

Chapter 1 - Introduction

Purpose

This thesis studied the relationship between one's knowledge of current events and one's ability to construct a world mental map. It was hypothesized that the more people know about current events, the more accurate their mental maps are. The study was designed using two activities recommended for 12th graders by *Geography for Life, National Geography Standards 1994*, and the theory of spatial familiarity (Gale, Golledge, Halperin, & Couclelis, 1990; Golledge & Spector, 1978; Kitchen, 1994b)). This thesis will help geographers understand how well college students are able to use mental maps to organize information about places in a spatial context.

Background

During the 1980s numerous tests demonstrated that American students were incompetent in geography. Awareness of this incompetence was heightened in 1983 when Professor David M. Helgren, Ph.D. (University of Miami, Florida) using a place location quiz, assessed the geographic knowledge of the students in his introductory courses. Helgren (1983) reported that his students were ignorant of the locations of significant nations and cities. To illustrate, 80.4% of the participants could not locate Kenya, 41.4% were unable to locate Los Angeles, 67.9% unable to locate Moscow, and 71.8% unable to locate Algeria (p.176). These results quickly became national news and headline stories. These included: "Geography Students Get Lost", "Duh, uh where is London Anyway", and "We don't know where things are" (p. 177). Helgren urged that geographers "capitalize" on these results and promote geography education (p. 178).

Since Helgren's report many studies have gauged geographic knowledge. In 1988 The National Geographic Society measured the extent of geographic literacy among adults in 10 nations (National Geographic, 1988). Others have assessed geographic awareness of pre-service teachers in America (Chiodo, 1993), and patterns of geography literacy worldwide (Saarinen & MacCabe, 1995). Each of these reports reconfirmed the general geographic illiteracy in the United States. Chiodo found that pre-service teachers had difficulty drawing a map of the world,

and that female elementary pre-service teachers were least knowledgeable. Saarinen and MacCabe's study found that the United States is not the only nation that could improve geography education. Canada, Australia, South Africa, and Great Britain had scores similar to the United States.

In response to these studies and recommendations from the United States government, the geography community began creating guidelines, resources, and organizations to improve geography education. These actions included publishing numerous education resources such as *Guidelines in Geographic Education, K-12* (1984), *K-6 Guidelines* (GENIP), and *7-12 Guidelines* (GENIP, 1987); the formation of the National Geographic State Alliance network; and completing the National Assessment of Educational Progress in geography (Geography Education Standards Project, 1994, p. 243). The most comprehensive geography education resource from this period is *Geography for Life, The National Standards 1994*. These standards, produced on behalf of the American Geographical Society, the Association of American Geographers, the National Council for Geographic Education, and the National Geographic Society, outline a "consensus on what constitutes a world-class education in geography for all students" (Geography Education Standards Project, 1994, p. 26). *Geography for Life* outlines the knowledge, skills and perspectives a student should demonstrate to be considered geographically informed. Objectives and expectations are provided for grade ranges K-4, 5-8, and 9-12.

Central to *Geography for Life* are six essential elements that serve as containers for the 18 standards that constitute a thorough education in geography. These essential elements are The World in Spatial Terms, Places and Regions, Physical Systems, Human Systems, Environment and Society, and The Uses of Geography. This thesis focuses on one of these elements – The World in Spatial Terms. This element incorporates the first three of the 18 geography standards:

The geographically informed person knows and understands:

- 1) How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective.
- 2) How to use mental maps to organize information about people, places, and environments in a spatial context.
- 3) How to analyze the spatial organization of people, places, and environments on Earth's surface.

(Geography Education Standards Project, 1994, p. 34)

This study is concerned with Standard Two and how well one is able to use mental maps to organize information about places in a spatial context.

Geography for Life is an important step for geography education. The standards are the capitalization Helgren sought back in 1983. Unfortunately, not many school systems are using the *Geography for Life* standards, and little is known about how students are performing against these recommended objectives. This thesis offers information that will help geographers understand how well college freshmen are able to perform some of the objectives pertaining to “The World in Spatial Terms”, and how well they are able to use mental maps to organize information about places in a spatial context (p. 34).

The Study

Golledge and Spector (1978) hypothesized that the more familiar a person is with a place or spatial layout the better his/her mental map of that setting will be. Only a few studies have explored the relations of spatial familiarity and mental mapping (Gale et al, 1990; Golledge & Spector, 1978; Kitchen, 1994b). Each of these studies was conducted for large-scale environments. None has been done on a global (smaller) scale.

Spatial familiarity pertains to one's “real” familiarity with a place. That is, it is concerned with a person's direct experience with a place or region. This familiarity can include, but is not limited to, visual familiarity, name familiarity, place location knowledge, and level of

interaction with a place (Gale et al., 1990). However, spatial familiarity is also related to indirect experiences. Kitchen (1994b) identified a fifth dimension to spatial familiarity. This dimension is “knowledge about the place such as the history and current affairs...acquired from secondary sources such as the media and education” (p. 44). This thesis uses this fifth dimension to study whether a person who stays abreast of current events possesses a better spatial grasp of the world than a person who does not.

As explained, two activities recommended for 12th graders were used to assess a person’s mental mapping ability. These activities are:

- Locate on a world map some of the places mentioned on a television or radio news broadcast and describe the cultural, political, and economic characteristics of these places.
- Draw from memory a map of the world, outline significant nations, and use the map to explain patterns of the standard of living in today’s world.

(Geography Education Standards Project, 1994, p. 241)

Rather than asking students to perform these activities as described, students were asked to a) draw from memory a map of the world outlining the seven continents, and b) locate on a world map places mentioned on a television or radio broadcast, and/or the newspaper or news magazine. These two activities, especially the latter, are common tasks asked of students. However, this study sought to learn how well students, after graduating from high school can perform them. This study also provides benchmark data that will be useful to other researchers as *Geography for Life* becomes more widely used.

Participants completed a participant profile and took a current event quiz. The profile was used to study what variables may be related to one’s ability to map the world from memory. The current event quiz consisted of questions related to significant current events that occurred around the world. Similar to the Participant Profile instrument, the current event test scores were analyzed to study the relationship between current event knowledge and participant mental mapping abilities.

The Hypotheses

This study treats the following hypotheses:

- 1) The more one knows about current events the better one will be able to draw from memory a map of the world.
- 2) The more one knows about current events, the better one will be able to locate places on a world map.
- 3) The more one stays informed with current events the better one will be able draw from memory a map of the world.
- 4) The more one stays informed with current events, the better one will be able to locate places on a world map.
- 5) The more one has traveled in North America, the better one will be able to draw from memory a map of the North American continent.
- 6) The more one has traveled in North America, the better one will be able to locate places on a map of the North American continent.
- 7) The more one has traveled internationally, the better one will be able to draw from memory a map of the world.
- 8) The more one has traveled internationally, the better one will be able to locate places on a world map.

This thesis also compares performances by males and females, by academic level, by geography courses taken, by types of sources used to gather information (local newspaper and/or television station, national newspaper and/or television news broadcast, national news magazine, and entertainment magazines), and by perceived map skill ability.

Summary

Geography for Life, National Standards Project 1994 has defined high expectations for students and schools. Very few studies explore how students are performing against these standards. This thesis provides information concerning how well college students are able to map the most basic of world maps-- the seven continents. It measures how knowledgeable college students are of significant current events and where these events occurred. Lastly, it examines whether or not knowledge of these events is related to mental mapping abilities. This study provides useful information for geography educators.

Chapter 2 - Literature Review

Interdisciplinary and Multidimensional

Mental mapping is a research topic that is studied by many disciplines including geography, cartography, psychology, planning, and sociology (Kitchen, 1994a; Lloyd, 1989). This interdisciplinary approach is a result of the complex nature of constructing a mental map. Mental mapping requires one to “[acquire, code, store, recall, and decode] information about the relative locations and attributes of phenomena in his everyday spatial environment” (Downs & Stea, 1973, p. 9). Mental mapping has many definitions and research techniques and is a subject debated by numerous researchers. (Downs, 1981; Kitchen 1994a; Tuan, 1975) As explained by Kitchen, the variation in definitions is due to the fact that “[mental] mapping has no strong subject base and is essentially a research topic from most of the social sciences” (1994a, p.5). It is not the purpose of this project to enter this debate of defining the term, but rather to use the one adopted by *Geography for Life*.

As already explained *Geography for Life* Standard Two states that a geographically informed person should know “how to use mental maps to organize information about people, places, and environments in a spatial context” (p.64). For this standard a mental map is

an individual’s internalized representation of some aspect or aspects of Earth’s surface. It represents what the person knows about the locations and characteristics of places at a variety of scales (local or global), from the layout of the student’s bedroom to the distribution of oceans and continents on the surface of Earth. These maps in the mind provide students with an essential means of making sense of the world, and storing and recalling information about the shapes and patterns of the physical and human features of Earth (p. 64).

The authors continue to explain that

[Mental maps] contain objective and precise knowledge about the location of geographic features such as continents, countries, cities, mountain ranges, and oceans. They also contain more subjective and less precise information, such as impressions of places, rough estimates of relative size, shape, and location, and a general sense of certain connections between places as well as priorities that reflect the mapmaker's own predilections (p. 64).

These general statements depict the broad and complex nature of mental mapping. In fact, the techniques one may use to measure one's "internalized representation" about people, places, and environments vary considerably. Research techniques employed include: labeling place locations on a map (Cross, 1987; Helgren, 1983; Lloyd, 1989), estimating directions from one reference point to another (Buttenfield, 1986; Chiodo, 1993; Lloyd & Heively, 1987; Matthews, 1984; Metz, 1990; Moar & Bower, 1983; Murray & Spencer, 1978; Sadalla & Staplin, 1980; Stevens & Coupe, 1978; Taketa, 1990), estimating the distance from one point to another (Antes, McBride, & Collins, 1988; Buttenfield, 1986; Hirtle & Jonides, 1985; MacEachren, 1980; Newcombe & Liben, 1982), verbally describing one's internal representation of a place (Axia, Baroni, & Peron, 1988; Lloyd, 1989), sketching free-recall maps (Chiodo, 1993; Drumheller, 1968; Matthews, 1984; Metz, 1990; Murray & Spencer, 1978; Pocock, 1976; Robinson, 1980; Saarinen, 1973; Saarinen, 1988; Saarinen & MacCabe, 1995; Saarinen, Parton, & Billberg, 1996; Taketa, 1990; Wise & Kon, 1990), ranking cities according to latitude and longitude (Muller, 1985), judging perception and desirability to reside in specific places (Gould & White, 1986), and area estimation (Driever, 1983). These techniques also assess different dimensions of one's mental maps and abilities.

In addition to employing widely varying techniques mental maps are also studied at numerous scales. They can be studied at large scales such as the hallway of a local school (Axia et al, 1988), a neighborhood (Matthews, 1984), or a city (Buttenfield, 1986; Lloyd, 1989; Pocock, 1976). They can be studied at smaller scales such as that of a state or country (Driever, 1983; Robinson, 1980). And they can be studied at one of the smallest scales - the global scale

(Chiodo, 1993; Cross, 1987; Helgren, 1983; Metz, 1990; Muller, 1985; Saarinen, 1973; Saarinen, 1988; Saarinen & MacCabe, 1995; Saarinen et al., 1996; Taketa, 1990; Wise & Kon, 1990). This thesis will use two well-established techniques to assess mental maps at the global scale: locating places on a map and freehand sketching.

Related Sketch Map and Place Location Research

The research techniques used here have been employed in classrooms and in previous research. Locating a place on a map is a common classroom task, but has not been a common research technique to measure mental mapping skills. To illustrate its popularity, most readers can recall locating the fifty state capitals on a United States political map. The task of sketching a map is not as common in the classroom as locating places, but sketching is more commonly used for research in mental mapping. Though the manner in which these techniques have been used differs, each has contributed to the literature for mental mapping research.

Place Location Research

Helgren's (1983) study is one of the few published reports that ask subjects to place a location on a map. As explained, in order to assess the geographic knowledge of the students in his introductory geography class, Helgren asked students to locate a number of places on a world base map. The results were exceedingly poor and news about the students' geographic illiteracy was spread throughout the media.

Cross (1987), building on Helgren's report asked students to locate eleven countries that had received significant attention in recent world affairs and to fill out a questionnaire regarding personal characteristics such as gender, college geography class experience, academic major, and use of mass media. A country's location was considered correct if it was marked and labeled within the country's borders. If a location was marked and labeled within 1000 miles of the country the author noted that the student was aware of the region. Gender was a significant factor. Male students performed better than females. No female was able to identify ten of the eleven countries to be labeled whereas about 5 percent of the male students could. Regarding

academic major, education and human resource majors performed the worst. Over one-fifth of the education majors that participated could not identify one country. The use of media was also a significant factor. About half of the students surveyed did not read the national or world section of a newspaper. However, students who stayed abreast of current events by watching the national or world news showed greater knowledge. Cross also reported that students who read newspapers or news magazines (*Newsweek*, *Time*, and *US News and World Report*) were “most likely to be able to correctly locate at least half of the countries, whereas students who relied on friends or acquaintances [for knowledge of current events] displayed the greatest ignorance” (Cross, 1983, p. 62). Travel experience, academic level, or previous high school geography coursework were not significant factors explaining place location knowledge differences.

Locating places on a map has been used for reasons other than assessing place location knowledge. Lloyd (1989) used the technique to learn if distortions of an urban setting (Columbia, South Carolina) in a person’s mental map differ according to the manner in which the spatial information was encoded. The encoding methods he studied were direct experience through navigation and indirect experience through studying a map. Using subjects from the University of South Carolina, Lloyd conducted two separate activities having the subjects use a digitizing tablet to locate a landmark in relation to one of three reference points. In his first study dubbed “The Columbia Experiment” subjects who passed a familiarity test of the landmarks were asked to locate a place in relation to one of three reference points. Each of the places to be located was randomly paired with the reference points. The second experiment dubbed “The Fargo Experiment” involved a hypothetical map of Fargo, North Dakota that used realistic names. The distances between the landmarks and the reference points were identical to those used in the Columbia experiment. After studying the map and being able to identify all the locations on the map, the subjects performed the location tasks identical to the Columbia study.

