (New Hampshire Employment Security 2012).

Table 3 Largest Employers in Keene, New Hampshire.

<table>
<thead>
<tr>
<th>BUSINESS NAME</th>
<th>EMPLOYEES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheshire Medical Center/Dartmouth Hitchcock Clinic-Keene Health Care Services</td>
<td>1,457</td>
</tr>
<tr>
<td>Keene State College Education</td>
<td>929</td>
</tr>
<tr>
<td>C &amp; S Wholesale Grocers Wholesale Foods</td>
<td>900</td>
</tr>
<tr>
<td>Keene School District Education</td>
<td>775</td>
</tr>
</tbody>
</table>

When comparing Keene to Marlborough and Nelson, the median household income is lower. This is most likely because many residents of Keene are recent graduates or still attending school and living in apartments with roommates. Many recent graduates settle on part-time jobs until they find full-time salaried jobs causing their household income to be lower. Also, with Keene being larger in population than Marlborough and Nelson, those with lower incomes may be more likely to live in Keene where rental properties are more abundant and many places can be accessed on foot, bike or by using the Keene City Express bus system. Keene also has many recreation areas, attractions and events that draw members of the Cheshire County community to the city every day. Some of these include: the YMCA facility, golf courses, bowling, youth sports, campgrounds, trails and theatres (New Hampshire Employment Security 2012).

To accommodate the youth and young adults of Keene, there are five public elementary schools, one middle school and one high school. Within city limits there are also four private and parochial schools. As we were interested in working with fifth grade students, we needed to identify classrooms in one of Keene’s elementary schools. We decided to work with Fuller
Elementary, as one of the authors of the study served there in 2012 as a student teacher, and the school draws students from a broad range of economic backgrounds. Currently Fuller Elementary serves 300 students ("Fuller Elementary School" 2013). We worked with three fifth grade classes at Fuller Elementary with a total of forty-nine students. The minimum starting teacher salary in Keene for 2010-2011 is $35,000 compared to New Hampshire’s average minimum salary with a bachelor’s degree, $33,603 (New Hampshire Department of Education 2006).

**Marlborough**

With a population of 2,057 as of 2012, Marlborough is a small town in comparison to others in New Hampshire. Although Marlborough is small, it does have a lively downtown area with small businesses, parks, youth sports, and many outdoor activities available throughout the year. In population it ranks 140th out of 234 New Hampshire towns (New Hampshire Employment Security 2012a). When broken down by age group, the demographics of Marlborough’s population (Figure 3) show that the largest sub-population group is between the ages of thirty-five and fifty-five.
Due to the many opportunities for jobs outside the town of Marlborough, many residents commute to larger, neighboring towns such as Peterborough to the east and Keene or Swanzey to the west. On average, Marlborough residents travel 18.6 minutes to work each day. The four largest employers in Marlborough could only employ around one-fifteenth of Marlborough’s population (Table 2). The current median household income was $60,500 in 2011. In 2011, 0.8 percent of the town’s families lived below the poverty level (New Hampshire Employment Security 2012a).

Table 4 Largest Employers in Marlborough, New Hampshire.

<table>
<thead>
<tr>
<th>Largest Businesses Product/Service Employees Established</th>
<th>Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mountain Industries</td>
<td>100</td>
</tr>
<tr>
<td>American Construction</td>
<td>15</td>
</tr>
<tr>
<td>Marlborough Country Convenience</td>
<td>10</td>
</tr>
<tr>
<td>Classic Car Parts</td>
<td>10</td>
</tr>
</tbody>
</table>
This is much lower than the percentage of families living below the poverty line in Keene or Nelson. We believe the median household income is higher than the city of Keene because a higher percentage of residents are between the ages of thirty-five and fifty-five. Due to their age, these residents have likely been out of school for at least ten years. This gives residents time to gain income and work their way up in their jobs achieving a higher salary than when they had first finished their schooling.

Children are provided an education at Marlborough Elementary School, which serves 183 students ranging from K-8. High school students go to school in the neighboring city of Keene. During our exercise we worked with a fifth and a sixth grade class at Marlborough Elementary. Ten fifth grade students and twenty-two sixth grade students participated in our activity. The minimum starting teacher salary in Marlborough for 2010-2011 is $35,347 (New Hampshire Department of Education 2006).

**Nelson**

With a population of 834 as of 2012, Nelson is a very small town in comparison to others in New Hampshire. In population it ranks 206th out of 234 New Hampshire towns (New Hampshire Employment Security 2012b). When broken down by age, the demographics of Nelson’s population (Figure 4) show that the largest sub-population is between the ages of thirty-five and fifty-four. The median household income was $63,558 in 2011. In 2011, 11 percent of the town’s families lived below the poverty level (New Hampshire Employment Security 2012b).
There are no businesses in Nelson that employ a substantial amount of people. Therefore, like residents of Marlborough, this means many residents of Nelson commute to larger, neighboring towns, Peterborough to the southeast and Keene or Swanzey to the southwest, where they have many options for jobs. On average, Nelson residents travel 27.4 minutes to work each day (New Hampshire Employment Security 2012b).

Children are provided their elementary education at Nelson Elementary School which serves forty-four students from kindergarten to sixth grade. From seventh to twelfth grade, Nelson students attend school in the city of Keene. “Traditionally, Nelson students in Keene Middle and High School have done well academically, outperforming students from other elementary schools” ("Nelson Elementary School" 2013). Nelson’s academic performance led to its designation as one of three Blue Ribbon Schools in New Hampshire.
shows dramatic changes in student achievement as well as being academically superior to other schools within the state; these schools are chosen each year by the Department of Education.

Nelson is currently a Blue Ribbon School due to having at least forty percent of students from disadvantaged backgrounds making large strides on state tests; some students achieve scores within the top ten percent ("Nelson Elementary School" 2013). A combined class of fifth and sixth graders totaling nine students participated in our research project. The minimum starting teacher salary in Nelson for 2010-2011 is $39,300 (New Hampshire Department of Education 2006).

Although schools throughout the world are lacking in geographic education, strides are being made. Schools in the United Kingdom have shown an increasing interest in geography at secondary grade levels through college. American schools are required to teach geography as a single discipline or with social studies material. The United States has implemented geographic material into the Common Core, requiring educators to teach geography through content areas such as English or language arts. Teachers may also reference the text Geography for Life for additional information on standards and topics regarding geography.
Chapter 2:
Literature Review
Introduction to the *Geography for Life Standards*

Throughout the United States, education is managed by individual states therefore there is not one commonly used curriculum for geography. In 1994, National Geographic wrote *Geography for Life* in order to provide teachers with classroom strategies as well as geography standards achievable for each grade level (Hurt 1997). According to Solem, Foote, and Monk (2013), “*Geography for Life* identifies content standards that articulate what students should know and be able to do at a range of grade levels. The standards serve as a guide to teachers, curriculum developers at state and local levels, textbook and instructional material publishers, and assessment developers” (150). The *Geography for Life: National Geography Standards* is used to some degree by educators when geography is taught, but it is not required by all states. Since geography is not a required topic of study in most K-12 settings, students in the U.S are rated some of the least knowledgeable worldwide when speaking about geography (Golledge, Marsh, and Battersby 2008). The National Council for Geographic Education (NCGE) publishes an academic journal, the *Journal of Geography*, as well as a periodic journal focused on K-12 teaching methods entitled *The Geography Teacher*. If teachers are interested in teaching geography but, for whatever reason, are not able to use the *Geography for Life: National Geography Standards*, they could also look to *The Geography Teacher* for supportive methods to help integrate into their everyday schedule.

Even though *Geography for Life* was written nearly twenty years ago, geography is still not part of the core curriculum in United States classrooms. Schools across the nation focus their curricula on four core subjects: math, English, social studies and science. Although geography is not a specific category within the curriculum, it is often intertwined with social
studies and science at the elementary level. It is not uncommon for elementary teachers to have no training in the field of geography (Catling 2000). In most cases geography is introduced to students between the ages of ten and eleven in those schools where they can elect to take a geography class. Without exposure to geography in elementary school, students would be less interested in the subject later in their education. A majority of secondary age students (fourteen-eighteen year olds), when faced with the opportunity, do not take additional geography classes (Catling 2000). If geography were one of the four main components of the curriculum, teachers would be required to teach students information regarding the topic for a specific amount of time each day.