Using the two sets of data, Lloyd (1989) compared the relative and absolute distortions of the subjects’ maps, the relationship between place location accuracy and reference point, and the overall proportion of error in one’s map that is absolute and relative. Absolute error in this case is defined as “systematic error caused by cognitive processes that translate, rotate, or scale

locations” (p. 105). These errors could be systematically removed by either moving the location of the place identified, rotating the orientation of the object drawn, or by scaling the item to make it larger or smaller. Relative error, on the other hand, “would distort the remembered shape of an area or cause the distances and directions between points...to be incorrect” (p. 105).

Analysis at the aggregate and individual levels indicated that reference points influenced place estimation accuracy for both the Columbia and Fargo subjects. In general, estimations were more accurate when a subject used a central reference point. Regarding location estimation ability, Fargo subject location placements were less distorted than those from the Columbia study. Columbia subjects made significantly more absolute and relative errors. Fargo subjects also completed the tasks quicker and made errors that followed a more consistent pattern.

Lloyd (1989) concludes these place estimation differences are related to the manner in which the information was encoded. That is, using a map allows people to encode it as “survey knowledge” that is similar to a map, whereas encoding it through navigation results in chunked pieces of information and most likely is verbal procedural knowledge (p. 122). Consequently, one may infer that if the tasks asked of the subjects were different, the results would also differ. Certainly one would think if the subjects were asked to drive to the places mentioned, those with navigational experience could complete the place location task better. Lloyd’s study is instrumental in analyzing how map reading and direct experience influence one’s ability to locate places on a map. In general, one who learns more from a map is going to perform the task quicker, more accurately, and consistently.

Free Sketch Map Research

Whereas research of place location knowledge has been narrow, the free sketch mapping technique has been used in many different situations. This broad use has been one criticism of the technique, because different researchers measure free sketch maps differently which makes comparisons between studies difficult (Kitchen, 1994a; Saarinen, 1988; Saarinen & MacCabe, 1995). Other criticisms include the idea that sketch maps measure drawing ability not knowledge, and that they vary in scale, orientation, and content which makes them difficult to be

measured directly with the environment (Saarinen). Nevertheless, these criticisms have not deterred researchers from employing the technique. As Saarinen and MacCabe explain, “the sketch map technique is not all things to all people, but it is widely used in education and research because it is flexible and easy to administer, and people can readily draw the maps at any scale” (p. 198). The next few paragraphs will offer an overview of related literature to sketch mapping.

Drumheller (1968) states, “the ability to conjure up a map is...perhaps the major map skill [one] needs as a citizen” (p. 141). However, he also cites that it is a skill that has been neglected in schools. His research compared the cognitive mapping abilities of sixth graders, college sophomores, and graduate students to part of Piaget’s (1967) developmental theory of a child’s concept of space. According to Piaget’s theory as one matures and adapts to one’s environment one’s ability to draw and represent spatial relationships advances through three stages. In stage one a child (preschool to early middle childhood) is able to construct simple space relationships like proximity and separation. In stage two a child (mid-preschool to middle childhood) is able to construct spatial relationships from different points of view. In stage three the child (adolescence and beyond) is able to use reference systems to organize space while taking into account length, distance, surface, and volume (Hart & Moore, 1973, pp. 259-269).

Grading the subjects’ cognitive maps from 0 (unidentifiable) to 5 (most accurate) Drumheller’s study found that at least 20% of each group could not draw a map of the world. Although there was some noted drawing improvement with age, Drumheller contends that Piaget’s developmental stages are not universal. While many adults will reach the expected level of development, some may not reach the level at all (p. 145). Therefore, these stages, Drumheller, concluded, are not automatic, and that improvements needed to be made in the teaching and learning of map skills (reading and drawing).

Saarinen (1973) employs the freehand sketch map technique to analyze four different groups of high school students’ views of the world and some of the factors that may influence the maps. The subjects tested were from the United States, Canada, Finland, and Sierra Leone. Saarinen analyzed how nationality, proximity, size, shape, location, and current events serve as

factors in mental maps. Regarding nationality, the subject's home nation was the most frequently included feature on the sketch map. This outcome supported the idea that students will have a better map of areas that are closer to their home. Saarinen further supports this hypothesis by providing the number of times the Canadian provinces were named by the students from Canada. Shape of an area was a significant factor. For instance, Chile was included more often than any of the other South American countries. This is most likely related to its distinct shape. Italy was another example Saarinen mentioned whose boot shape probably helped students remember its inclusion. The size of a country also influenced its inclusion in a subject's map. Current events also influenced the students' maps. To illustrate, Israel, Vietnam, Nigeria, and Egypt were more clearly drawn on students' maps. Each of these countries, at the time of the study, had been mentioned in the news often. Lastly, Saarinen noted that cultural factors, such as military involvement and schooling may influence one's mental map. This was evident in Canadian students where 32 % of all the features noted on their world maps were part of the British Commonwealth.

Pocock (1976) studied large-scale sketch maps by comparing the characteristics of those drawn by the residents, visitors, and tourists of Durham, UK. Visitors were considered residents of Durham County who were enrolled at Durham University, and tourists were those who visited the city infrequently. The maps were first categorized as sequential or spatial based on Appleyard's (as cited in Pocock) classification system. Sequential maps are those that consist primarily of roads, whereas spatial maps primarily contain spatial elements such as residential or business districts. Most maps drawn (56 %) were sequential. The maps were then further classified into sub-categories of each type.

Next, Pocock (1976) analyzed the complexity of the maps and compared the results to variables of gender, age, familiarity (years of residence or number of visits/year), sense of attachment to the area, and sense of attraction to the area. More complex maps were drawn by male tourists, and by visitors and tourists younger than 40 years of age. Familiarity was measured by years of residence in the area, and was separated into two categories – less than 10 years and greater than 10 years. Those living in the area less than 10 years showed a higher probability of producing more complex maps. This was also the case for tourists who visited the

area often. These findings led Pocock to conclude that activity in the city influences whether or not a map will be more or less complex.

Pocock (1976) also evaluated the orientation of the subject's maps. Less than 37 % drew maps with a conventional (north/south) orientation. Spatial maps were more likely to be drawn with conventional orientation whereas sequential maps were less conventional. Regarding subject type, visitors to the city were most likely to draw non-conventionally oriented maps, whereas tourists were least likely. This, Pocock suggests, is related to how each population group uses the city. Since visitors travel to the city more frequently their orientation may be related to the route they use to travel into the city, hence causing a less conventional orientation.

Pocock (1976) graded the figure of the maps by evaluating organization and form. The maps were categorized into three categories (high, some, or none) regarding the tendency for the map to have good figure. Good figure maps were classified on the basis of proximity, closure, symmetry, parallelism, and rectilinearity (p. 502). About 20 % of all of the maps were considered "high" good figure maps, whereas approximately 40 % did not exhibit good figure. Residents and visitors to the city drew "high" good figure maps more frequently than the tourist group. Pocock concluded that a good figure map is "more likely to be produced if the respondent is male, middle class, or is familiar with the city" (p. 506).

Murray and Spencer (1979) used Pocock's (1976) and Appleyard's classification methodologies to study how mobility influences one's mental mapping abilities. Five sets of maps drawn by a high mobility (airline pilots) group, a medium mobility group (community college students), and a low mobility group (miners older than 40 years old) were compared. The subjects drew maps of five different scales. These scales were: immediate locality, town, route to and from work, region, and world. The most mobile group tended to draw more complex maps than the other groups for each type of map except for the route map. This, the researchers contend, is due to the fact that the route map is perhaps "the most over learned of the tasks...[and] the low mobility groups are at no disadvantage when compared with the medium and high mobility groups" (p.388).

As part of the same report, but with a different group of subjects, Murray and Spencer studied the association between mental mapping skills, general image strength, and the extent of general graphic ability. They analyzed these differences by comparing subjects' drawings of their house to their mental map of the university campus. The study found that one's ability to draw is significantly related to the level of complexity and organization of one's mental maps. The researchers note however, that "whilst drawing ability is related to the performance of the tasks it only accounts for between 10 and 25 percent of the variance, and thus its importance should not be overstated" (p. 391). They further explain, that "mental mapping techniques may be flawed, but they do reflect the differences in the skill of cognizing the environment which could only otherwise be brought out by laborious interview or questionnaire techniques" (p. 391).

Matthews (1984) studied neighborhood free sketch maps of children ages 6 – 11 to see if gender influences one's awareness of and ability to map a place. The maps were measured by averaging the distance between the subject's home and the farthest places included on the maps, and using a standard distance statistic that allowed the subject's place knowledge to be compared. Boys in each age group were more aware of places farther away from their homes than girls. However, older boys' (11 years old) maps were generally less detailed and tended to be more artificial, whereas 11 year-old girls maps tended to show more detail, but contained less area and understanding of local routes. Matthews suggests that these differences are a result of "gender expectations" by parents and society (p. 334). These expectations may include girls staying closer to home to play, and boys being more adventurous playing throughout their neighborhood.

Much recent sketch mapping research has been education related. Some researchers have reported on sketch map suitability as an instructional tool for teaching mapping skills (Metz, 1990; Taketa, 1996). Metz reported that sketch maps are useful for teaching world spatial relations in a developmental manner. Sketch mapping is much different than placing a location on a map. Students must, in addition to knowing where the places are located, have a more holistic understanding of the continent shapes, areas, and relative locations. Metz's students were asked to draw from memory a map of the world on the three different occasions throughout

the academic year. In general, the first set of maps revealed that the students' mental maps primarily consisted of continents and oceans. However, in January and May the students' maps included the equator, the prime meridian, and the tropics as reference points. Metz also noted a noticeable improvement in continent shape, area, and location in the maps from the latter drawing sessions. The number of items included on the maps also increased. Taketa using his sixth grade class as a case study, reports that sketch maps are excellent tools for teaching elementary students basic map properties such as scale and distance.

Sketch maps have also been identified as excellent diagnostic and assessment tools for high school and college students. Robinson (1981) has used sketch maps to assess the types of mental maps his students brought into his college level geography classes. One of the values of this exercise, he explained, was how he learned "how little [the students] actually know" (p. 53). Physical features were not that common on the maps and some of the larger cities were rarely included. Political units were the most common features, however the eastern Atlantic Provinces seemed to be unknown to many of the students. Robinson suggested that this may be due to the lack of attention the Atlantic Provinces receive in Canadian newspapers and television newscasts. Other explanations for their exclusion may include the complexity in shape and size of the eastern provinces, or simply students did not have enough room on the sheet of paper to draw the provinces. Nonetheless, the maps provided Robinson with a good idea of the images his students possess of their nation, and he was able to adjust his lessons accordingly.

Wise and Kon (1990) used sketch maps as an evaluation tool for individual and class geographic knowledge. Comparing sketch maps drawn by sixth graders at the beginning and end of the academic year their research evaluated the growth of geographic knowledge by analyzing the quality of the maps. The quality was measured through four types of questions that evaluated student understanding of place inclusion, spatial relations, map conventions, and the whole world model. The results demonstrated overall improvement in geographic knowledge. During the pretest only 23 of the 51 subjects even included Africa on their sketch maps. During the posttest 49 included the continent. During the pretest six subjects drew Africa as being larger than the United States. During the posttest 36 subjects depicted this relationship. Improvements were also noted for the inclusion and relative positions of North America and South America.

Chiodo (1993) analyzed the sketch maps of pre-service teachers to evaluate four items. They were: the extent that these teachers' mental maps of the world are developed; the differences that may exist between secondary and elementary pre-service teacher mental maps; the differences that may exist between female and male pre-service teachers mental maps; and whether there was a common map projection that pre-service teachers used to construct their mental maps. To measure the maps, Chiodo graded the maps with the following criteria:

- 1) Continents: The students were able to draw all seven continents on their maps.
- 2) Relative Location: The students were able to draw the continents in the correct hemisphere and place the continents in the approximate location within the hemisphere.
- 3) Correct Labels: The students were able to correctly label all seven continents on their maps.
- 4) Size Relationships: The students were able to draw the correct size relationships between the landmasses. (Chiodo, p. 111)

From his sample of 70 subjects Chiodo (1993) found that secondary pre-service teachers, generally drew better quality maps than elementary pre-service teachers. Regarding gender, male students' maps were better. Female elementary school pre-service teachers performed the worst of all the subject groups. Secondary male teachers performed the best. As for a specific map projection depiction, more than half of the participants drew maps that resembled the Mercator projection.

Perhaps Saarinen and MacCabe conducted the most extensive sketch map study. In the late 1980's they collected over 3800 sketch maps from subjects living in more than 50 countries to assess worldwide patterns of geography literacy. From this map collection a number of reports were presented. Saarinen (1988) analyzed the maps to evaluate how they were centered. In general he found the maps to follow three centering patterns. Eighty percent of the maps collected were Eurocentric. Eurocentric maps are characterized with "the Americas on the left; the Atlantic Ocean, Europe and Africa central; and East Asia on the right" (p. 118). This projection was most commonly drawn by in European and African subjects. Sinocentric

centered maps are characterized with “Europe on the far left, East Asia and the Pacific Ocean central, and the Americas on the right” (p. 119). Eleven percent of all of the maps collected were drawn with this type of centering. These maps were dominant in Oceanic countries such as New Zealand, Australia, and Papua New Guinea. The last centering pattern identified was Americentric. This projection is one that places the Americas in the center. It was the least used type of centering (7 % of all maps collected). The area whose subjects centered their maps this way most often were from Alaska. To explain these centering patterns Saarinen identified two dominant factors. First, longitude seemed to be a significant influence. The likelihood of the type of centering used by the subjects was strongly related to their nation’s longitudinal location. Another explanatory factor is colonial influence. Many of the country’s education systems are influenced by Europe’s imperial legacy, thus helping to explain why students in India and Pakistan favored the Eurocentric centering technique.