**Teaching Geography**

The goals of a geographic education include “informing and helping pupils appreciate the world around them so that they develop a strong sense of responsibility, concern and commitment to a just world and to environmental protection and improvement” (Catling 2000, 869). Although geography is not taught in United States schools on a regular basis, students are interacting with material involving the subject every day. At the ages of five and six, students interact with the environment through hands on activities, reading material, as well as looking at pictures. Students also begin to tell stories about places they have been, people they have met and their own experiences. By the age of eleven, students are expected to be able to use maps and globes to identify places, compare and contrast ideas relating to geography, describe basic human and natural processes and the diversity of different locations throughout the world. As they progress through school, students are expected to make inferences, analyze, discuss, explain, and reference areas of geography (Catling 2000).
When students are taught geography, they are often engaged in active learning and investigations. It is important when teaching geography that the investigations are conducted by following the inquiry process of “collecting, organizing, and analyzing data” (Solem, Foote, and Monk 2013, 148). Geography teachers should use the inquiry process when conducting fieldwork with students. Fieldwork provides students with visual context about the material as well as experience with data collection. Secondary sources present students with an opportunity to view geography in various ways. This information builds upon prior knowledge and further develops geographic thinking. “The examination of secondary sources of information, such as maps, satellite photographs, census data, geographic information systems, reports and summaries, provides pupils with experience in using a range of techniques to read and interpret such sources” (Catling 2000, 872). As a student’s education progresses, they develop more knowledge as well as experience. With a higher degree of knowledge and experience students do not need as much assistance from the teacher; their assigned tasks can be done independently and be based on their own investigation.

One of the biggest issues in teaching geography for elementary teachers is finding time for it within the curriculum (Hume and Boehm 2001). Since there is not usually a set time for a geography class, there is a “competition for class time...with geography often losing out to history, civics, and even economics” (Hume and Boehm 2001). When teachers are not given a subject as a core class, they have to find ways to integrate it into the core subjects of science, math, and reading. With teachers having to plan according to national standards, it is often difficult to integrate extra material. According to Curwood (2007), early elementary education now focuses more on math and reading skills instead of spatial thinking and reasoning. The
focus on discovery and learning by doing has been replaced by facts and figures. Without experimenting and reasoning, children are not learning about themselves and their communities (Curwood 2007).

Geography terms have to be defined and used in the classroom for students to comprehend, recognize, and use them in their own lives (Golledge, Marsh, and Battersby 2008a). When these terms are not used in the younger grades, students have a more difficult time comprehending harder geographic concepts as they age. Often, geography is not a required class until middle or high school. By then, students may not be interested or have much prior knowledge of the subject (Hume and Boehm 2001).

**Incorporating Geography in the Classroom**

According to Hinde et.al. (2011), when geography is integrated into other forms of curriculum (English, social studies, science), teachers have noticed positive effects on reading achievement. Also, “when teachers link new information to students’ prior knowledge, the topic has more interest to students, which in turn stimulates their interest in reading” (Hinde et al. 2011, 49). Research suggests geography and literacy skills are directly related. By having students read about various topics involving geography (people, places, and environments) they may discover a specific area within the discipline that they find interesting. Therefore geography has the ability to inspire an interest in reading among students (Hinde et al. 2011). Geographic issues can be discussed and understood through the use of children’s literature. Students have connections to the books they read, or that they have read to them, and can draw on that knowledge when discussing geography.
Education is about connections, and geography forms a connection with various disciplines. Geography is an interdisciplinary study that covers people, places, and environments (Wilson and Cook 2009). Interdisciplinary teaching helps students find correlation between the subjects they are studying. Wilson and Cook (2009) explain that social studies helps students connect to the world around them. Elementary teachers often try to connect subjects to each other in order to develop student knowledge. The more connections a child can make between subjects, the easier it will be for him or her to remember and use that knowledge in everyday situations.

**Use of Geography in the Classroom**

Hands-on lessons are important for students to gain knowledge because they require the use of fine motor and visual skills (Wilson and Cook 2009). According to Balci (2010), many teachers believe that knowledge is better formed while doing hands-on activities in the field. Field trips are also important for students to have experience observing and being a part of the world they live in. Geography is often thought of as “maps, memorization, and recitation”, but geography teachers are working to step away from that outdated notion of the discipline and show students the connections to their own world (McCall 2011, 132). Students can go outside and experience geography by walking in the woods or visiting a body of water, which can lead to an interest in geography.

Although McCall (2011) focused mainly on the use of maps in the classroom, many points are significant in other aspects of geography and social studies. Teachers should challenge students thinking and help them to look at the world in different ways (McCall 2011). Using maps or GIS technologies can allow students to view another aspect of geography they
may not be familiar with. The focus of geography in the classroom should be on location, place, human-environment interaction, movement, and regions (Hume and Boehm 2001). Since many students do not have a strong foundation in geography, it is important for them to be able to ask questions in a classroom that provides a judgment free setting. When students are allowed to ask questions, it helps them think through potential solutions. McCall (2011) writes that teachers need to provide a foundation of geographic learning for their elementary students to encourage them to be “well-minded citizens” (132).

**Difficulties Incorporating Geography in the Classroom**

One of the impediments with including geography as a part of elementary education is that schools focus on standardized tests that do not include social studies or geography (Knap 2011). Often, teachers will have to teach for the tests instead of about subjects that introduce students to the world. The teachers in charge of teaching geography need the proper training and education to teach material. However, they often lack the training and education which is needed to give students the education they deserve (Golledge, Marsh, and Battersby 2008).

Another issue is teachers do not have enough information about GIS and new geographic technologies (Bednarz and Bednarz 2004). Having geography workshops and teachers that are interested and have a background in geography can encourage the use of these tools. Also, for students to be successful in geography, the teachers “need to be proficient in using a wide range of geospatial technology tools” (Solem, Foote, and Monk 2013, 148). Unless teachers are trained to use these tools properly, they will struggle implementing the software in the classroom.
Schools throughout the nation value the state and national education standards. These standards provide guidelines and specific topics teachers must abide by during the school year. Geography is not listed within these state standards, but numerous other subjects are found on the list. Math and language arts (reading and literature) are the two prominent subjects within the national and state standards and are the subjects which students are expected to know the most about. This is because the United States is competing in a global marketplace and being outpaced by nations with students well trained in these areas.

**National Geography Standards**

The National Geographic Society helped to change the way geography is taught in schools by developing the National Geography Standards (Bednarz and Bednarz 2004). The standards are considered to be evolving since they must always incorporate new ideas. Teachers typically base their geography lessons on the State Geography Standards. The sections of the standards are “The World in Spatial Terms” which looks at maps and how to think spatially; “Places and Regions” refers to physical systems and how the earth is shaped; “Human Systems” covers cultural geography and how people interact with the earth around them; “Environment and Society” sets a basis for how people and the earth shape each other; and “The Uses of Geography” establishes how geography is looked at in the past, present, and future (National Geographic 2013). The purpose of setting standards for elementary geography is to keep teachers and students across the nation working on the same goals and objectives.
According to the National Science Foundation (2012), spatial thinking can be defined as “thinking that finds meaning in the shape, size, orientation, location, direction or trajectory, or objects, processes or phenomena, or the relative positions in space of multiple objects, processes or phenomena”. In everyday life, geospatial thinking is widespread, such as when estimating the size of a gap in moving traffic while driving, estimating proximity, safely walking around your house in the dark and recognizing shapes by touch (Golledge, Marsh, and Battersby 2008). A main part of thinking like a geographer is to think spatially. Every day we perform spatial tasks that are often not related to the large-scale environment. In fact, we perform them so often we give little to no attention to the fact that those tasks involve spatial thinking. According to Golledge, Marsh, and Battersby (2008), spatial thinking is used across a wide array of disciplines, including math, history, art, literature and the social sciences. According to Solem, Foote, and Monk (2013, 147), “Geography provides students with a spatial context for analyzing issues and developing modes of spatial thinking that complement the study of topics in many other fields, including math, science, technology, engineering, and social sciences”. There are many simple tasks that geographers frequently complete while thinking spatially, possibly without even knowing. Some of these tasks include comprehending scale transformations, comprehending orientation and direction, comprehending locations and places, and comprehending proximity and adjacency and their effects (Golledge 2002). By “engaging students in using data and formulating answers to questions regarding geography [they are exposed] to the geographical thinking and tasks that geographers employ in their own
research and work” allowing students to transfer their thoughts geographically (Solem, Foote, and Monk 2013, 150).