Using this same collection of maps, Saarinen and MacCabe (1995) analyzed them to evaluate world patterns of geography literacy. The maps were graded and ranked by counting the number of nations and countries included on each sketch map. These maps were then categorized into five groups: poor (fewer than 20 items per map), flawed (20-29 items per map), good (30-44 items per map), very good (45-75 items per map), and excellent (over 75 items per map) (p. 197). The overall average number of items per map was 35.6. Forty-five percent of all of the students could draw a good map. Five percent of the students drew excellent maps, and of that group 13 individuals were able identify over 100 items. By continent, European subjects provided the most complete maps, while South American and African subjects provided the most incomplete maps. This pattern, the authors suggest, is related to education and culture. The nations that performed best generally had better geography education programs. Moreover, most of the sites whose maps fell into the good or very good category were from modern industrial societies. Most of the participant’s from poor countries drew poor or flawed maps. Exceptions to this explanation included Rwanda, Zimbabwe, and Argentina. The report also compared its findings to the 1988 National Geographic Gallup poll survey. There was a direct comparison of how the countries ranked. This supports the validity of Saarinen and MacCabe’s research. This study, as they explain, “provides baseline data comparing geographic knowledge in fifty two nations” (p. 202).

Using a subset of the sketch map collection, Saarinen, et al. (1996) compared the size of continents to study patterns of relative area distortion. The area of the continents was calculated “as a percentage of the total of all segments measured on [each] map” (p. 39). In general, a participant’s home continent and Europe were exaggerated in area. Africa’s area was consistently diminished in size. The authors explain that, “the size of an area is generally proportional to its perceived importance and how well it is known” (p.46). Another possible factor is the prevalent use of the Mercator projection, which enlarges Europe and compresses Africa. . The authors suggest that the consistent exposure of a distorted projection may influence an individuals sketch map in the same manner.

Influences on One’s Mental Map

Mental maps are anything but perfect. Like two-dimensional map projections it is impossible for one to draw a mental map that shows all three-dimensional properties cartographically correctly. A person’s cognitive understanding and representation of his/her immediate and surrounding environments result from many direct and indirect experiences (Downs & Stea, 1973; Gould & White, 1986, Kitchen, 1994a). Kitchen identifies nine groups of variables that can affect mental mapping ability. These variables are:

- 1) Environmental deterministic sources (unalterable) e.g. general physical topography, objective distance.
- 2) Environmental deterministic sources (alterable) e.g. number of turns or intersections along a route, urban structure.
- 3) Environmental interaction sources e.g. familiarity, mode of travel, travel time.
- 4) Social circumstances and interaction sources e.g. Education, Socioeconomic status, media, social/verbal mediation, and experience of map use.
- 5) Perceptual filters, perceptual context and anticipatory schemata e.g. senses, current emotional state, what you expect to find.
- 6) Characteristics of the mapper (determined) e.g. age, gender.

- 7) Characteristics of the mapper (undetermined) e.g. inner organismic, factors such as beliefs, needs, emotions, personality, self-confidence.
- 8) Cognitive style e.g. how a subject approaches a problem.
- 9) The form, function, structure and contents of the information in the brain.

(Kitchen, p. 43)

A number of variables that influence cognitive mapping abilities have already been mentioned. These include gender (Chiodo 1993; Cross, 1983; Matthews, 1984), navigation versus map usage (Lloyd, 1989), age (Drumheller, 1968; Matthews, 1984, Pocock, 1976), nationality (Saarinen, 1973; Saarinen, 1988; Saarinen & MacCabe, 1995; Saarinen et al., 1996), proximity (Gould & White, 1986; Saarinen, 1973; Saarinen, 1988; Saarinen & MacCabe, 1995), length of residency (Pocock, 1976), mobility (Murray & Spencer, 1978), and media (Cross, 1983; Robinson, 1981; Saarinen, 1973). Encoding variables such as rotation and alignment also influence the quality of mental maps (Tversky, 1981; Tversky, 1992). The variables being researched here however, are mostly associated with one relatively newly phrased influence--spatial familiarity.

Golledge and Spector (1978) hypothesized that the more familiar one is with one's environment the more accurate his or her cognitive configuration of the environment will be. At the time of the Golledge and Spector publication, spatial familiarity had not yet been defined. In fact, it was an ambiguous term until Gale et al. (1990) explored its meaning. Using a random sample of subjects in Goleta, California, Gale et al. used three tests to analyze those variables associated with one's familiarity of a place or location. The first of these tests asked subjects to "list the ten places you believe you know the best in this area" (p. 302). From these responses the researchers identified four dimensions to spatial familiarity. The first dimension is place location knowledge. One knows where the place is. The second dimension is name identification. One is able to identify a place by knowing its name. The third dimension is visual recognition. One can identify a place by seeing a picture (remote sensed image, general photograph) of that place. The last dimension is interaction. One's familiarity is also related to one's close association with a place. The more one interacts with a location, the more familiarity one will have.

Gale et al. (1990) further tested these dimensions by assessing how the four dimensions were associated to one's familiarity of a specific place. Using the twelve most mentioned places from the first experiment, subjects were asked to rate how familiar they were with a place based on location accuracy, visual recognition, name recognition, and frequency of interaction/encounter. The results indicated that most of the cues were considered familiar to the subjects. The results also showed that three of the four variables were closely related to one another and thus measured similar things. The only dimension that was distinctive was interaction. To confirm these findings a third test was conducted to assess the significance of each of the dimensions. Interaction with a place seemed to be the most important dimension explaining one's spatial familiarity of a place. Gale et al. concluded that one's overall spatial familiarity is a two dimensional construct. It can be measured by having one rank their interaction with a place and using one of the other three dimensions.

Kitchen (1994b) identified a fifth dimension to spatial familiarity. This dimension is "knowledge about the place such as the history and current affairs...acquired from secondary sources such as the media and education" (p. 44). In his study, Kitchen researched whether or not spatial familiarity is truly two-dimensional. He analyzed the dimensionality by using a test very similar to the second study conducted by Gale et al. (1990). The primary difference in his study was the types of places chosen. Rather than using only well-known places, Kitchen's list of locations included well-known, well-known to some subjects, and unknown areas. This, Kitchen contended would allow for a "more complete study of familiarity," because it is studying places not as familiar in addition to familiar places (p. 46).

Using a familiarity index of place formula, Kitchen obtained a value of 0-100 for each dimension of familiarity for each location. This test enabled him to assess whether or not two measures of familiarity are necessary to determine spatial familiarity. The values for each of the dimensions were ranked and a correlation test was administered. No correlation between the variables was below 0.958. As a result, Kitchen's concluded that only one dimension has to be measured to assess familiarity. Kitchen then tested whether or not spatial familiarity is a significant influence on one's configurational knowledge of an area. Subjects placed 25 locations onto maps and the accuracy of these locations was measured using a bidimensional

regression technique that is similar to linear regression. A one tailed t-test revealed that one's location accuracy is strongly related to spatial familiarity. Yet, whether or not spatial familiarity is the most influential variable has not yet been determined.

Scope of Research

One's knowledge of current events, as identified by Kitchen (1994b) is a dimension of spatial familiarity. Employing many of the methods used in the studies mentioned, this thesis studied the relationship between knowledge of current events and their ability to construct a mental map of the world. It was hypothesized that the more a person knows about current events the more accurate that person's map of the world will be.

Current event knowledge was used in studies conducted by Saarinen (1973) and Cross (1983). Yet, their assessment using this factor was very general. Saarinen looked for general patterns in global mental maps as they may be related to current events. Cross researched the relationship between one's effort to keep up with current events to their ability to locate nations on a world map. This study is more comprehensive. It tests students' knowledge of specific significant current events, thus providing a quantitative, and more measurable, test score.

The subjects also identified the location of specific cities on a world map, and drew from memory the seven continents of the world. Similar to Cross, the difference between the location of the city identified by the student to the correct cartographic location was measured. However, unlike his study, it did not count a location as correct or incorrect, but rather, using ATLAS Geographic Information System (ATLAS), the total distance error was measured (in miles).

The subjects' mental maps were measured using variables similar to those employed by Chiodo (1993). The maps were measured on the basis of continents, location, and size relationships. Most of these variables were quantitatively scored using ATLAS. However, as will be mentioned in the next chapter, some analysis was done manually.

The absolute, quantitative measurement of sketch maps has been criticized due to map variations in scale, orientation, and content (Saarinen, 1988). This thesis controls these variables. First, students were asked to draw a map of the world on a sheet of paper using the same longitude and latitude control points as the base world map it was measured against using ATLAS. The prime meridian and equator were provided as reference lines for orientation and scale. It was assumed that college students should be able to identify and use these lines to orient and scale their world maps. Content was also controlled since subjects were only being asked to draw the seven continents of the world. These instructions allowed ATLAS to better measure those variables already mentioned.

This study did not assume that the mental maps drawn would be cartographically correct. However, the study hypothesized that more knowledge of current events would be related to more accurately placed city locations on a world map and more accurately drawn free sketch maps. The methodology of this study is addressed in Chapter 3.

Chapter 3 - Methodology

Several methods were used to measure the relationship between current event knowledge and the ability to construct a mental map of the world. This chapter outlines the tasks completed to obtain the results discussed in Chapter Four. These steps include the development and use of four data collection instruments, the organization and measurement of data (current event, participant profile, and mental mapping skills), and the statistical analysis of these variables.

Participants

One hundred twenty-eight students drawn from two courses offered at Virginia Tech participated in this research project. One hundred and twelve of the participants were from a freshman level Introduction to Human Geography course. Since the course is an option in the required core curriculum it provided a diverse pool of subjects. The majority of the students in this course were freshman and sophomores from many different academic majors. Except for class standing, the individual characteristics of this group varied considerably. The course does not focus on developing map skills or knowledge of world regions. Thus, it is assumed that the group would not have an unfair advantage performing the map drawing and map labeling exercises. In order to confirm the reliability of the study, a control group of 16 students were drawn from a junior-level History course. Subjects from both classes received academic extra-credit for participating in the study, to encourage them to take it seriously.

Procedures and Instruments

Data collection occurred during two one-hour phases and involved four separate tasks. These tasks were filling out a participant profile, taking a current events quiz, drawing from memory a map outlining the seven continents of the world, and locating and labeling 27 world cities/places on a world map. Each of the data collection instruments were approved by Virginia Tech's Institutional Review Board (IRB #97-117). The first two tasks described were completed during the first one-hour sitting, and the latter two tasks were completed during the second sitting. The next few paragraphs explain the design and use of the research instruments.

Instrument One - The Participant Profile

The Participant Profile was modeled after that used by Cross (1987), and consisted of 19 questions regarding the participant's personal and academic background, perceived effort to remain informed of current events, perceived travel experience, and perceived map reading ability. Background questions included gender, academic major, academic level, and previous geography coursework taken. The questions pertaining to effort to remain informed of current events, travel experience, and map reading ability were designed to obtain ranked answers. This question structure was chosen, so that the students' efforts and behaviors could be scored quantitatively. The descriptive statistics of this data could then be used to study their relationship to the subjects' performance on the other three tasks. The complete participant profile can be found in Appendix A.

Instrument Two - Significant Current Event Quiz

A test containing 36 questions was developed to gauge the participants' knowledge of recent significant national and international current events. The test did not have a time constraint. This instrument served as a way to measure the fifth dimension of spatial familiarity - knowledge about a place's current affairs acquired from indirect experiences (Kitchen, 1994b). The development and nature of the quiz are explained next.

Robinson (1981) found that Canadian students knew very little about the far-eastern part of Canada. He attributed this lack of knowledge, in part, to the little coverage that Canadian newspapers and television stations gave to these regions. Since not much is reported about the area, little is known. With this in mind, it was deemed necessary to ask questions about current events considered significant. To be significant, the event had to receive substantial media coverage in those sources through which students would be exposed to national and international news. To be included in the study, an event met the following criteria:

- 1) The event had to have received media attention during the period of February 1, 1997 through March 31, 1997.**
- 2) The event must have been reported in at least 2 of the following general media sources: Major Newspaper (*USA Today*, *Washington Post*, and *Roanoke Times*), major television newscast (CNN, NBC, CBS, and ABC), and major news magazine (*Newsweek*, *TIME*, and *US News and World Report*).**
- 3) For newspaper reports and television newscasts, the event must have been extensive. If the event was reported on at least three separate occasions, it was considered significant.**

The sources used to gather current event information were chosen due to their availability to students. All on-campus (all freshman must live on campus their first year) students have cable television thus they are able to receive news broadcasts from each of the major networks mentioned. Regarding newspapers, we chose *The Washington Post*, *USA TODAY*, and *The Roanoke Times*, because they are available in the vending machines around campus. It is assumed then, that these would be the most widely read newspapers. *Newsweek*, *TIME*, and *US News and World Report* were chosen, because they are the leading news magazines on the market, and are available in most convenience stores and bookstores.

Since these media sources are United States based, many regions and events did not meet the criteria. That is, certain regions of the world did not receive much coverage in these sources. Each inhabited continent, except Australia, had at least one question included in the quiz (see Table 3.1).

Table 3.1. Breakdown of Current Event Questions by Continent

<i>CONTINENT</i>	<i># OF QUESTIONS</i>
AFRICA	4
ANTARCTICA	0
AUSTRALIA	0
ASIA	4
EUROPE	8
N. AMERICA	18
S. AMERICA	2
<i>TOTAL</i>	<i>36</i>

As Table 3.1 demonstrates, North American current events dominate the quiz. However this was expected considering the media sources most readily available were American. The complete current event quiz can be found in Appendix B.

Instrument Three – Free Sketch Mental Maps

The third instrument used was the world map drawing task. This task was similar to the one employed by many of the studies discussed in Chapter 2 (Chiodo, 1993; Drumheller, 1968; Metz 1990; Saarinen 1973; Saarinen, 1988; Saarinen & MacCabe, 1995, Saarinen et al., 1996; Taketa, 1990; Wise & Kon, 1990). The primary similarity was that students were asked to draw from memory a map of the world. However, for this study the directions were not as open-ended as those employed in these studies.