Recently, more and more people have been interested in spatial thinking, due in large part to the rapid expansion of geotechnologies, including the use of GPS receivers in cars (Kerski 2008). According to Kerski (2008), the interest could also be due to the National Research Council's 2005 report, Learning to Think Spatially—GIS as a Support System in the K-12 Curriculum, which suggests that spatial thinking be a part of K-12 curriculum because it encourages the use of problem-solving skills. The three elements of spatial thinking are space, representation and reasoning (Kerski 2008; National Research Council 2006). As a teacher in a K-12 setting, it is important to help students switch from everyday spatial thinking to a more informed type of spatial thinking where they understand what is happening, how it is happening, and why it is happening (Kerski 2008).

“Spatial thinking and reasoning...are central to geography and other geosciences” because geography focuses on viewing the earth in different ways (Golledge, Marsh, and Battersby 2008a). The way that students view objects and their recognition are both part of spatial thinking (National Science Foundation 2012). Some of the ways “spatial cognition can be revealed [are] by: solving problems...; performing tasks; being able to construct external representations of information...; by the effective use of spatial language to communicate; and by the ability to spatialise non-spatial data or information” (Golledge, Marsh, and Battersby 2008a).

According to Lee and Bednarz (2009), spatial thinking should be a part of the classroom throughout a person’s education. They also found spatial thinking is a constructive tool that
requires the knowledge of the nature of space, the methods of representing spatial information, and the processes of spatial reasoning (Lee and Bednarz 2009). They conducted a study on college students in geography departments in Korea and Texas. The authors wanted to see if there was a change in spatial thinking skills based on the courses students took. In the study, students took a pre and post-test, before and after taking geography classes related to Geographical Information Systems (GIS). They compared students who took various levels and courses and found that students who took both GIS classes and cartography classes at the same time score significantly better than students who only took one of the courses.

Spatial Reasoning

Knap (2011) analyzes material initially discussed by a Yale Researcher, Jonathan Wai about spatial reasoning in schools. According to Wai, educational systems throughout America do not value spatial reasoning nearly as much as math and verbal reasoning. Knap (2011) and Wai both agree that school systems do not support the idea of thinking spatially.

Knap (2011) believes there are three main reasons spatial reasoning is not apparent in classrooms. The first reason involves the teachers. He believes educators are most comfortable with teaching verbal and math reasoning, and therefore neglect other subject matter. His second reason is resources. School districts as well as teachers cannot afford to have specific tools or equipment for only minimal usage during the school year. If the specified subject matter is only taught once a year, a school does not find it fitting to invest in all of the necessary materials. It is common for a classroom to have only minimal resources such as paper, books and pencils. In contrast, “spatial reasoning requires hands-on learning, which requires more materials and ultimately more resources” (Knap 2011). The third reason behind
the lack of spatial thinking integration in classrooms involves time-consuming testing. Unlike standardized testing of math and verbal skills, spatial thinking requires the test of three-dimensional reasoning onto a two-dimensional surface (Knap 2011).

Lack of Spatial Thinking in Schools

Although researchers believe schools are distancing themselves from spatial thinking, one can ask if they truly are. If a student can properly navigate from point A to point B on a map, then they are thinking spatially. “For students who are not talented with words and numbers but who are talented with mentally rotating figures and shapes in their minds, there is often very little offered to recognize and challenge them in the regular school system” (Knap 2011). From an educator’s point of view, spatial reasoning is integrated into other coursework. In math class, students are not only using mathematical reasoning but spatial reasoning as well. When students use manipulatives such as tangrams, they are using various shapes in order to create a much larger shape. An example is how properly placing two trapezoids together will create a hexagon.

Even though the use of spatial thinking is not defined as subject matter within school districts it is still apparent within classrooms. If the use of spatial terminology is visible in classrooms, as well as students’ lives, they will be more likely to think spatially. Studies show that “children who hear and produce spatial language during various spatial-cognitive tasks often perform better on those tasks than those who do not receive or produce spatial language” (Pruden, Levine, and Huttenlocher 2013). An example is students who properly said the terms “left” and “right” are more likely to reorient themselves if they feel disoriented. Students who could not identify or pronounce these words will likely not reorient themselves if
they become lost. Overall, spatial language helps determine a child’s spatial skills (Pruden, Levine, and Huttenlocher 2013).

**Giant Maps’ Effect on Schools**

College students, especially education majors with an interest in geography can engage with elementary students on teaching and learning activities that promote and explore spatial thinking. For the past ten years, the University of Wisconsin-River Falls has had a very active geography department. Every year, the geography students paint a playground map of the United States at a local elementary school. Accompanying the map is a scale and north arrow. Upon request of the school district, an alternative map other than the United States may be produced, whether it is a specific state or a different continent.

The playground maps provide numerous benefits for elementary educators because they are not only used to have students identify states but also integrate spatial and geographic relationships. Petzold and Heppen (2005) provide educators with guidelines and examples on how to integrate the five themes of geography as well as the *Geography for Life* standards with the playground map. By having a large map at their school, students can relate geographic concepts including location, landmarks, and natural features to one another as well as measure distance, area and landscape.

Having a map on the playground also promotes geographic knowledge while allowing students to be active. Kinesthetic learners will retain information if they are able to move about and learn. These playground maps can help to reinforce knowledge learned by students in the classroom. The students can use the map to create and maintain spatial skills such as
orientation and location. While it is often an issue for teachers to find time to teach geography, the map can be used before or after school, during gym class, or during recess.
Chapter 3: Methodology
Determining Our Project Goals

Our goal for this research project was to assess the impact of a large, interactive map on the spatial thinking abilities of fifth and sixth grade students. Our research focuses on a giant map provided by National Geographic, which allows students to participate in map learning activities in a completely new way. Our hypothesis was the giant map activity would foster knowledge in students which would be demonstrated by their improved score on a spatial skills test. Our experiment began with a pre-test in the classroom, followed by an interactive spatial learning activity on the giant map. We tested students in Southwestern New Hampshire, specifically the towns of Keene, Nelson, and Marlborough.

Our coordinator, Dr. Lara Bryant, is part of the New Hampshire Geographic Alliance and works with National Geographic. National Geographic rents a giant educational map to schools and libraries around the country each year. The giant maps available are: South America, Africa, Asia, Europe, North America, and the Pacific Ocean. The alliance brought the map to New Hampshire schools and libraries before and it was used successfully by many students and teachers. Students and adults are welcome to experience the map at any designated location as part of Geographic Awareness Week (GAW). Dr. Bryant informed us the giant map of South America was scheduled to visit Keene, NH; Antrim, NH; and Marlborough, NH in the fall of 2013.

The giant map of South America is twenty-six feet by thirty-five feet and can easily fit on a gym floor. It comes with a trunk of supplies, including games to use with students, poly-spots, lanyards for teams, legend cards for each team, an instruction manual for teachers, and other materials to help with activities. National Geographic offers the use of these maps for teachers around the country to expand their students’ geographic knowledge. The National Geographic
giant map provides a fun way for teachers to take their students outside the classroom and experience maps through this interactive method of teaching. The goal of the map is to promote geographic literacy by providing hands-on activities for classroom teachers.

**Pre and Post-Test Creation**

The central component of our study was to test how using the giant map supports spatial learning. The tests focused on spatial modes, not geographic content. We created a multiple choice pre- and a post-test to conduct with the students, before and after they experienced the giant map. We chose to use pre and post-tests because we believed, with our activity, the results would show if students learned any new skills or if their skills improved after the activity. We were able to compare the results from the pre-test to the results from the post-test to determine any changes in the spatial thinking of the students. The test questions focused on spatial modes such as direction, location, spatial association, scale, distance, condition, and connections. We created questions that would span various modes of spatial thinking in order to thoroughly test the knowledge of the students. The test questions on both the pre and post-tests were similar in spatial content. We asked the same types of questions on both tests to determine if the students learned spatial thinking skills, not content knowledge. We wanted to test the spatial thinking skills, so our questions asked the students how to locate, how to orientate, and how to determine direction. The maps provided a basis for students to visualize and use their spatial thinking skills.

The pre and post-tests included maps of Africa and Asia (Appendix B and C). We created an answer key for each test (Appendix D). We decided to create tests focused on different continents than South America to prevent students from memorizing answers for the post-test.
This concept is known as priming, which is the idea that the brain remembers previous stimuli and will refer back to those stimuli in later events. We did not want to use the same map because the students would refer back to learned content instead of using spatial skills. We are interested in whether students are able to take spatial thinking skills learned from working with one continent and apply them to another continent. These spatial concepts could translate between the two maps. We could see through the answers on the tests whether students understood certain spatial thinking concepts.

For our tests, we made maps in ArcMap 10.2 (ESRI 2013) of Africa and Asia. We wanted both maps to be clear and concise for the questions we asked. We began with shapefiles of Africa and Asia. We added a layer of cities for both, but we omitted many locations in order to focus on those we asked about in the test. We did the same for bodies of water, landforms, and neighboring continents. For the map of Asia, we kept part of Africa to show the Red Sea makes a boundary between the two. For the same reason, on the Africa map, we kept part of Asia. We used different font styles to emphasize rivers, oceans, deserts, and other water bodies. The background colors were muted so the features would stand out, and so teachers could print the maps in black and white without losing critical information.

Based on the activities available, the contacts we had in area schools, and our own interests, we decided to work with fifth and sixth grade students. Many middle schools offer geography classes as electives. We used fifth and sixth grade classrooms who would already have been introduced to some spatial thinking skills regarding maps. We did not want to work with younger grades because we thought the activity would consist of us directing them instead of having them learn. The fifth and sixth graders would better understand the pre and post-test
format and why they were taking the tests. Students are more apt to take a geography class in middle school, leading to greater interest in the geographic material for fifth and sixth grade.

**Participating Classrooms**

We reached out to points of contact at schools where the giant map was scheduled to arrive. We asked classrooms in Keene to come to the giant map while it was at the Keene Public Library. Dr. Brehme identified a fifth grade teacher, Keene State College alumnus John “JJ” Prior, who has an interest in geography. We emailed Mr. Prior to find out if he was interested in participating in our study (Appendix E). He and other interested teachers would be required to plan a field trip to visit the map, so we needed to provide adequate time for them to plan for the event.

We emailed contacts at other schools, including Diane Goodman at the Marlborough Elementary School and Gail Zachariah, the Head of Youth and Community Services at the Keene Public Library. Both Goodman and Zachariah are coordinators in charge of bringing the map to their respective locations in Marlborough and Keene. Diane Goodman is the Spanish teacher at Marlborough Elementary School. She wanted to use the map with students in her Spanish classes because they were studying about South America. Gail Zachariah provided a space at the public library for schools to use the map during the time it was in Keene. The library used its status as a community resource to host the map for local schools. Ms. Zachariah agreed to help us schedule the teachers’ classrooms whom we had invited.

John Prior contacted us to confirm his interest and to suggest another teacher, his wife Emilia Whippie Prior, who teaches in Nelson, NH. We were able to work with Nelson
Elementary School because Emilia Whippie Prior teaches both fifth and sixth grade there. John Prior also coordinated with the two other fifth grade classes at Fuller Elementary School to bring their students to our map activity. With Diane Goodman’s knowledge of the map coming to her school, she had already signed up her fifth and sixth grade Spanish classes.

With the schedule in place, we had forty-nine fifth graders from Fuller Elementary School in Keene, NH; and nine fifth/sixth graders from Nelson Elementary School in Nelson, NH who would use the map at the Keene Public Library. We also had ten fifth graders and twenty-two sixth graders from Marlborough Elementary School who would use the map in their school gym in Marlborough, NH. These three groups allowed us to examine differences between schools and towns in Southwestern New Hampshire. Participating teachers agreed to administer the pre-test to their students within a few days before travelling to the map. We felt it would be easier to have the teachers administer the test at their discretion, as to not interrupt their school day.

**Activity Creation and Implementation**

National Geographic’s website provides various activities created specifically for the giant map. We reviewed all the activities available on the website and discussed which activities suited our research needs and would be most flexible with students at different developmental levels. We decided to use a “Simon Says” activity because we would be able to ask a large number of questions, and the activity would be fun for students. The “Simon Says” activity allowed us to see students’ understanding because if they knew the answer to our statement, they would go directly to the place, but if they did not know the answer, they would wander around the map or watch other students. This helped us see what concepts students needed
more help understanding. Some examples of “Simon Says” phrases are given on the National Geographic giant map webpage (Appendix F). We created other phrases to address more spatial thinking ideas. Some of our examples are “Stand in a land locked country”, “Sit on a country that borders the Atlantic Ocean”, and “Put one toe in the ocean under the southernmost point of South America”.

Figure 5 Fuller and Nelson students ready to start the map activity.
Source: Christopher Brehme.

Throughout the activity, we called out “Simon Says” phrases that directed the students where they needed to move to on the map. There was a large group of nearly 60 students the first time we administered the activity so we had to develop some creative ways to call out phrases. Some of the ways included calling students by: colored teams, gender, what they were wearing, map corners, class, and combinations of these.

After the activity was completed, we had students take the post-test. We administered the post-test to students while at the map location so the results could be collected, and so the
students could refer back to the giant map of South America if necessary. This allowed the students to refer to general geographic knowledge such as direction, latitude and longitude, and location. By having students take the post-test in the map area, the conditions for test taking were not ideal. If we had the time and opportunity, we would have had the students take their tests in a classroom setting, so they would have more time, space, and silence.

Figure 6 Marlborough students participating in the “Simon Says” activity.

We worked with the students on separate days to complete the activity. The test results were divided by different towns, schools, and gender so we could make comparisons between these variables. We numbered the tests according to class and different students so that we could compare the pre and post-test results for each student. All the data to answer our research questions came from the pre and post-tests.
Chapter 4: Results
Our methods were very simple. We conducted a pre and post-test with an activity to foster learning in between. We wanted to compare the six classes we worked with, the various school districts, and the towns. Another aspect we looked at was gender. It was important for our study to see how these components related. Much of our information was able to be analyzed by descriptive statistics. In graphs, we could see if students did better on the pre-test or post-test, and we could determine if males or females scored higher on the tests. Using SPSS, we ran paired sample t-tests comparing the pre and post-tests of students in school to see if there was a significant change in the test grades. We also created tables with numbers of questions correct that improved or did not improve on the post-test. Some of our results led to additional questions that led to additional comparisons between the classes. We looked at number of questions correct and made graphs for all classes, male and female, and schools.

![Figure 7 Pre and post-test results for all students.](image)
Figure 7 shows the results of all students who participated in the pre-test, activity, and post-test. The mode for the pre-test was ten questions correct while the mode for the post-test was nine questions correct. Only one student answered all questions correctly on the pre-test, and one student answered all questions correctly on the post-test. There were more students who answered half the questions correctly on the pre-test than the post-test. More students answered nine questions correctly on the post-test than the pre-test. For all students, the average number correct on the pre-test was 8.1 and the average number correct on the post-test was 7.8.