Constraints were placed in the directions, so that the participant maps could be compared against each other using ATLAS GIS. The students were provided an 8½x11 inch sheet of paper that included a 1:134750000 scale Robinson Projection grid containing the Equator and Prime Meridian. This projection was chosen, because it minimizes the angular and area distortions of the world (Robinson et al., 1995), and is a common projection included in textbooks and classrooms. The Equator and Prime Meridian were included as reference lines so that a common

orientation could be used to analyze the maps. These two cartographic lines are basic mapping principles so it is assumed that college level students should be able to use them as referencing agents to draw from memory a map of the world. Lastly, rather than asking the students to include continents, countries, cities, and physical features on their mental maps, the directions limited them to outline and label the seven continents. This constraint was chosen so that the maps would remain legible and could be measured by ATLAS GIS. In short, each participant was asked to do the following with the 8½x11 inch sheet of paper containing the Robinson Projection grid.

In the space provided, please draw from memory a map of the world outlining and naming the seven continents.



Instrument Four – Place Location Exercise

The last data collection instrument was the significant place location exercise. This instrument had the students locate and label twenty-seven cities on a world map. The cities selected were at or near the location where the significant current events chosen for the current event quiz questions occurred. If the current event could not be tied specifically to a major city, or was referring to a nation in general, the nation's capital was chosen as the significant city. Like the current event quiz, North American cities significantly outnumbered those for each of the other continents (See Figure 3.1). Again this is due to the amount of media coverage each of these areas received during the months of February and March 1997.

Using a ©Rand McNally & Company Desk Activity Map (Denoyer Semi-Elliptical Projection), the students were asked to locate each of the places by marking its location with a point and labeling it with its appropriate name and number. The map contained major rivers and political boundaries. These features provide a reference system to increase the accuracy of the student's ability to locate the places. The students were also given verbal instructions to not attempt to locate a place if they had no idea where it was located. However, if they had a general idea (relative location), such as which continent it is located on, they were asked to go ahead and guess its location. This was done so that place location ignorance could be measured. That is, leaving a place off of one's map indicated complete place location ignorance; whereas allowing them to locate it relative to the political boundaries allowed for the distinction between absolute and relative place location ignorance.

Algiers, Algeria (Africa)	Everglades, FL (N. America)	Los Angeles, CA (N. America)
Atlanta, GA (N. America)	Grozny, Russia (Europe)	Mexico City, Mexico (N. America)
Bangkok, Thailand (Asia)	Helsinki, Finland (Europe)	New York City, NY (N. America)
Beijing, China (Asia)	Jakarta, Indonesia (Asia)	Oklahoma City, OK (N. America)
Belgrade, Yugoslavia (Europe)	Jerusalem, Israel (Asia)	San Diego, CA (N. America)
Boulder CO (N. America)	Kinshasa, Zaire (Africa)	Sarajevo, Yugoslavia (Europe)
Cairo, Egypt (Africa)	Lima, Peru (S. America)	Tehran, Iran (Asia)
Chicago, IL (N. America)	Little Rock, AR (N. America)	Tirana, Albania (Europe)
Edinburg, Scotland (Europe)	London, England (Europe)	Washington, DC (N. America)

Figure 3.1. Significant Current Event Sites

Data Collection

Data collection occurred during two separate one-hour sessions. During the first session participants completed the participant profile and the significant current events quiz. Their answers were recorded on op-scan sheets for efficient scoring. All subjects were able to complete each task within the one hour time period.

During the second session the participants completed the free sketch exercise and the place location exercise. No maps of any kind were visible to the subjects during the completion of these exercises. All subjects completed the exercises during the time allotted.

Data Organization

Once the data were collected, each participant's results were examined to measure completeness. Out of the initial 128 participants, 48 sets of data were considered incomplete for reasons including failure to complete all four parts to the study, failure to follow instructions, and mental map or place location world map illegibility. Consequently 80 sets of data were analyzed. Out of these 80 participants, 69 were enrolled in the Introductory to Human

Geography course and 11 were enrolled in the 3000 level History course. A demographic breakdown of the qualifying participants is offered in Table 3.2.

Table 3.2. Participant Demographics

Females	Males	Freshman	Sophomores	Juniors	Seniors	Graduate
45	35	35	20	15	9	1

Digital Transformation of Data

The data collected via the sketch map exercise were digitally converted into geographic files. Using six control points to control scale and orientation, each individual sketch map was digitized (traced) into a file using ATLAS GIS. Converting the maps allowed the datum to be analyzed with cartographic overlay and intersection. Individual data from the place location exercise were digitally converted using the same technique.

Sketch Map Measurement

Once the maps were in digital format they were analyzed, similar to Chiodo (1993) on the basis of continent inclusion, location, and size relationships. However, unlike his study in which Chiodo employed a Likert scale of 1-5 to assess each variable, ATLAS allowed each of the variables to be scored against a cartographically accurate Robinson Projection. These scores would be in ratio form, hence allowing analysis of the data with more thorough statistical methods such as correlation.

A number of inaccuracy values were calculated for each mental map. Three values of inaccuracy were calculated for each continent drawn on the mental map, and three cumulative error values for each mental map were calculated. First, using a basic GIS overlay operation, each mental map was placed over a Robinson Projection base map of the same scale. The area of intersection between the two maps was calculated. A value of cartographic location accuracy

for each continent was then calculated by dividing the amount of area that intersected with the base map continent by the total area of the mentally drawn continent. A value for Location Error was obtained by subtracting the cartographic location accuracy value from 1.0. This formula calculated the percentage of the sketched continent that was inaccurately drawn (see Figure 3.2).

A second value, Area Error, was calculated by dividing the size of each of the continents drawn to the true cartographic size of the continent on the Robinson projection. If the value calculated was less than 1, it was subtracted from 1.0. However if the value was greater than 1.0, 1.0 was subtracted by this value. This calculation was done in this fashion so that the percentage of size inaccuracy would be consistent for each continent (see Figure 3.2).

The total amount of cartographic inaccuracy, coined Cartographic Error, was then calculated for each mentally mapped continent by summing the continent's Location Error and Area Error together. Missing continents were given a value of 14 which was the next whole number greater than the value calculated for the most inaccurately drawn continent in the sample. The errors for the continents on each individually drawn map were then summed together to calculate the total amount of location (MM Location Error), area (MM Area Error), and total (Mental Map Error) inaccuracy for each mental map (see Figure 3.2).

Once each of these values were calculated a fourth value, Mental Map Score (MMS), was calculated. To score each map the Area Error value for each continent was scored against each other. That is, each Area Error was divided by the largest error value for each continent Area Error. These values were then added with each map's MM Location Error. Consequently, maps with a larger Cartographic Error did not necessarily have a larger MMS. This was done so that one extremely high continent Area Error did not drop the map to the bottom of the Mental Map Error rankings, when in fact they did very well on drawing the sizes of the other six continents.

Given each of these formulas: a value of 0.0 for each of the variables would mean that one's map corresponded with the Robinson Projection base map perfectly. The greater the value, the less accurate the individual's sketched continent or mental map. In total, 25 values were

calculated for each mental map. Three values for each continent (21), three cumulative inaccuracy values for each mental map, and one value for Mental Map Score.

<p><u>LOCATION ERROR (LE)</u> = 1 – (intersection area/mentally mapped area)</p> <p>If the size of the mentally drawn continent is larger than the base map continent, than</p> <p><u>AREA ERROR(AE)</u> = (mental map area/cartographically accurate map area) – 1.0</p> <p>If the size of the mentally drawn continent is smaller than the base map continent, than</p> <p><u>AREA ERROR (AE)</u> = 1.0 – (mental map area/cartographically accurate map area)</p> <p><u>CARTOGRAPHIC ERROR (CE)</u> = LE+AE</p> <p><u>MM LOCATION ERROR</u> =</p> <p style="padding-left: 40px;">LE(AFRICA)+LE(ANTARCTICA)+LE(AUSTRALIA)+LE(ASIA)+LE(EUROPE) +LE(N. AMERICA)+LE(S.AMERICA)</p> <p><u>MM AREA ERROR</u> =</p> <p style="padding-left: 40px;">AE(AFRICA)+AE(ANTARCTICA)+AE(AUSTRALIA)+AE(ASIA)+AE(EUROPE) +AE(N. AMERICA)+AE(S.AMERICA)</p> <p><u>MENTAL MAP ERROR</u> = MM LOCATION ERROR + MM AREA ERROR</p> <p><u>MENTAL MAP SCORE</u> =</p> <p style="padding-left: 40px;">LE(AFRICA)+LE(ANTARCTICA)+LE(AUSTRALIA)+LE(ASIA)+LE(EUROPE) +LE(N.AMERICA)+LE(S.AMERICA)+AE(AFRICA)/13+AE(ANTARCTICA)/13 +AE(AUSTRALIA)/13+AE(ASIA)/13+AE(EUROPE)/13+AE(N. AMERICA)/3.1342 +AE(S. AMERICA)/1.1529</p>
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Figure 3.2. Mental Map Error Formulas

Place Location Analysis

Similar to the mental map digital transformation, the place locations for each individual world map were digitized into an ATLAS datapoint file using six control points. The amount of

place location error in miles from the cartographically accurate locations was then calculated. For a missing or unknown place location, a value greater than the most misplaced location for each city was substituted. The total amount of place location error for each map was then calculated by summing the values for each location on the map. Values were also grouped and summed according to continent location. Similar the Mental Map Score, a Total Distance Score was calculated. Each place location error was divided by the largest place location error for each location. These values were then summed to create a Total Distance Score for each map. This was done so that one extremely misplaced location would not drop the participant's total place location error to the bottom of the rankings, when in fact the participant did very well in locating the other locations. In all, 34 values were calculated for each map. One value for each place location (27), one value for each continent that contained a city or cities located (5), one value summing all of the place location errors, and one value scoring the place location errors.

Organization and Measurement of Participant Profile and Current Event Quiz

The scoring of the participant profile and the current event quiz were much simpler than the digital transformations described above. The participant profile was scored and the answers were formatted into an Excel spreadsheet. As for the current event quiz, scores for the entire test were calculated. Quiz scores were also calculated according to continent. That is, questions pertaining to a specific continent were grouped and then scored together. These values were also formatted into an Excel spreadsheet. A total of six current event scores were calculated.

Statistical Analysis of the Data

To obtain the results provided in Chapter Four descriptive statistics and correlation analysis were used to study the relationship between current event knowledge and mental mapping ability. Descriptive statistics were used to gauge the general mental mapping abilities and current event knowledge the participants possessed on a number of levels. The mean +/- 95% were calculated for current event quiz performance, place location error, Cartographic Error, Location Error, and Area Error. These statistics were then broken down and displayed by aggregate, by continent, by place location, and by participant characteristics.

Before studying the correlation between current event knowledge and mental mapping ability each data variable was ranked from the smallest value to the largest value. The smallest observation received the value of one, the second smallest observation the value of two, and so on for the entire set. If a value or score was shared the ranks were averaged. This transformation was performed, because the distribution of the data was extremely abnormal (Conover & Iman, 1981). By ranking each of the scores the correlation analysis results would be more reliable.

Once the data were transformed Spearman rank correlation was performed for a number of studies. The variables correlated were current event test score, place location distance error, the four cumulative mental map errors (see Figure 3.2), and participant profile characteristics. Correlations were considered significant if the p-value was within the .05 confidence interval.

To maintain consistency/simplicity for the analysis and display of the data, Spearman rank correlation was used to study the relationship between participant mapping ability and a few nominal variables. These variables were group, gender, and high school geography. Each of these characteristics was given values of 0 or 1 (Group 1=0, Group 2=1; Female=0, Male=1; HS Geography YES =1, NO = 0). The results for these relationships should only be interpreted to indicate whether or not there was a significant difference of ability between participants in each of these categories.

Summary

To gather the results for this thesis the data acquired by the four data collection instruments went through a number of calculations and transformations. Once the data were organized statistical analysis was done at the aggregate, continental, and place location levels. Descriptive statistics were used to assess the general mental mapping abilities and current event knowledge of the participants. Spearman rank correlation was used to observe the relationship between mental mapping abilities and current event knowledge. Specific results are addressed in Chapter Four.

Chapter 4 – Results

Current Event Knowledge

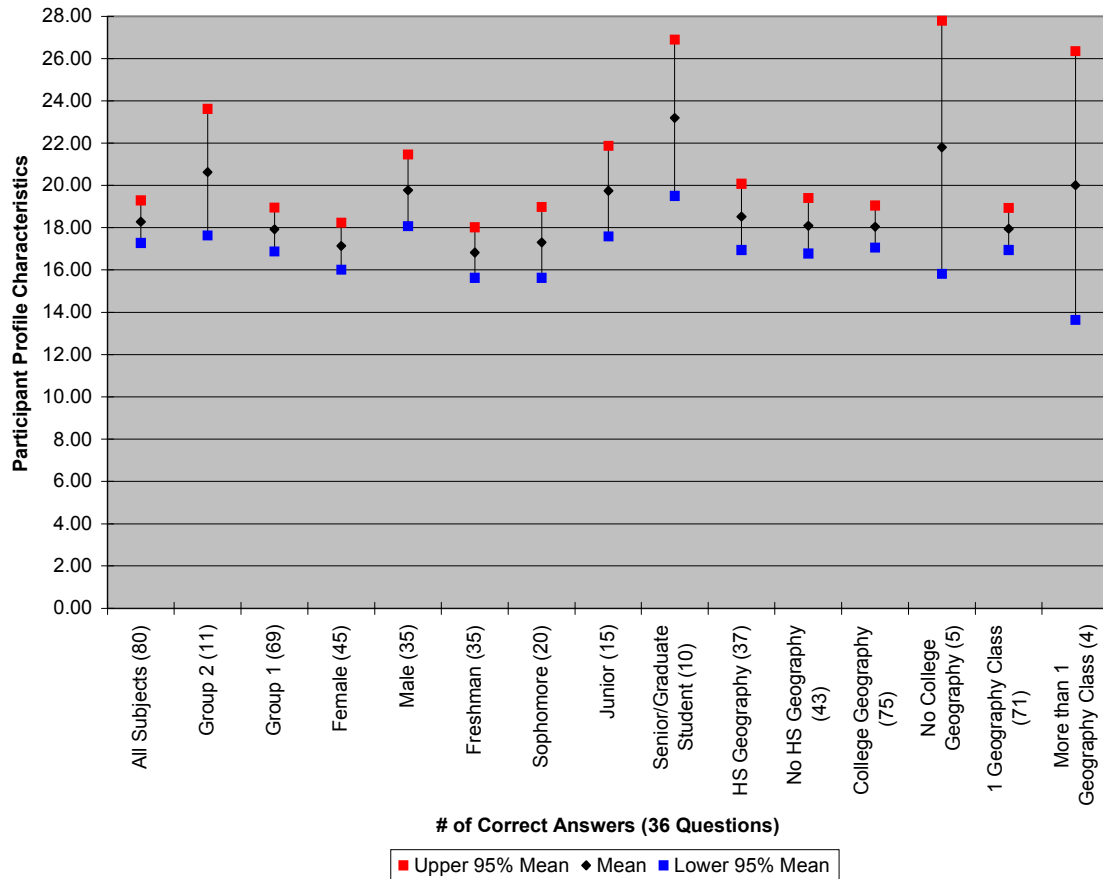


Figure 4.1. Current Event Test Performance According to Participant Characteristics. The number of participants possessing each characteristic is indicated in parentheses.