![Bar chart showing the number of students who answered each number of questions correctly on the pre-test and post-test.](image)

**Figure 8** *Pre and post-test results for all female students.*

Figure 8 features the scores of females on both the pre and post-tests. The average number correct for females on the pre-test was 8.2 while on the post-test it was 7.6. Only one student answered all questions correctly on the post-test, and no students answered all questions correctly on the pre-test. More females answered ten questions correctly on the pre-
test than the post, but more answered nine questions correctly on the post-test. The number of females who answered nine questions correctly on the test more than doubled the number from the pre-test. We can see more students answered between two and nine questions correctly on the post-test than the pre-test. The same number of students answered six and eight questions correctly on the pre-test and post-test. There does not seem to be a larger number of female students who did better on the post-test than the pre-test. On the pre-test most females answered between six and eleven questions correctly. However, on the post-test, most females answered between four and ten questions correctly.

![Figure 9 Pre and post-test results for all male students.](image)

According to Figure 9, more male students scored between eight to ten questions correct on the post-test than the pre-test. The same number of males answered four and eleven questions correct on both the pre and post-tests. The average number correct on the
pre-test was 8.1 and on the post-test it was 8.0. More males scored lower on their post-test than their pre-tests. Only one male answered all questions correctly on the pre-test.

![Figure 10: Pre-test results for all male and female students.](image)

According to Figure 10, more females answered between ten and eleven questions correctly on the pre-test than males. One male answered all questions correctly, and one female answered only one question correctly. Most students answered more than four questions correctly on the pre-test. Most students answered more than half the questions correctly. The largest group of students answered between six and ten questions correctly.
For the post-test, one male student answered only one question correctly while one female student answered all questions correctly, and another female student answered two questions correctly. Again, most students answered more than half the questions correctly. More females answered nine questions correctly than males, while more males answered between ten and eleven questions correctly than females.
Figure 12 compares the average scores of students in each class. There is one sixth grade class, four fifth grade classes, and a combined fifth and sixth grade class (5WP). The sixth grade class generally scored lower on the pre-test than the post-test. 5G scored much higher on their post-tests than pre-tests with an increase of more than 10 percent. 5P scored somewhat lower on their post-tests than pre-tests with a decrease of about 2 percent. 5OC scored much lower on their post-tests than pre-tests as did 5WP, which was the combined class. 5OC’s post-test average score dropped more than 15 percent from the average score on the pre-test. 5L scored just a little bit higher on their post-tests. 5WP’s drop in score was not as dramatic as 5OC’s, but they still made a 7 percent decrease in score from pre-test to post-test. 5P, 5OC, 5L, and 5WP all took their post-tests at the same time, yet there is a large difference in how well they did on the tests.
6G and 5G were both from Marlborough Elementary School and while both class average scores improved, 5G’s score improved more. Right before the activity, Diane Goodman gave students a short introduction with a map of the world. Students were able to name different continents and see South America in the context of the world. She asked them a few questions about South America such as the language most countries speak and how many countries are part of the whole continent. She went over what a landlocked country is and also what territories in South America are owned by other countries. This introduction could have helped some students achieve better scores on their post-tests.

![Figure 13 Pre and post-test average by school.](image)

Figure 13 provides an overview of scores by town. When class percentages are combined to form the school average, Marlborough Elementary School students were the only school to see improved scores on the post-test. Marlborough had better scores on their post-tests than both Fuller Elementary in Keene and Nelson Elementary. All schools averaged scores
between 65 percent and 70 percent on the pre-test. On the post-test, Marlborough was near 68 percent, Keene was near 63 percent, and Nelson was near 59 percent.

**Results based on individual questions**

The questions were each based on modes of spatial thinking. While some questions could be classified under the same mode, some questions stood alone as a separate mode. The number of modes used in each test was nine. The spatial modes coincide on the pre and post-test for each question. The most commonly used mode was situation.

**Table 5 Questions classified by spatial mode**

<table>
<thead>
<tr>
<th>Spatial Mode</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>Q1</td>
</tr>
<tr>
<td>Direction</td>
<td>Q2</td>
</tr>
<tr>
<td>Orientation</td>
<td>Q3, Q10</td>
</tr>
<tr>
<td>Situation (Connections)</td>
<td>Q4, Q5, Q9</td>
</tr>
<tr>
<td>Region</td>
<td>Q6</td>
</tr>
<tr>
<td>Scale</td>
<td>Q7</td>
</tr>
<tr>
<td>Location</td>
<td>Q8, Q11</td>
</tr>
<tr>
<td>Condition</td>
<td>Q12</td>
</tr>
</tbody>
</table>

While the Figures 14 and 15, do not group questions by spatial modes, Table 5 displays how the questions are classified.
The question answered incorrectly most frequently was question seven which featured using the scale bar. Most students answered the other questions correctly. Questions two and five were answered correctly most often. Those questions were about direction and location. The last six questions were commonly left unanswered. We are unsure as to why these are the most frequently unanswered. However, we presume it had to do with time constraints allotted for the test.
On the pre-test, questions one, eight, and ten had the most incorrect answers. Question one was about distance while questions eight and ten were about condition (latitude and longitude). These could have been more difficult on the post-test than the pre-test due to the map projection used. On the pre-test of Africa, the latitude and longitude was a regular grid of rectangles because Africa is located within the tropics where latitude and longitude lines meet at near ninety degree angles. On the post-test, because Asia is a very large continent spanning with much of its landmass at high latitudes, the grid system was dramatically curved making it challenging to determine latitude and longitude. Question five was answered correctly most of the time, just as it was on the pre-test. Unlike the pre-test, question two on the post-test appeared to be more difficult. Students had trouble with orientation.
Table 6 Top Ten Students Who Improved Their Score from Pre-Test to Post-Test.

<table>
<thead>
<tr>
<th>Student</th>
<th>Gender</th>
<th>School and Class</th>
<th>Pre-test correct</th>
<th>Post-test correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>#18</td>
<td>Female</td>
<td>Fuller 5L</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>#50</td>
<td>Male</td>
<td>Marlborough 5G</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>#59</td>
<td>Female</td>
<td>Marlborough 5G</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>#79</td>
<td>Female</td>
<td>Marlborough 6G</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>#70</td>
<td>Female</td>
<td>Marlborough 6G</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>#75</td>
<td>Male</td>
<td>Marlborough 6G</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>#54</td>
<td>Female</td>
<td>Marlborough 5G</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>#2</td>
<td>Female</td>
<td>Nelson 5WP</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>#47</td>
<td>Female</td>
<td>Fuller 5P</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>#74</td>
<td>Male</td>
<td>Marlborough 6G</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

Table 6 includes the top ten students who improved their scores from pre-test to post-test. The students are in order of the largest percentage of improvement by number of questions correct. We thought male students would achieve higher scores on the tests, but this table shows seven female students and three male students improved. Marlborough classes, 5G and 6G had students who received a higher score on their post-test than pre-test. One student from Fuller 5L improved her grade by seven questions.

Table 7 Top Ten Students Whose Score Decreased from Pre-Test to Post-Test.

<table>
<thead>
<tr>
<th>Student</th>
<th>Gender</th>
<th>School and Class</th>
<th>Pre-test correct</th>
<th>Post-test correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>#26</td>
<td>Female</td>
<td>Fuller 5P</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>#62</td>
<td>Female</td>
<td>Marlborough 6G</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>#33</td>
<td>Female</td>
<td>Fuller 5OC</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>#55</td>
<td>Female</td>
<td>Marlborough 5G</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>#42</td>
<td>Female</td>
<td>Fuller 5P</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>#25</td>
<td>Female</td>
<td>Fuller 5OC</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>#34</td>
<td>Female</td>
<td>Fuller 5OC</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>#3</td>
<td>Male</td>
<td>Nelson 5WP</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>#81</td>
<td>Male</td>
<td>Marlborough 6G</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>#66</td>
<td>Female</td>
<td>Marlborough 6G</td>
<td>10</td>
<td>6</td>
</tr>
</tbody>
</table>
The students in Table 7 are in order of largest decrease in correct answers from pre-test to post-test. More females than males received lower scores on their post-tests. Half of the students were from Fuller, and four of the students were from Marlborough. The largest number of questions that decreased was seven. We believe many of the students from Fuller who did worse on their post-test did so because of the distractions of taking a test in a room with fifty plus other students.