The first analysis performed dealt with participant performance on the Current Event Test. Figure 4.1 displays the average performance broken down by participant profile characteristics.

The average number of questions answered correctly on the 36-question test for all participants was 18.3 (50.8%). Group 2 participants performed better than Group 1 participants averaging 20.6 (57.2%) correct answers, whereas Group 1 participants averaged 17.9 (49.6%)

correct answers. Male participants performed better than female participants averaging 19.8 (54.8%) correct answers while females averaged 17.1 (47.6%) correct answers. Regarding academic standing, while the range of scores were large in each group, Juniors (54.8%) and Seniors/Graduate students (64.4%) knew more about current events than Freshmen (46.7%) and Sophomores (48.1%). Whether or not a student took geography in high school does not appear to influence knowledge of current events. Since only five students indicated that they had not taken college geography, it was not considered a reliable factor.

Correlation Analysis for Current Event Scores

To further study the relationship between current event knowledge and participant characteristics Spearman rank correlation was used. Current event test scores were correlated with each of the profile variables (group, gender, academic standing, high school geography, effort for staying informed of local, national and international current events, characterization of reading local and national newspapers, characterization of watching local and national newscasts, characterization of reading news and entertainment magazines, characterization of watching television, characterization of domestic and international travel, and perceived mapping ability). Significant correlation coefficients and p-values are provided in Table 4.1.

Table 4.1. Participant Profile Characteristics Correlating Significantly with Current Event Knowledge

Variable	Spearman r	P-Value
<i>Gender</i>	0.278	0.012
<i>Academic Class</i>	0.369	0.001
<i>Effort for National Current Events</i>	0.339	0.002
<i>Effort for International Current Events</i>	0.381	0.000
<i>Characterization of Watching National News</i>	0.311	0.005

As the table shows, five variables correlated significantly with current event knowledge. The variables that were significant were gender, academic standing, perceived effort to stay informed of national and international current events, and one's

characterization of watching a national news broadcast. Each of these variables had a positive relationship with one's performance on the current event quiz.

Place Location Knowledge

Place location knowledge was analyzed using descriptive statistics and Spearman rank correlation. As the statistics show, participant ability to locate a city on the world map decayed as the location's distance from North America increased. Further, participants attempted to locate more North American and Western European cities than those located outside of these areas (see Figure 4.2). To illustrate, six North American Cities were attempted by all participants. These cities are Atlanta, Chicago, Mexico City, New York City, San Diego, and Washington, DC.. Bangkok, Sarajevo, Jakarta, Algiers, Tirana were the least attempted cities.

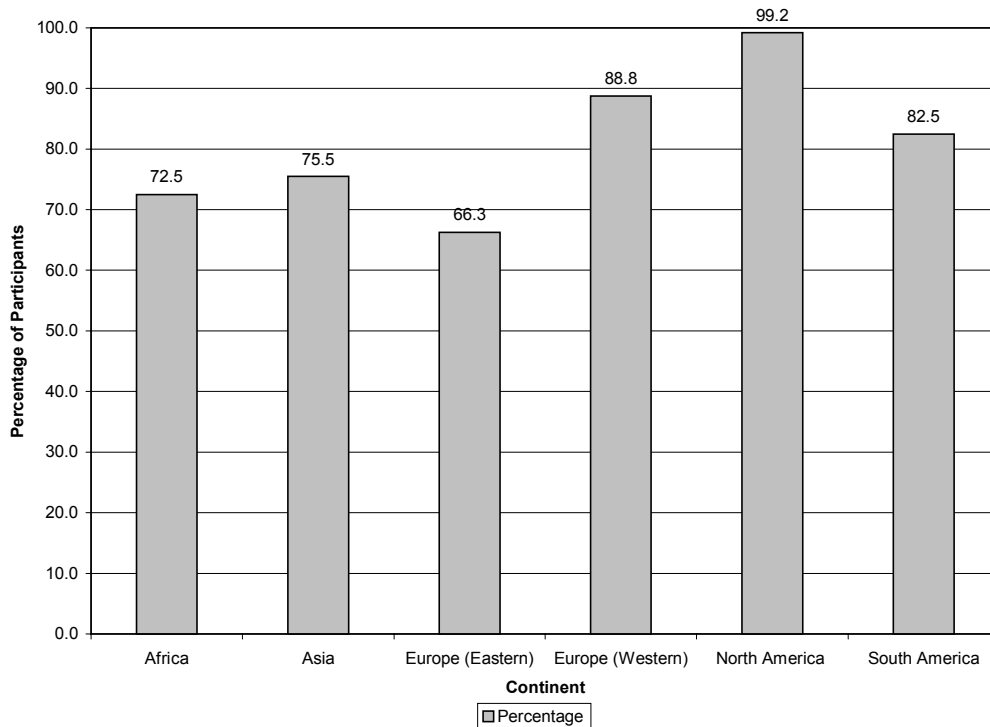


Figure 4.2. Percentage of Participants Attempting to Locate Cities by Continent

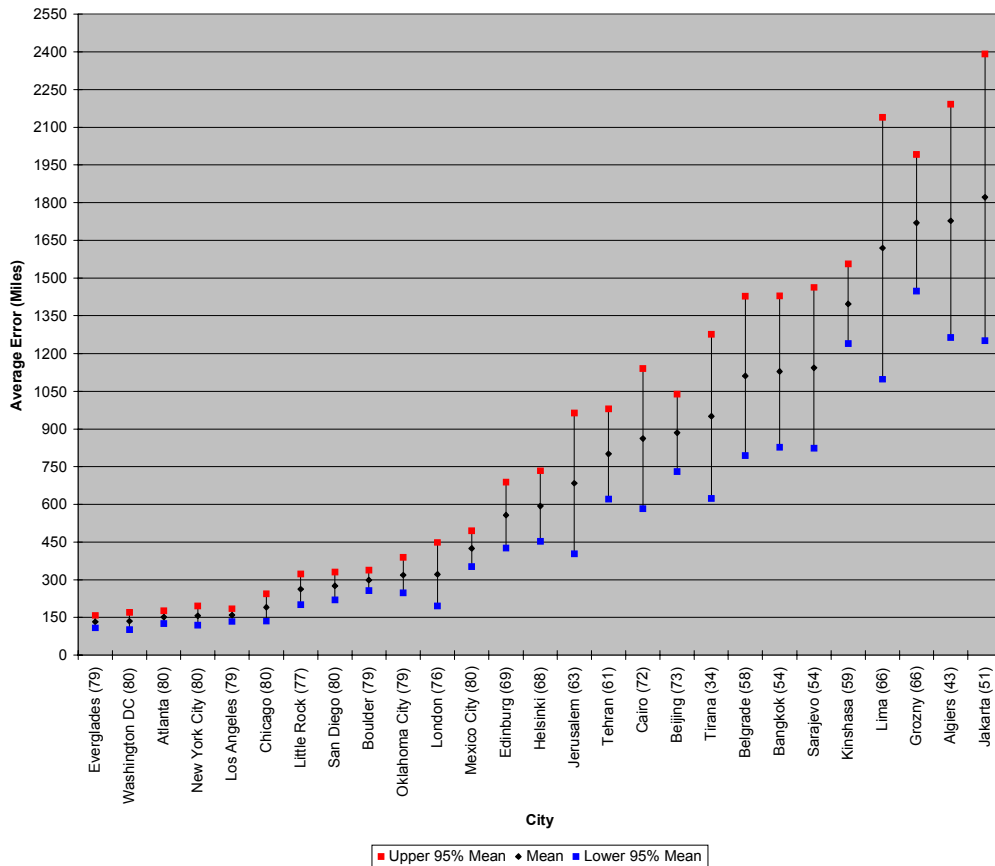


Figure 4.3. Mean Place Location Error for All Attempted Placements The number of participants attempting to locate each location is provided in parentheses.

Figure 4.3 shows the mean place location error for all attempted placements. It does not include data for those who indicated they did not know where the city was located. As Figure 4.3 indicates, the most accurately placed locations were North American and Western European. In fact, the 10 most accurately placed cities were North American. The Everglades was the most accurately placed location with an average distance error of 133.6 miles. Washington, DC was second with an average location error of 135.8 miles. On the world map used, 160 miles is roughly 0.1 physical inches of placement error. Anything within 480 miles was placed within 0.3 inches of the cartographic location. Considering this measurement, all North American cities except for Little Rock, Arkansas, averaged a placement error within 0.3 inches of their cartographic location. London was the most accurately placed European location averaging 321.7 miles of

inaccuracy. Kinshasa, Lima, Grozny, Algiers, and Jakarta were the least accurately placed cities averaging over 1500 miles inaccuracy.

Figure 4.4 shows overall place location knowledge including “no-knowledge of location” data. These results are similar to Figure 4.3 with a few exceptions. Washington, DC replaced the Everglades as the most accurately placed location. This occurred because one participant did not locate the Everglades. Beijing was also much more accurate since it was attempted more often than many of the cities that were located more accurately in Figure 4.3. Tirana was the least accurately placed city, because 57% of the participants did not attempt to locate it on the map.

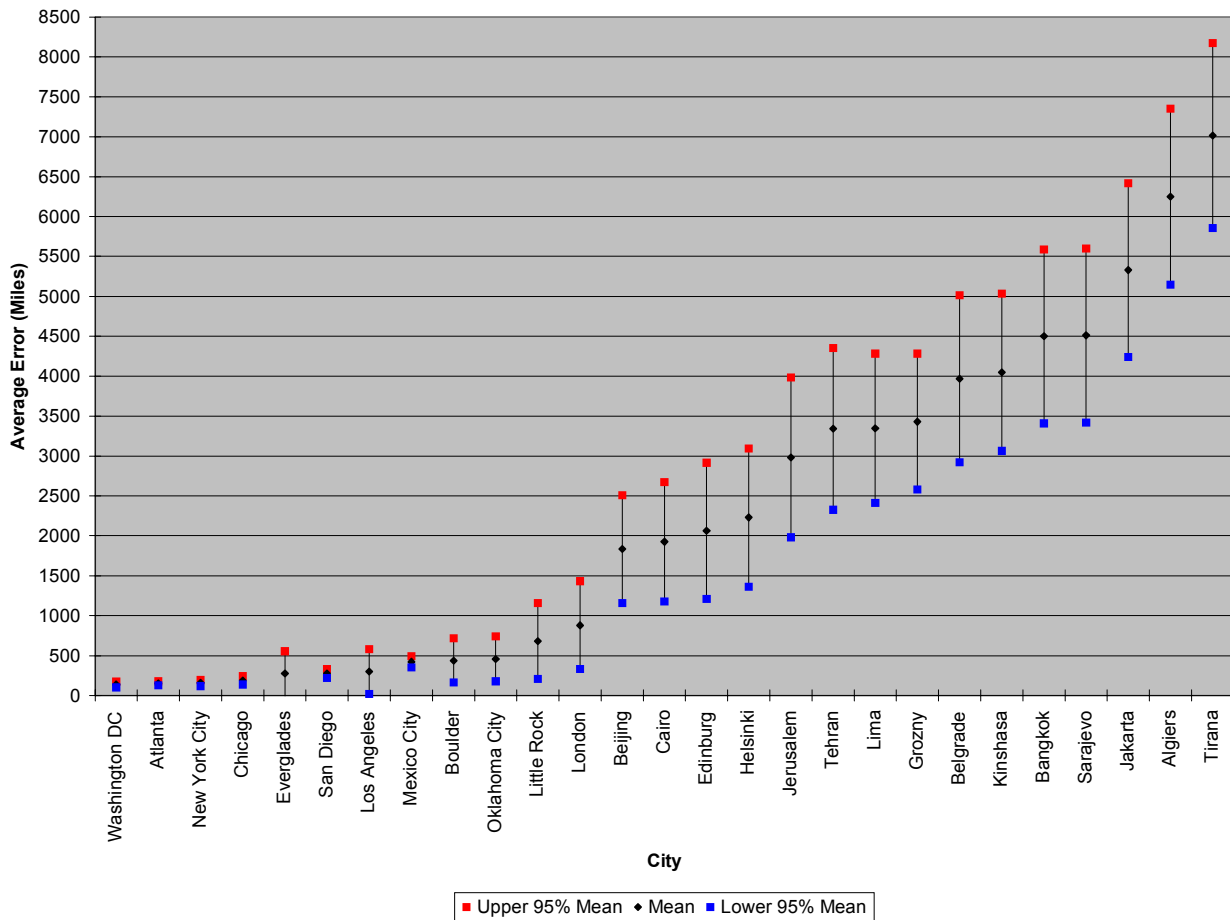


Figure 4.4. Mean Place Location Error for all Participants Including Non-Attempts

There are a number of explanations for the disparity between North American location accuracy and the rest of the world. First, the USA is the resident country for most of the participants. Secondly, students raised in the United States have been exposed to the United States map for a number of years. Lastly, in agreement with previous research (Robinson, 1981; Saarinen, 1973), certain places remain unknown due to a lack of press coverage. The places that were most inaccurately placed in general do not receive as much press coverage in the US.

Participant Profile Characteristics and Place Location Ability

Spearman rank correlation was used to study the relationship between participant characteristics and place location knowledge. Each participant’s Total Distance Error was correlated with the participant’s profile variables (group, gender, academic standing, high school geography, effort for staying informed of local, national and international current events, characterization of reading local and national newspapers, characterization of watching local and national newscasts, characterization of reading news and entertainment magazines, characterization of watching television, characterization of domestic and international travel, and perceived mapping ability). The coefficients and p-levels for significant correlations are shown in Table 4.2.

Table 4.2. Significant Relationships of Participant Characteristics with Place Location Error

Participant Characteristic	Spearman r	P-Value
<i>Gender</i>	0.380	0.001
<i>Academic Class</i>	0.374	0.001
<i>Effort for Local Current Events</i>	0.261	0.019
<i>Effort for National Current Events</i>	0.226	0.043
<i>Effort for International Current Events</i>	0.386	0.000
<i>Characterization of Reading a Newspaper</i>	0.255	0.022
<i>Perceived Map Reading Ability</i>	0.271	0.015

Seven variables correlated significantly with participant place location knowledge. Males performed better than females. Sophomores, Juniors and Seniors performed better than Freshmen. Participants who indicated more effort to stay informed about current events (local, national, and international) tended to place locations on a world map more accurately. However, only one method of obtaining current event knowledge correlated significantly with a participant’s place location ability. This method is reading a daily newspaper. Participants with stronger perceived mapping abilities also displayed a tendency to locate places on a world map more accurately. Descriptive statistics are provided in Figure 4.5.

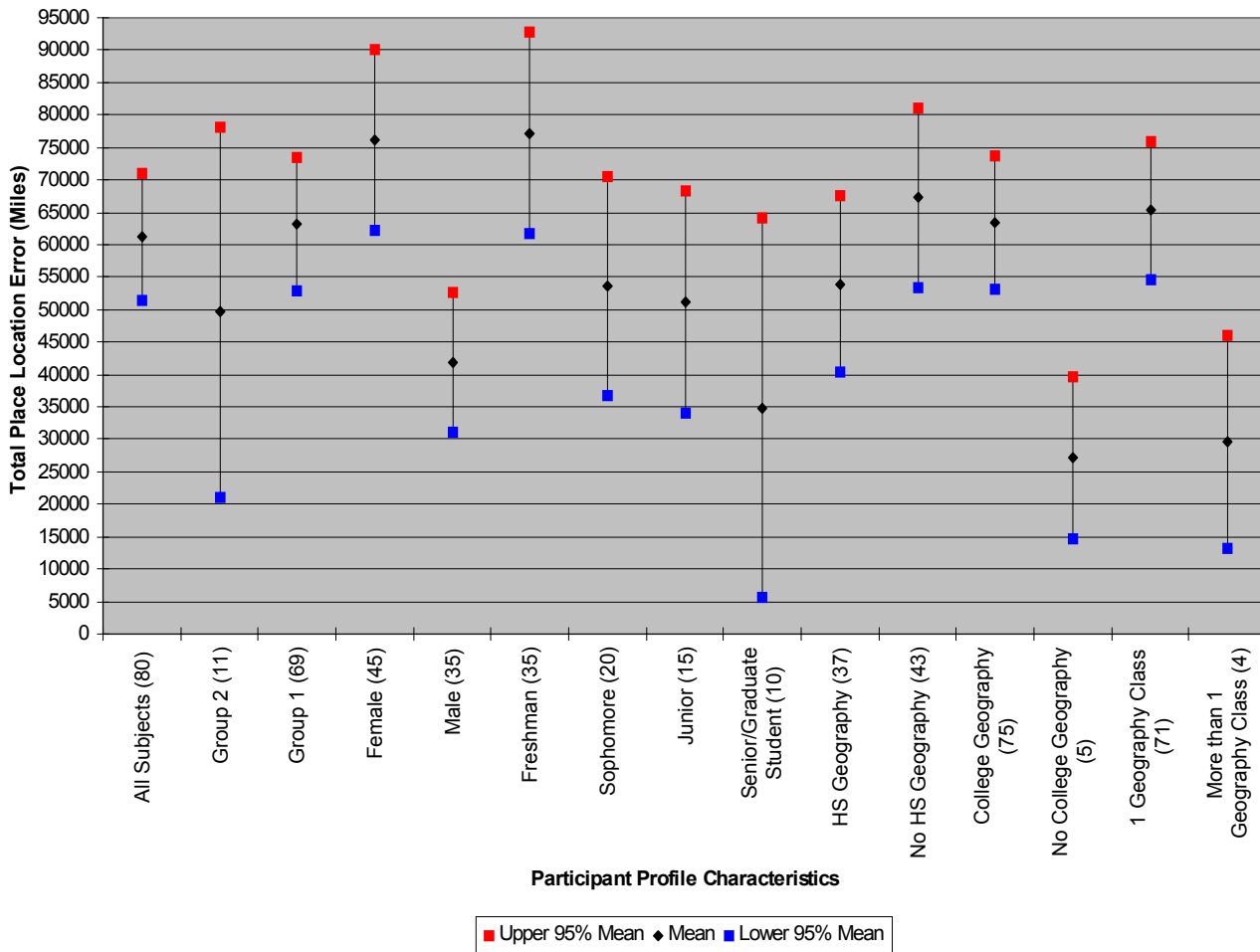


Figure 4.5. Mean Total Distance Error based on Selected Participant Profile Characteristics

Sketch Mapping Performance

Seven variables were considered in the analysis of a subject's sketch mapping performance. These variables were Location Error, Area Error, Cartographic Error (Location Error + Area Error), MM Location Error, MM Area Error, Mental Map Error, and Mental Map Score. Descriptive statistics were calculated for data for only drawn continents on the mental maps, and for data including drawn and excluded continents.

Figures 4.6 and 4.7 provide the mean Cartographic Error for each continent. Figure 4.6 displays data for all drawn continents, whereas Figure 4.7 was calculated using all data including missing continents. The most accurately drawn continents were Asia, Antarctica, Africa, and South America. North America and Europe were the least accurately drawn continents averaging over 150% inaccuracy. When missing data were included in the analysis the results changed. Since South America and North America were included on each of the sketched maps, each continent's average cartographic error was unchanged. However each of the other five continent's cartographic error increased since each were excluded from at least one mental map. Australia was excluded most, not appearing on seven of the mental maps. This helps explain its overall ranking as the second least accurately drawn continent.

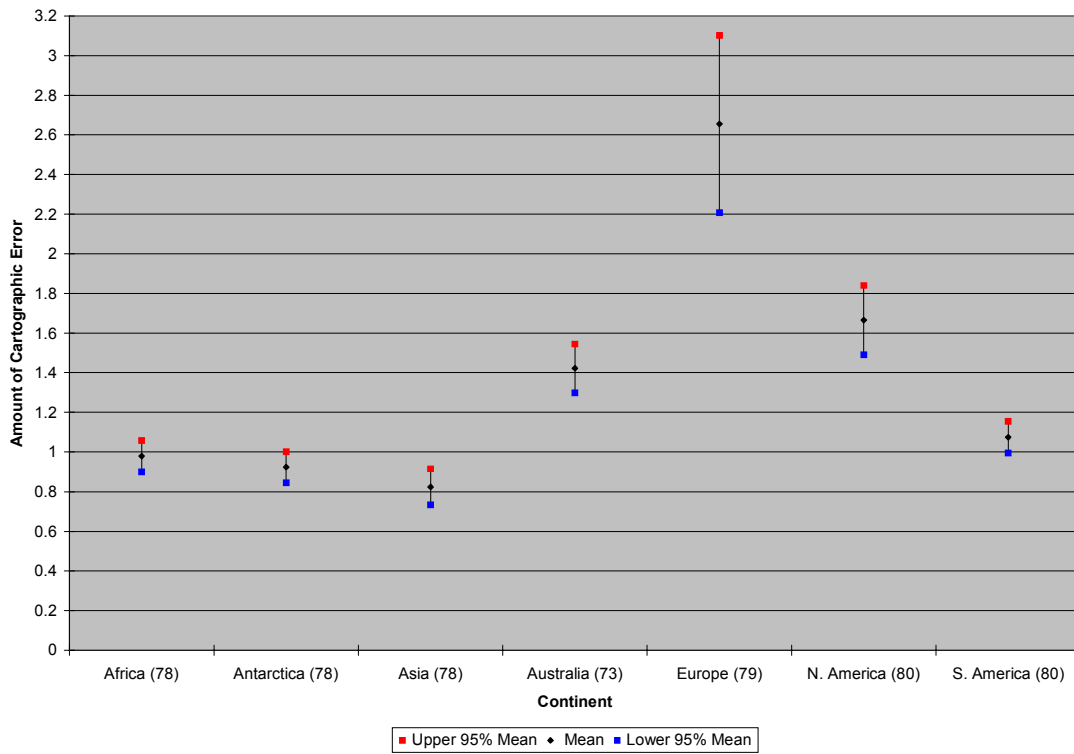


Figure 4.6. Mean Cartographic Error for All Drawn Continents
 Number of maps the continent was included on is provided in parentheses.

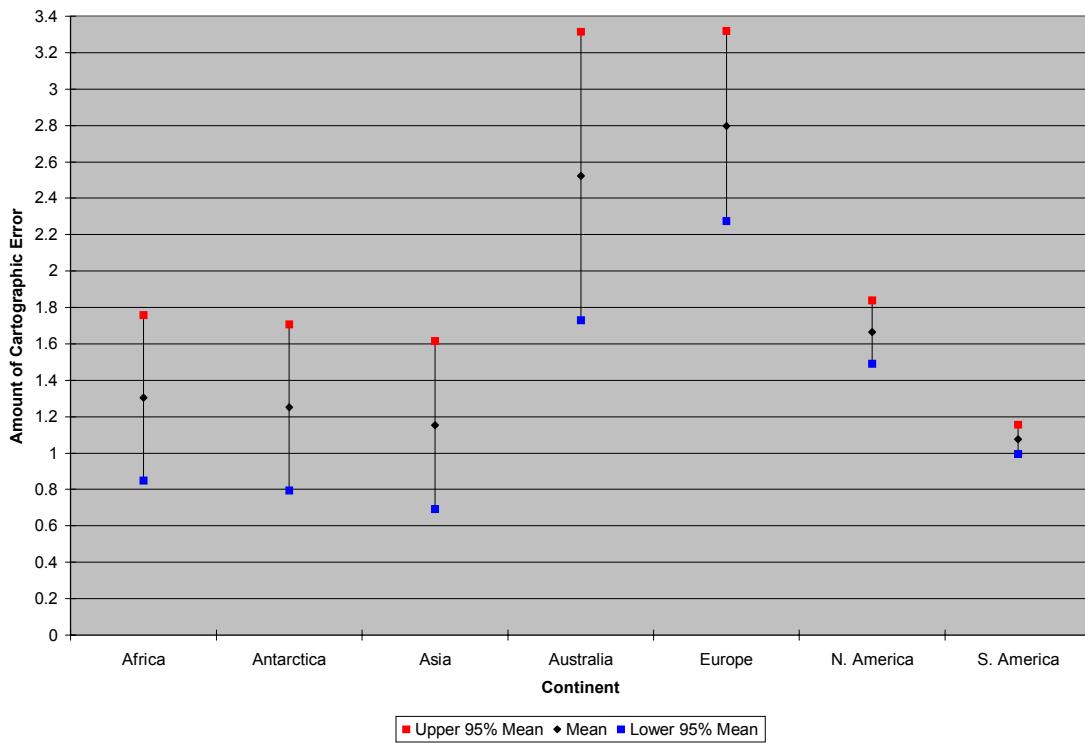


Figure 4.7. Mean Cartographic Error for All Data Including Excluded Continents

Figures 4.8, 4.9, 4.10, and 4.11 provide a break down of the mean location and mean area errors by continent. Location Error patterns did not change much with regard to the different sets of data used. Antarctica was the most accurately placed continent. This is not surprising given its relative location at the South Pole. Asia and North America were the next most accurately placed continents. A possible explanation for these results is that both of these continents dominate the total landmass located in their respective semi-hemispheres.

The least accurately placed continents were Australia, Europe and South America. These results can be attributed to a number of things. First, each continent does not dominate the landmass area of their semi-hemisphere. Also, during the period of the study, South America and Australia were not significant international locations included in US current events. In fact, Australia was not involved with any significant current events included on the current event quiz while South America was involved with one event.

Area Errors reveal more variation depending on the set of data analyzed. For data only including drawn continents, Africa, Asia, and South America were the most accurately sketched continents. Consistent with Saarinen et al.'s (1996) findings, the most exaggerated continents in size were Europe and North America. A possible explanation for this "larger" image of these two continents is the fact that they are the dominant regions covered in US news and classrooms. Thus influencing the participants to draw the continents larger than they really are.

When data, including missing continents, were used a few differences emerged. Africa, Antarctica, Asia, and Australia each scored much lower. Australia, since it was excluded the most was the second least accurately drawn to scale continent behind Europe. North America and South America's ranking improved since they were included on all of the mental maps.