<table>
<thead>
<tr>
<th>Paired Samples Statistics</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>N</td>
<td>Std. Deviation</td>
</tr>
<tr>
<td>Pair 1 Pretest</td>
<td>7.9003</td>
<td>32</td>
<td>2.24843</td>
</tr>
<tr>
<td>Posttest</td>
<td>8.1875</td>
<td>32</td>
<td>2.29217</td>
</tr>
</tbody>
</table>

Paired Samples Test

<table>
<thead>
<tr>
<th>Paired Differences</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Std. Error Mean</td>
<td>Interval of the Lower</td>
<td>Upper</td>
<td>t</td>
</tr>
<tr>
<td>Pair 1 Pretest - Posttest</td>
<td>-.28125</td>
<td>3.28471</td>
<td>.58066</td>
<td>-1.46551</td>
<td>.90301</td>
<td>- .484</td>
</tr>
</tbody>
</table>

**Figure 16** Paired sample t-test for Marlborough Elementary (one sixth and one fifth grade class).

We ran statistics to compare pre- and post-test scores. For the first test, we included both the fifth and sixth grade classes from Marlborough Elementary School. Overall, the post-test mean of 8.2 was higher than the pre-test mean of 7.9. The significance value was .632 meaning that there was no significance between the mean scores. The standard deviation shows two-thirds of the students answered between 5.7 and 10.1 questions correctly on the pre-test and answered between 5.9 and 10.5 questions correctly on the post-test. There is not much of a difference between these two variables.
For this paired sample t-test, we compared the pre and post-test scores of all three Fuller Elementary School classes. The mean for the pre-test was 8.4 and the mean for the post-test was 7.6. While the scores went down from pre-test to post-test, the significance value was .043 which means the results are significant. There is a significant difference between the answers correct in the pre-tests and the post-tests. The standard deviation in the pre-test was between 6.2 and 10.6, and the standard deviation for the post-test was between 5.3 and 9.9.

The means for both the pre and post-test for the fifth/sixth grade class at Nelson Elementary School were similar as 7.9 and 7.1. The significance value is .301 which is much higher than .05, so the results were not significant. The standard deviation shows two-thirds of
the students answered between 6.2 and 9.6 questions correctly on the pre-test, and on the post-test two-thirds of the students answered between 4.9 and 9.4 questions correctly.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1</td>
<td>Pretest</td>
<td>8.4545</td>
<td>22</td>
<td>2.21955</td>
</tr>
<tr>
<td></td>
<td>Posttest</td>
<td>8.2273</td>
<td>22</td>
<td>2.11417</td>
</tr>
</tbody>
</table>

Figure 19 Paired sample t-test for all sixth grade students.

For this paired sample t-test, we compared the pre and post-test scores of the only sixth grade class. The mean for the pre-test was 8.5 and the mean for the post-test was 8.2. The significance value was .736 meaning there was no significance between the mean scores. The standard deviation shows two-thirds of the sixth grade students answered between 5.4 and 11.6 questions correctly on the pre-test and answered between 5.1 and 11.3 questions correctly on the post-test. These results are very similar because the means were very similar.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>N</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1</td>
<td>Pretest</td>
<td>8.0200</td>
<td>50</td>
<td>2.25416</td>
</tr>
<tr>
<td></td>
<td>Posttest</td>
<td>7.6800</td>
<td>50</td>
<td>2.40272</td>
</tr>
</tbody>
</table>

Figure 20 Paired sample t-test for all fifth grade students.
For this paired samples t-test, we compared the pre and post-test scores of all of the fifth grade classes in our study. The mean for the pre-test was 8.0 and the mean for the post-test was 7.7. The significance value was .401 meaning there was no significance between the mean scores. The standard deviation shows two-thirds of the fifth grade students answered between 5.2 and 10.8 questions correctly on the pre-test and answered between 4.9 and 10.5 questions correctly on the post-test. These results are also similar because of how close the means were.

Table 8 Pre-Test Data Averages and Standard Deviation.

<table>
<thead>
<tr>
<th></th>
<th>Overall</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Correct</td>
<td>8.1</td>
<td>8.1</td>
<td>8.2</td>
</tr>
<tr>
<td>Min Correct</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Max Correct</td>
<td>12</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>Standard Deviation(1)</td>
<td>2.2</td>
<td>2.1</td>
<td>2.2</td>
</tr>
</tbody>
</table>

The average number of correct answers for all students is 8.1. When comparing the pre-test means, males and females have very similar results. However, females have a slightly higher mean by 0.1. There were no male students who only answered one, two, or three questions correct on the pre-test. There were no female students who answered all of the questions correct. The standard deviation of all males shows two-thirds of the students answered between 6.0 and 10.2 questions correctly on the pre-test. The standard deviation of all females shows two-thirds of the students answered between 6.0 and 10.4 questions correctly on the pre-test.

Table 9 Post-Test Data Averages and Standard Deviation.

<table>
<thead>
<tr>
<th></th>
<th>Overall</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Correct</td>
<td>7.8</td>
<td>8</td>
<td>7.6</td>
</tr>
<tr>
<td>Min Correct</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Max Correct</td>
<td>12</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Standard Deviation (1)</td>
<td>2.3</td>
<td>2.4</td>
<td>2.2</td>
</tr>
</tbody>
</table>
The average number of correct answers for all students is 7.8. When comparing the post-test means we find although they are similar, they are more varied results than the pre-test means. Although we expected to find the post-test results to be an improvement from the pre-test, we found the opposite to be true. The post-test mean for females decreased by 0.6 from the pre-test while the post-test mean for males only decreased by 0.1 from the pre-test. There were no male students who answered all of the questions correct. There were no female students who answered only one question correct. The standard deviation of all males shows two-thirds of the students answered between 5.6 and 10.4 questions correctly on the post-test. The standard deviation of all females shows two-thirds of the students answered between 5.4 and 9.8 questions correctly on the post-test.
Chapter 5: Conclusions and Discussions
The results we found were not what we expected. We had hypothesized that a hands-on activity with fifth and sixth grade students would lead to better spatial thinking skills for them. We would know they had gained greater spatial skills through an improved score on their post-tests. If there had been more time to teach and for students to take the post-test, we believe they could have done better on the assessment.

If we were to conduct the research again, we would administer both the pre-test and the post-test to each classroom ourselves. We had requested teachers not help students with the test as to not interfere with the study. However, since we were not in the classroom while the pre-tests were being taken, we do not know how much information teachers may have given students. If teachers did give their students information, we do not know if it was correct or if it affected students’ tests in our study. Due to time constraints for us and the classroom teachers, we had to administer the post-tests on the day of the activity. If we had more time, we think it would have been beneficial to let students comprehend the information on the day of the activity and have them complete the post-test a few days later. We created different pre and post-tests based on the modes of spatial thinking that we were looking to test. The modes we focused on were: distance, direction, orientation, location, spatial association, region, scale, condition, and connections. In the future, we think it would benefit the study to limit the number of spatial modes. It would be easier to focus on three to four modes of spatial thinking than the nine we chose to work with. We would be able to see the difference in each mode instead of having questions overlap various modes.

It would be interesting to see the changes in spatial thinking if we were able to teach a formal lesson and also do an activity with the students. This could be a way for students to
comprehend the material and then use their skills in the activity. The activity was in a setting not ideal for learning because students were either in a new place or an area where they were usually allowed to play. If we did a formal lesson than there would be more opportunities for information to be given and for questions to be asked, both by the students and by us.

If we had met the students before facilitating the activities, we believe the students would relate to us better. It may have been helpful for us to give students nametags, so we would know their names if a student acted inappropriately or for us to call on a student. The teachers let us have most of the control over the students while doing our activity. Since we did not know the students well, we did not know who would act out or not pay attention.