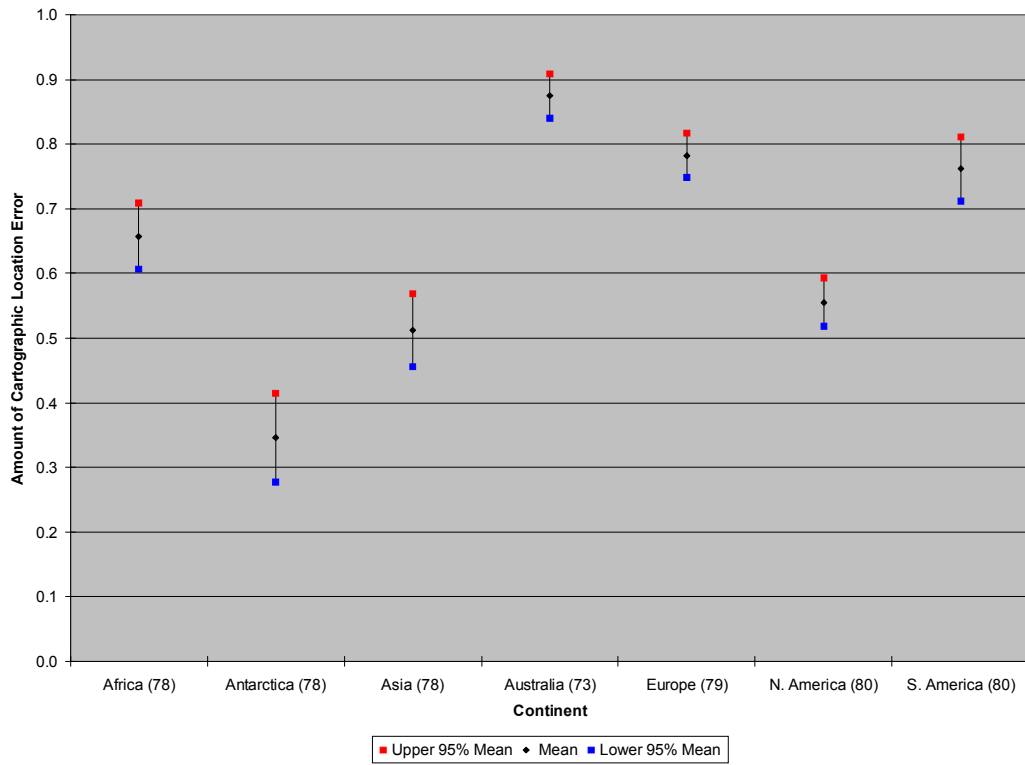


Figure 4.8. Mean Location Error for all Attempted Continents

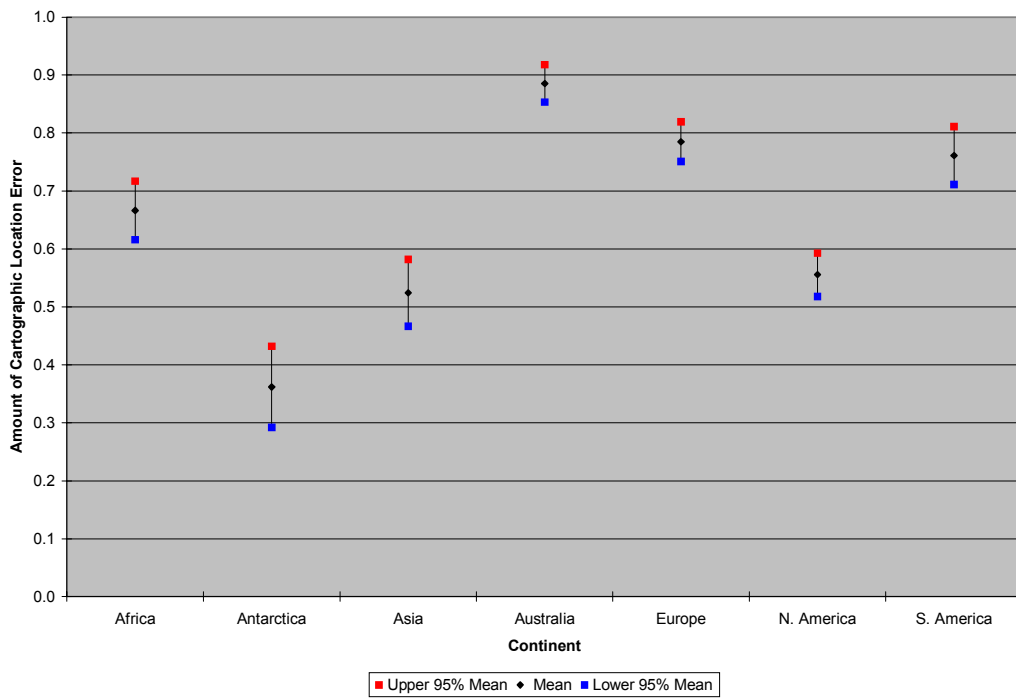


Figure 4.9. Mean Location Error for Data with Excluded Continents

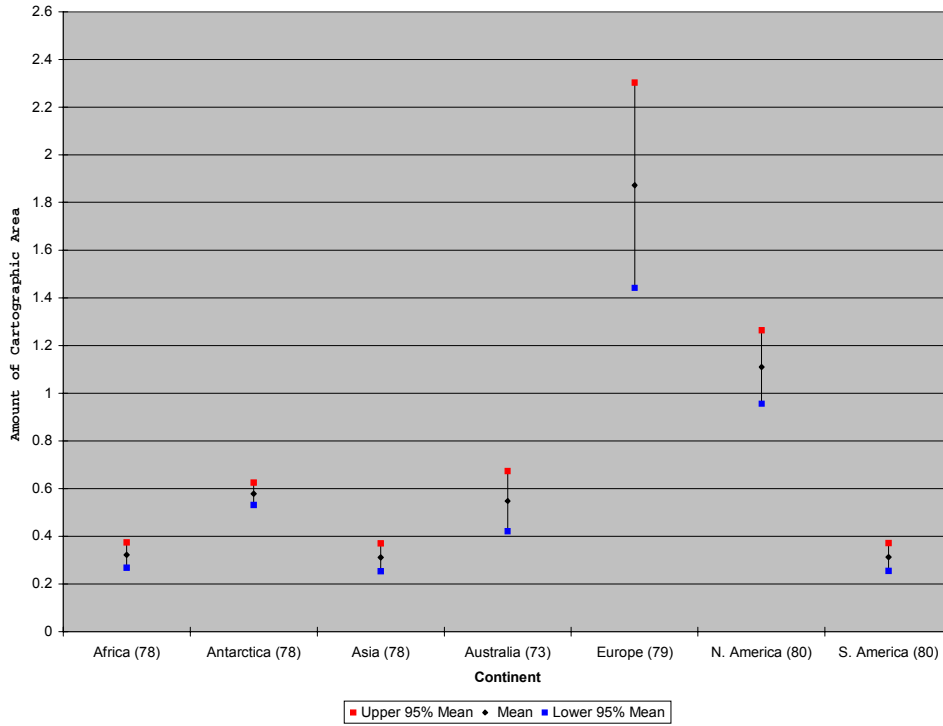


Figure 4.10. Mean Area Error for all Attempted Continents

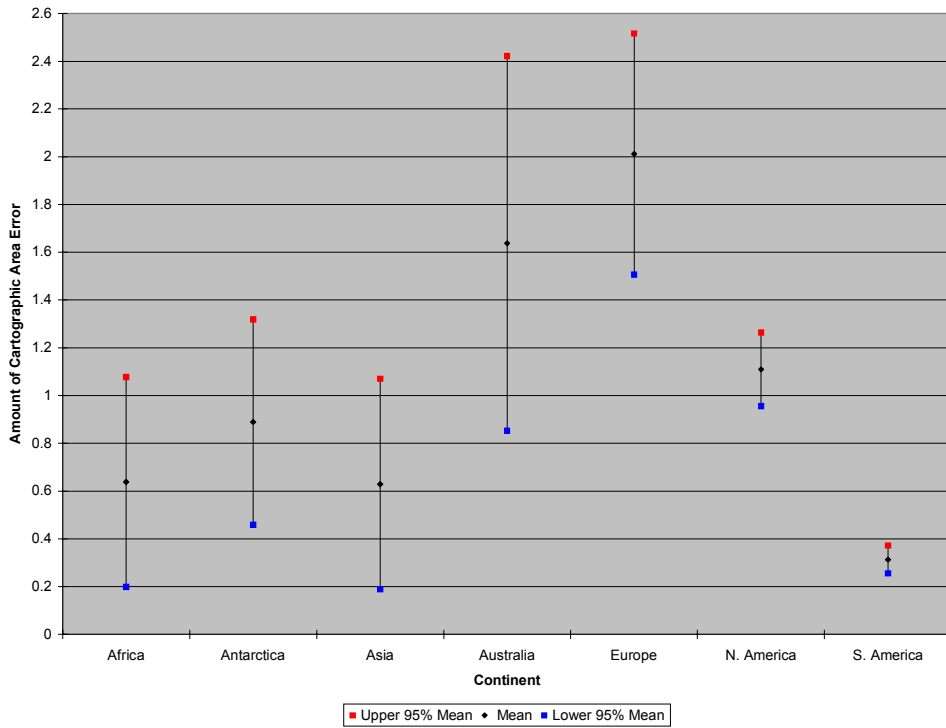


Figure 4.11. Mean Area Error for Data with Excluded Continents

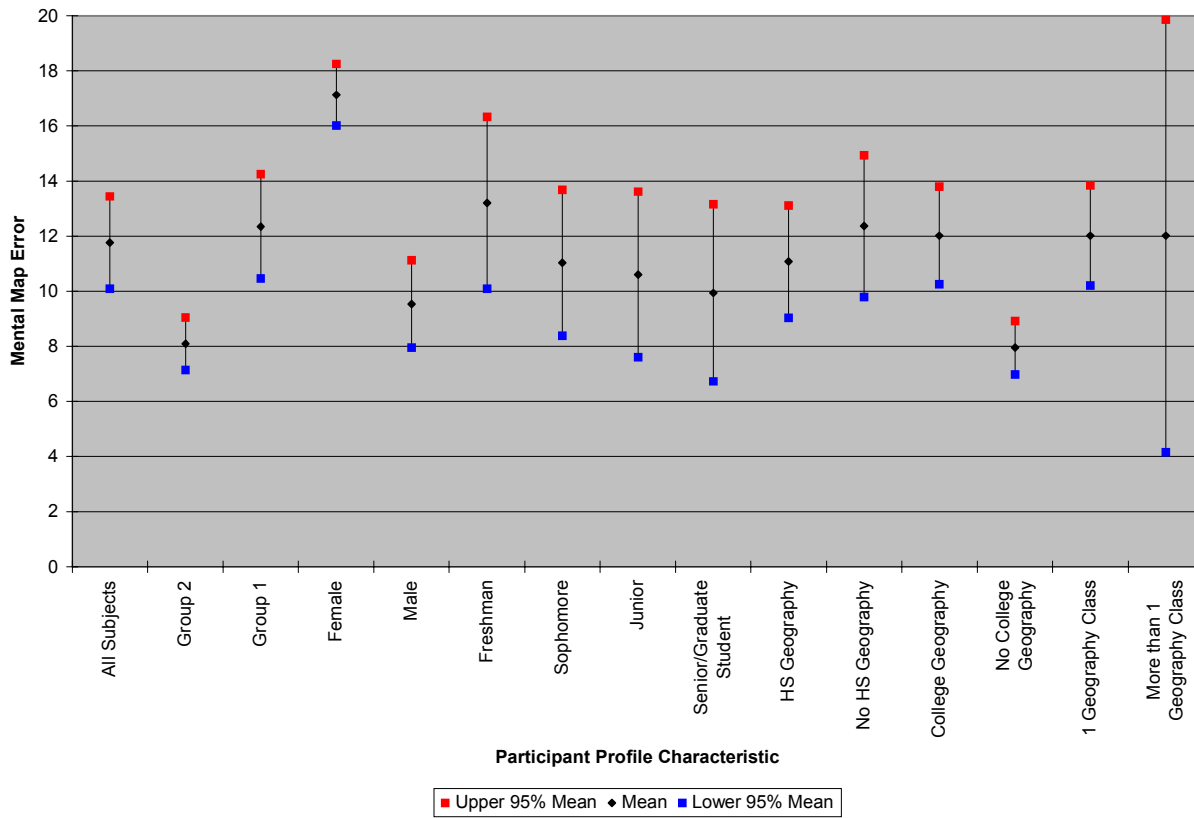


Figure 4.12. Mean Mental Map Error by Selected Participant Characteristics

Participant Profile Characteristics and Sketch Mapping Ability

The next step in the analysis measured participant mental mapping ability against different participant profile characteristics. Figure 4.12 shows Mental Map Error based on different participant characteristics. Group 2 participants drew more accurate maps than group 1 participants. Male participants outperformed female participants. Though the mean Mental Map Error improved as one's class standing increased, there was a large range of error making conclusions difficult. The large range of error for those taking or not taking high school geography had similar effects. As previously explained, the sample of participants not taking college geography was too small to be considered a reliable variable.

Figures 4.13 and 4.14 show MM Area and MM Location Errors for participants based on selected participant characteristics. Overall few variables were possible influences on a participant's ability to locate all of the continents accurately. The two characteristics that may have an influence are gender and class status. Males performed better than females, and the scores improved as one's class status increased. Three variables may influence MM Area Errors. These variables are group, gender, and class status.