Our first activity was at the Keene Public Library with forty-nine students. We do not know how many of the students had been to the library before, but it was much different than teaching students at a school. The students knew it was a field trip, and some of them wanted to explore and talk with each other instead of participating in the activity. With the large number of students it was important that we divide students into two groups. One group participated in the “Simon Says” activity while the other group had an opportunity to read or look at different books about South America, including its people, culture, and land. If the students did not want to use the books, then they had another option. The librarian had set up a creative arts area where students could draw on and design door-hangers. The group we had participating in “Simon Says” was then divided into four different teams (blue, yellow, red, and green) and sent to different colored corners of the giant map.
The small group of nine students from Nelson Elementary was at the Keene Public Library with the large group of three fifth grade classes from Fuller Elementary. The students from Nelson arrived after the students from Fuller Elementary. This caused the two schools to be segregated from one another because Nelson students had to sit across the room. When we divided the groups, the Nelson students were mixed with the Fuller students, which allowed for a more diverse group of students to interact. When the post-test was given, the students went back to their original seats. Being in a talkative area when trying to complete a test is difficult and it could have skewed the test results for some students.
In Marlborough, we taught the students at their own school. While they were not in the same classroom setting they usually are, many of them were well behaved. Both we and the teacher had set expectations for the students to follow. There were two, very different, classes that we worked with from Marlborough. We worked with one small class of ten students, fifth grade and one average sized class of twenty-two students, sixth grade. The success of the fifth grade class stood out from all of the classes involved in the study. The fifth grade students seemed very familiar with the map of South America and the legend key. We think having a smaller class size while teaching aided in the students’ ability to understand the skills learned. The sixth grade class, although larger than the fifth grade, was still much smaller than the group that participated at the Keene Public Library.

Another reason we think the fifth grade class scored better on the post-test than the sixth grade was because of the atmosphere at the map. With the fifth grade, the teacher, Ms. Goodman, showed great enthusiasm about the activity and excitement at the opportunity to gain new geographical knowledge and skills.

We believe this study is worth pursuing further. There are not many studies about students and spatial thinking skills especially including a pre and post-test. We thought using a pre and post-test as a method would be more common, yet we had difficulties finding examples. It was interesting for us to see how students thought and comprehended the information about spatial thinking.

Since not all students are kinesthetic learners, it would be interesting to teach the students a lesson instead of doing an activity on the giant map. We could give the students the same tests, but they could learn in a classroom environment instead of through a hands-on
activity. Not all students benefit from kinesthetic activities; for some, it hinders their learning. This could be a reason not all students did better on the post-test than the pre-test.

If this study were to be conducted again, we think it would be important to work with schools throughout the state of New Hampshire. With Keene sitting in the Southwestern corner, working with a school in the North, East and center of the state would provide a range of town and School Administrative Unit demographics. Another idea would be to work with one School Administrative Unit and then ask one classroom to participate from each district. For example, Keene’s School Administrative Unit 29 has seven districts. If each school had one classroom participating in the study there would be seven different towns to run demographics on and seven different classrooms to compare for our results. The last idea would be to ask schools from different states to participate in the study. With Keene sitting close, within twenty-five miles, to the borders of Massachusetts and Vermont it would be accessible to conduct the study within schools near the borders. This would be very interesting to see which state would do better on the post-test because it may reflect back on the state’s education philosophy. Also, it would be interesting to compare other test scores the state took regarding geography (NAEP) to the scores on the post-test we created.

Beginning this project, we thought we had a good idea of how our results would turn out. We believed students would achieve higher scores on the post-test after doing an activity on the giant map. After looking at our data and running tests, we determined our hypothesis would not be accepted. We have many ideas for new research to combine with our research to further study spatial thinking skills of elementary students. We believe with further lessons and activities, students would garner better spatial thinking skills. It would be interesting to see if
students could use their spatial skills in a way other than test-taking. We think that geography should be a more relevant subject in elementary school curriculum today. Since spatial thinking skills are important for everyday life, classes who reflect these spatial learning practices should be apparent in all schools.
Literature Cited


National Science Foundation. 2012. *Spatial Thinking in Geosciences.*


Appendices
## Assessment of Candidate’s Strengths and Professional Development Needs

### For Elementary Education (K-6) (K-8)

<table>
<thead>
<tr>
<th>COMPETENCY</th>
<th>ASSESSMENT</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) To be certified as an elementary education teacher for grades K-6 or K-8, the candidate shall have:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) At least a bachelor’s degree, and</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(2) Qualify for certification under one of the alternatives in Ed 502.01 – Ed 505.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) A candidate for certification as an elementary education teacher for grades K-6 or K-8 shall have the following skills, competencies and knowledge through a combination of academic and supervised practical experiences in following areas:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) In the area of curriculum and assessment, the ability to:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Design, administer, and use the results of informal assessments to meet individual needs;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Use the results of standardized tests, observations, and daily student performance to plan instruction; and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Help K-6 or K-8 students develop the ability to assess their own progress as learners;</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(2) In the area of planning and instructional strategies, the ability to:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Use the following strategies to promote student learning:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Development of student literacy, including reading instruction that leads to development of student strategies for word recognition, decoding skills, and reading comprehension;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii. Development of student writing skills: including writing process, usage, and grammar; and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii. Development of student mathematics skills, including number systems, number series, algebraic concepts, informal geometry, measurement, data organization and interpretation skills;</td>
<td></td>
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<td></td>
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<tr>
<td>---</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Apply fundamental skills of social interaction, problem solving, and higher order thinking and to foster development of these skills in students by integrating them into all subject areas;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>Use enthusiasm and appropriate language and behaviors to provoke interest, curiosity, and engagement in learning for all subjects;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>Demonstrate understanding of all subject areas through the proper use of subject specific language, behaviors, and skills;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>Use literature and artistic expression as teaching tools in all subject areas;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>Use developmentally appropriate practices to create authentic learning experiences crucial to teaching elementary students; and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g.</td>
<td>Integrate effectively a variety of content areas into a holistic, thematic approach to teaching;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3)</td>
<td>In the area of communication and collaboration:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Knowledge of the roles and responsibilities of various personnel, including principal, speech language specialist, speech language pathologist, occupational therapist, special education administrator, and Paraeducator, indigenous to elementary schools and districts;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Ability to effectively access and collaborate with school district personnel to support student learning; and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>Skill in using a variety of appropriate, constructive communication strategies that effectively engage families, parents, and guardians in discussions of children’s growth and development;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td>In the area of professionalism:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Knowledge of the laws governing the education of all learners and ability to use that knowledge to create an inclusive learning environment;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Ability to understand how the dynamics of the classroom and the teacher’s own behavior and skills can impact students’ behavior and learning; and</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(5) In the area of technology:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Ability to discriminate between developmentally appropriate and inappropriate use of technology with children;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Skill in utilizing technologies effectively to assist student learning; and</td>
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<tr>
<td>c. Knowledge of how to provide equal access to the digital world;</td>
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<tr>
<td>(6) In the area of language arts content, the ability to:</td>
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<tr>
<td>a. Explain the usage of structure, grammar, and orthography of the English language;</td>
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<tr>
<td>b. Analyze, interpret, and evaluate the elements of literary works, including fiction, non-fiction, drama, and poetry; and</td>
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<td>c. Apply knowledge of the influence of social, cultural, psychological, and economic factors to the acquisition of language and language learning and to the teaching of literacy;</td>
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<td>(7) In the area of mathematics content, the ability to:</td>
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<tr>
<td>a. Explain the meaning and use of numbers and the standard algorithms for the 4 basic operations of addition, subtraction, multiplication, and division;</td>
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<tr>
<td>b. Explain basic algebraic concepts, representations, and formulas;</td>
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<td>c. Explain the proportions of geometry, including relationships and theorems in figures and shapes;</td>
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<td>d. Explain standard units of measurement; and</td>
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<tr>
<td>e. Organize and interpret data through the use of visual displays, probability, and statistics;</td>
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<td>(8)</td>
<td>In the area of social studies content, ability to:</td>
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<tr>
<td></td>
<td>a. Explain world geography and its effects on human, physical, political, and economic systems;</td>
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<td>b. Explain the pre-history and early civilizations to those of the current day, including their developments and transformations;</td>
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<td></td>
<td>c. Explain United States history from European exploration and colonization to current developments and transformations;</td>
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<td></td>
<td>d. Explain the nature, purpose, and forms of local, state, national, and international government;</td>
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<td>e. Demonstrate a working knowledge of the tools, goals, and areas of study in anthropology, sociology, and psychology; and</td>
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<td></td>
<td>f. Explain basic micro- and macro-economics; and</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>(9)</th>
<th>In the area of science content, ability to:</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>a. Explain, in the area of earth science, the structure and the process of the earth system and its relationship to the universe;</td>
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<td></td>
<td>b. Explain, in the area of life science, the structure, function, and healthy maintenance of living systems;</td>
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<td>c. Explain, in the area of physical science, the structure, property, and interactions of energy and matter;</td>
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<tr>
<td></td>
<td>d. Apply the inquiry process, an educational standard of science pursuant to RSA 193-C.3.III(a), through the use of scientific inquiry; and</td>
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<tr>
<td></td>
<td>e. Apply an awareness of history and nature of science to an inquiry process, an educational standard of science pursuant to RSA 193-C.3.III(a), illuminating the history of science.</td>
</tr>
</tbody>
</table>
Appendix B

Name: Africa Quiz Date: 

Please answer the following questions choosing the best fit answer. All questions must be answered.

1. Which country extends the furthest East?
   a. Eritrea
   b. Senegal
   c. Mozambique
   d. Somalia

2. If you were in Sudan, which of these countries is directly to the West of you?
   a. Chad
   b. Ethiopia
   c. Democratic Republic of the Congo
   d. Mali

3. Begin at Niger. Move one country South. Then move four countries West. Where are you?
   a. Ethiopia
   b. Cote d'Ivoire
   c. Angola
   d. Ghana

4. Circle an example of a landlocked country.
   a. Tanzania
   b. Djibouti
   c. Mali
   d. Tunisia

5. Which ocean surrounds Madagascar?
   a. Atlantic Ocean
   b. Indian Ocean
   c. Pacific Ocean
   d. Arctic Ocean

6. Circle two countries that are within the Sahara Desert.
   a. Morocco, Western Sahara
   b. Algeria, Burkina Faso
   c. Egypt, Libya
   d. Chad, Egypt

7. Using the scale bar, determine which country is the widest in miles?
a. Sudan  
b. Ethiopia  
c. Algeria  
d. Democratic Republic of the Congo

8. Which river starts at 8° N latitude and 11° W longitude?  
a. Nile River  
b. Zambezi River  
c. Niger River  
d. Congo River

9. What is the capital of Niger?  
a. Agadez  
b. Niamey  
c. Algiers  
d. Windhoek

10. What lake has the Equator running through it?  
a. Lake Malawi  
b. Lake Victoria  
c. Lake Chad  
d. Lake Albert

11. What body of water does the Nile River flow into?  
a. Red Sea  
b. Indian Ocean  
c. Atlantic Ocean  
d. Mediterranean Sea

12. What body of water provides a border between Africa and Asia?  
a. Persian Gulf  
b. Atlantic Ocean  
c. Red Sea  
d. North Sea
Name: Asia Quiz Date:

Please answer the following questions choosing the best fit answer. All questions must be answered.

1. Which country extends the farthest East?
   a. Indonesia
   b. Japan
   c. Turkey
   d. Russia

2. If you were in Thailand, which country is directly to the West of you?
   a. Myanmar
   b. Laos
   c. Cambodia
   d. Malaysia

3. Begin at Nepal. Move one country South. Then move one country West. Then move one country North. Where are you?
   a. Bhutan
   b. Afghanistan
   c. India
   d. Uzbekistan

4. Circle an example of a landlocked country.
   a. Philippines
   b. Saudi Arabia
   c. Mongolia
   d. Thailand

5. Which ocean surrounds Japan?
   a. Pacific Ocean
   b. Yellow Sea
   c. Sea of Japan
   d. Indian Ocean

6. Circle two countries that contain the Gobi Desert.
   a. Mongolia and Kazakhstan
   b. Mongolia and China
   c. Iraq and Iran
   d. Yemen and Oman

7. Using the scale bar, determine which country is the widest in miles?
   a. India
   b. Kazakhstan
   c. China
   d. Russia

8. What river ends at 66.5° N latitude and 69° E longitude?
   a. Yenisey River
b. Lena River
c. Ob River
d. Ural River

9. What is the capital of India?
   a. New Delhi
   b. Delhi
   c. Mumbai (Bombay)
   d. Bangalore

10. What sea has the 60° E longitude line running through it?
    a. Aral Sea
    b. Caspian Sea
    c. Black Sea
    d. Sea of Okhotsk

11. What body of water does the Ganges River flow into?
    a. Andaman Sea
    b. Arabian Sea
    c. South China Sea
    d. Bay of Bengal

12. What body of water provides a border between Africa and Asia?
    a. Persian Gulf
    b. Atlantic Ocean
    c. Red Sea
    d. North Sea
Appendix D

Africa Answer Key

1. Somalia (D)
2. Chad (A)
3. Cote D’Ivoire (B)
4. Mali (C)
5. Indian Ocean (B)
6. Egypt, Libya (C or D)
7. Democratic Republic of the Congo (D)
8. Niger River (C)
9. Agadez (A)
10. Lake Victoria (B)
11. Mediterranean Sea (D)
12. Red Sea (C)

Asia Answer Key

1. Russia (D)
2. Myanmar (A)
3. Afghanistan (B)
4. Mongolia (C)
5. Pacific Ocean (A)
6. Mongolia, China (B)
7. Russia (D)
8. Ob River (C)
9. New Delhi (A)
10. Aral Sea (A)
11. Bay of Bengal (D)
12. Red Sea (C)
National Geographic and the New Hampshire Geographic Alliance are offering teachers the opportunity to experience the Giant Map of South America with their class at the Keene Public Library. The Giant Map will enhance students’ geographic learning by providing them the experience of walking about South America. The map is 26’ x 35’ featuring landforms, rivers, cities and countries making up South America.

We are students from Keene State College’s Geography Senior Seminar class. Our project this semester involves testing students’ spatial abilities in a geographical context. We are looking for 5th or 6th grade classrooms to be participants in our study. The study involves a pre and post-test as well as an activity we would teach your class using the Giant Map at the Keene Public Library. We will be providing the pre and post-tests as well as the activity.

We would like to invite you to join us at the Keene Public Library between October 28-30 from 1-3pm and October 31 from 9:30am-12pm to help us conduct our research. The time we will spend at the library with your class is a minimum of 30 minutes. The pre-test will be administered at the school prior to the activity with the Giant Map. The post test, depending on time constraints, may be given either at the library or back in the classroom. Each test is expected to take approximately 20 minutes. We would be grateful to use your classroom in our study. It would be a fun and interactive way for your students to learn about geography and gain spatial skills!
SIMON SAYS STATEMENTS FOR LARGE GROUPS

*Simon Says* statements for the start of the game or with larger numbers of students

Sit in the Atlantic Ocean.

Kneel on one knee in the largest country in square miles.

Stand south of the Tropic of Capricorn.

Place one foot on a different capital city.

Stand on the Equator and face east.

Sit anywhere along the Andes Mountains.

Put one toe on the Amazon River.

Sit in a country that borders South America’s only colony.

Stand in the Pacific Ocean and face west.

Sit in the country with the largest population in South America.

Stand in the country that will host the Summer Olympics in 2016.

Place a finger on any major highway.

Put one toe on a different city that has an airport.

Stand south of the Equator and face north.

Line up on 40 degrees south latitude and face Antarctica.

Put one toe on any tributary of the Amazon River.

Stand in Brazil and face northeast.

Sit within six feet of the map scale.

Stand on the Tropic of Capricorn and face south.

Line up on 70 degrees west longitude.