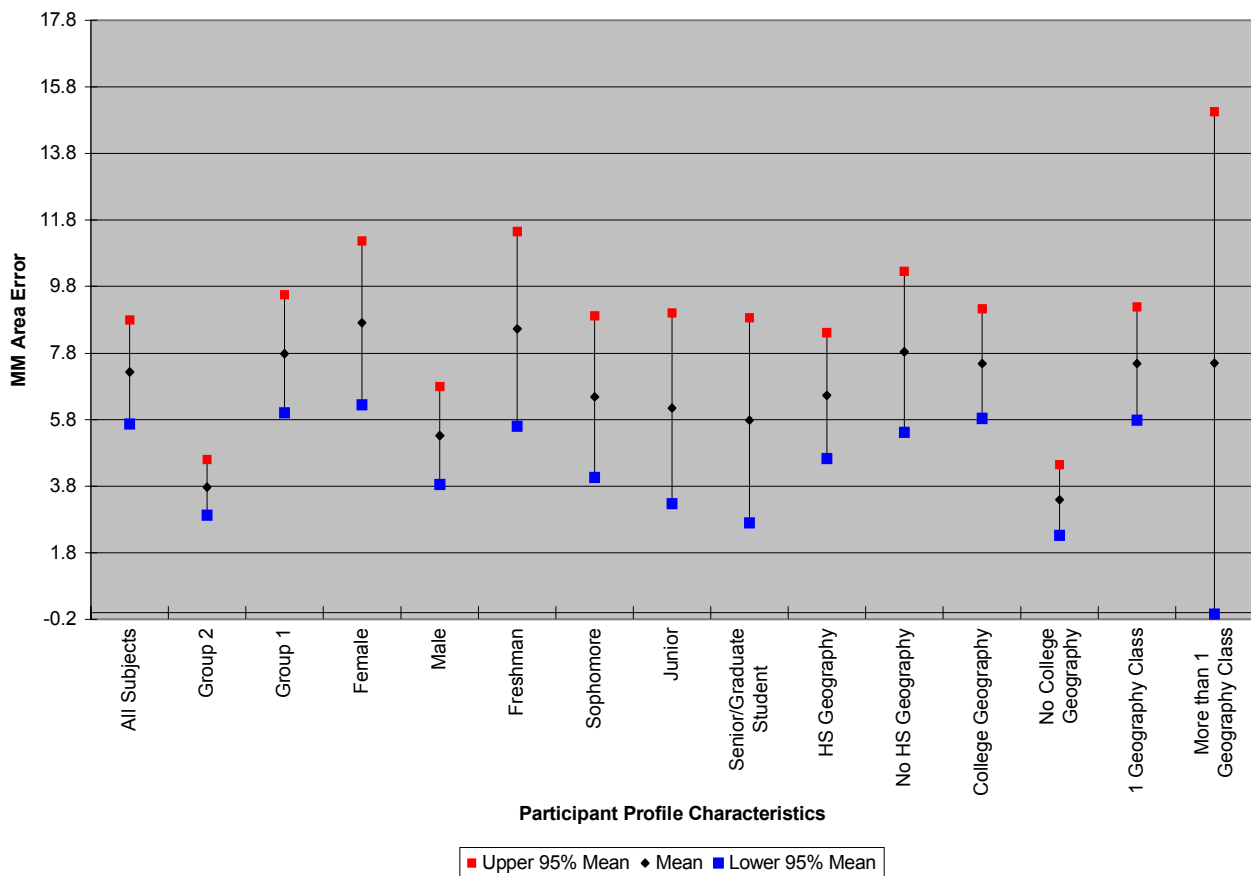


Figure 4.13. Mean MM Area Error by Selected Participant Characteristics

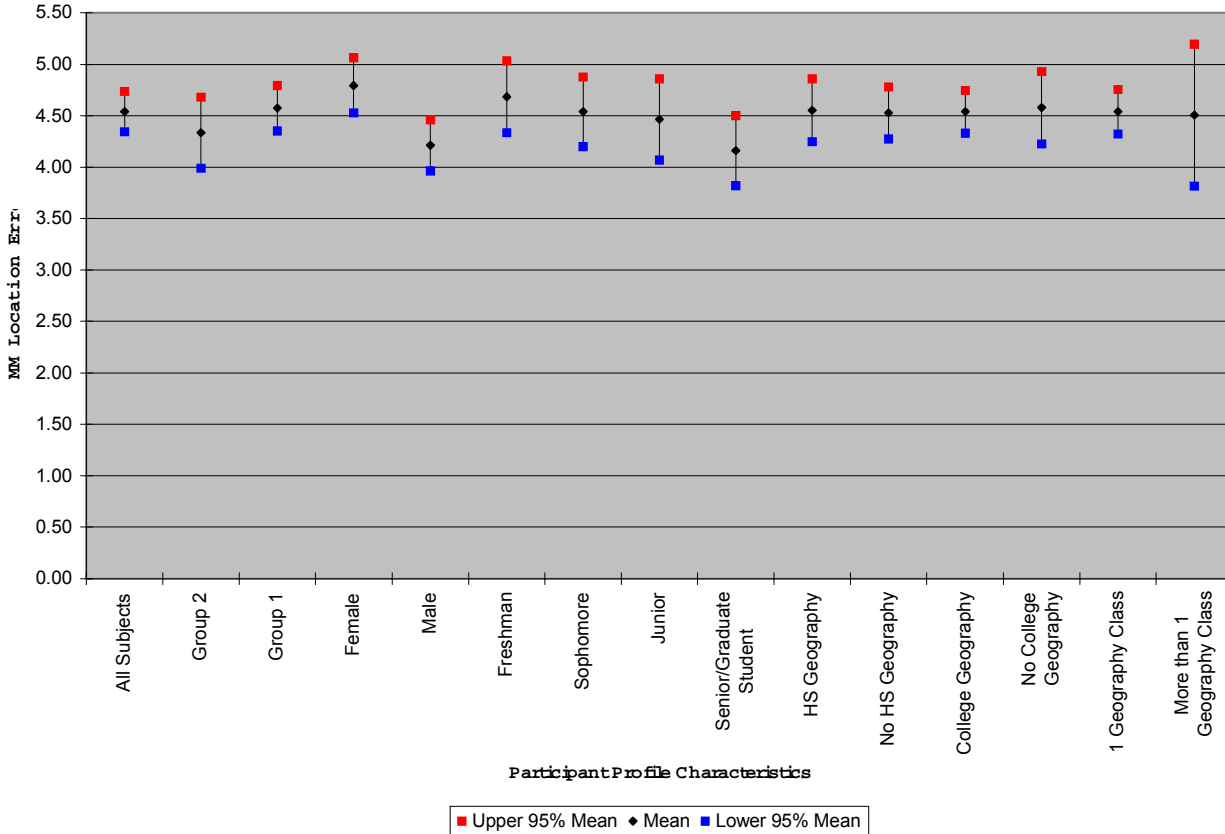


Figure 4.14. Mean MM Location Error by Selected Participant Characteristics

To further study the relationships between participant characteristics and participant mental mapping performance Spearman rank correlation was used. Mental Map Error was correlated with each of the profile variables (group, gender, academic standing, high school geography, effort for staying informed of local, national and international current events, characterization of reading local and national newspapers, characterization of watching local and national newscasts, characterization of reading news and entertainment magazines, characterization of watching television, characterization of domestic and international travel, and perceived mapping ability). The estimated coefficients and p-values for significant correlations are presented in Table 4.3.

Two variables correlated significantly with a participant’s overall sketch mapping ability. These variables were gender and one’s characterization for reading a national news magazine. Perceived map reading ability was included in the table, because the p-value is very close to .05.

Table 4.3. Significant Relationships of Participant Profile Characteristics with Mental Map Error

Participant Profile Characteristic	Spearman r	P-Value
<i>Gender</i>	0.317	0.004
<i>Characterization of Reading a News Magazine</i>	0.226	0.044
<i>Perceived Map Reading Ability</i>	0.218	0.052

Current Event Knowledge and Mental Mapping Ability

The main purpose of this thesis was to study the relationship between current event knowledge and the ability to construct a mental map of the world. This section looks at the data already discussed related to the following hypotheses:

- 1) The more one knows about current events, the better one will be able to draw from memory a map of the world.
- 2) The more one knows about current events, the better one will be able to locate places on a world map.

To analyze these hypotheses Spearman rank correlation analysis was again used. Each of the participant mental mapping variables (Total Distance Error, Total Distance Score, Mental Map Error, MM Location Error, and MM Area Error, Mental Map Score) were correlated with the participant's current event test score. Significant correlation coefficients and p-values are given in Table 4.4.

Table 4.4. Relationships of Current Event Knowledge with Mental Mapping Ability

Mental Mapping Variable	Spearman r	P-Value
Total Distance Error	0.300	0.007
Total Distance Score	0.257	0.021
Mental Map Error	0.282	0.011
Mental Map Score	0.277	0.013
MM Location Error	0.305	0.006
MM Area Error	0.231	0.039

The data shows that participants who knew more about current events tended to have stronger mental mapping abilities. Current event knowledge significantly correlated with each of the mental mapping ability variables.

Table 4.5 provides the results for the correlation analysis between current event knowledge and continent place location ability. Participants with stronger current event knowledge tended to locate places more accurately on each continent except for Asia. The most significant p-values and coefficients were calculated for Europe and North America.

Table 4.5. Significant Relationships of Participant Profile Characteristics with Mental Map Error

Mental Mapping Variable	Spearman r	P-Value
Africa Distance Error	0.223	0.046
Asia Distance Error	0.209	0.063
Europe Distance Error	0.360	0.001
N. America Distance Error	0.441	0.000
S. America Distance Error	0.294	0.008

Table 4.6 shows the correlation statistics for current event knowledge and one's sketch mapping abilities by continent. Africa was the only continent drawn whose accuracy significantly correlated with current event knowledge.

Table 4.6. Relationships of Current Event Knowledge with Sketch Mapping Ability by Continent

Mental Mapping Variable	Spearman r	P-Value
Africa Cartographic Error	0.235	0.036
Antarctica Cartographic Error	0.120	0.287
Asia Cartographic Error	0.125	0.267
Australia Cartographic Error	0.218	0.051
Europe Cartographic Error	0.182	0.105
N. America Cartographic Error	0.172	0.127
S. America Cartographic Error	0.006	0.958

North American Analysis

Spearman rank correlation was used to study the relationship between participant mental mapping abilities for North America and North American current event knowledge and the extent of domestic travel. Descriptive statistics previously provided indicate that, in general, participant knowledge of North America was superior to knowledge of other parts of the world. These analyses further tested some of the hypotheses already stated.

Similar to the other analyses, current event test scores for North American questions were correlated with participant mental mapping abilities for North America. The estimated coefficients and significant levels for each of the correlations are given in Table 4.7.

Table 4.7. Relationships of North American Current Event Knowledge with North American Mental Mapping Abilities

Mental Mapping Variable	Spearman r	P-Value
N. America Distance Error	0.480	0.000
N. America Cartographic Error	0.140	0.214
N. America Area Error	0.133	0.239
N. America Location Error	0.110	0.329

Consistent with the previous results, current event knowledge was positively related to a participant's ability to locate cities located in North America. However, unlike the previous results, knowledge of North American current events did not improve a participant's ability to accurately sketch the continent of North America.

To measure the relationship between domestic travel and mental mapping abilities for North America Spearman rank correlation was again used. The relationship between domestic travel and participant mental mapping abilities was not significant.

Chapter Summary

The results of this thesis provide a general understanding of how well the participants were informed of current events, how proficient the participants mental map of the world are, and the relationship the former has with the latter. Male participants consistently displayed better current event knowledge and mental mapping abilities than female participants. Juniors, seniors, and graduate students also consistently demonstrated better current event knowledge and mental mapping abilities than freshmen. Other variables consistently related to a participant's current event knowledge and mental mapping abilities were class standing, and perceived effort to stay informed of current events. The data also revealed that participants with stronger current event knowledge tended to demonstrate better mental mapping abilities. Further discussion of these results and other observations are provided in Chapter 5.

Chapter 5 - General Discussion and Conclusion

Geography for Life recommends that graduates from high school should be able to draw a map of the world and locate places mentioned on a television or radio news broadcast. The results of this thesis are valuable for understanding how well college students can perform these tasks. The results show that college students with stronger current event knowledge tend to have better mental maps of the world. General discussion of the results, their relationship to related literature, and other noted observations are provided in the following pages.

Discussion of Place Location Ability

Knowledge of current events increased the accuracy of a participant's ability to find a city on a world map. However, if the place was not located in North America or Western Europe a student's ability to locate the city accurately diminished. There are several possible explanations for this observation.

Similar to previous research findings (Robinson, 1981; Saarinen, 1973), the disparity between place location knowledge of North America/Western Europe and the rest of the world may be related to the amount of media coverage an area receives. The media in the United States is dominated by domestic and Western European news thus allowing people more opportunities to be exposed to cities and characteristics of these regions. Some of the places included on the current event quiz and place location exercise were in the news more frequently than other places. Frequently mentioned places include Washington DC, Atlanta, New York, and London. These cities were among the more accurately placed by the participants. Cities less-frequently mentioned in the news, such as Tirana, Little Rock, Bangkok, and Jakarta, were less known by the participants. This lack of media exposure to these places reduces the general knowledge of their locations.

Relative location is another factor that may influence the placement of certain cities. Examples of possible relative location influences on place-location knowledge include Chicago's proximity to Lake Michigan, the Everglades location near the Southern tip of Florida, San

Diego's location along the US/Mexico border, and Cairo's location along the Nile River. Lastly, schooling may influence participant ability to place North American and Western European cities on a world map. North American and Western European location placements were attempted most by the participants. In fact, North American cities were placed on the world map by 99 percent of the participants, while Western European cities were attempted by 89%. American students are consistently exposed to North American and Western European locations through a number of different courses such as social studies, foreign language, and English classes. This consistent exposure probably positively influences place location knowledge.

Another possible explanation for this disparity between western/non-western knowledge is map accompaniment with current event stories. Many stories are provided without a map to indicate global location of events reported. A participant may be aware of a current event, but does not have a clear idea of its location because its cartographic location was not provided with the story. Nevertheless, regardless of these possible explanations for place location inaccuracies, participants knowing more about current events were able to place locations on a world map more accurately.

Another observation consistent with the related literature was the evident hierarchy of place location knowledge (Hirtle & Jonides, 1985; Stevens & Coup, 1978). This hierarchy indicates that participant knowledge decreases as the area they are identifying is reduced. Participants consistently located a place's continental location more accurately than its country location. Figure 5.1 provides statistics for all attempted placement of each of the locations except for Grozny, Chechnya. Grozny was excluded, because it is located in Russia, which has landmass in both Asia and Europe. As the figure explains, 93 % of the participants attempting to place a city on the world map correctly placed it in the correct continent. Sixty-seven percent placed the city in the correct country, while only 6.8 % of the participants placed the city outside of the correct continent. Regarding Grozny, out of the sixty-seven participants attempting to locate the city, forty-three participants marked its location in Russia. However, less than half of these participants (21) placed it on the European area of Russia. Thus, showing that participants have a general knowledge of Russia's location, but knowledge diminishes once inside the country.

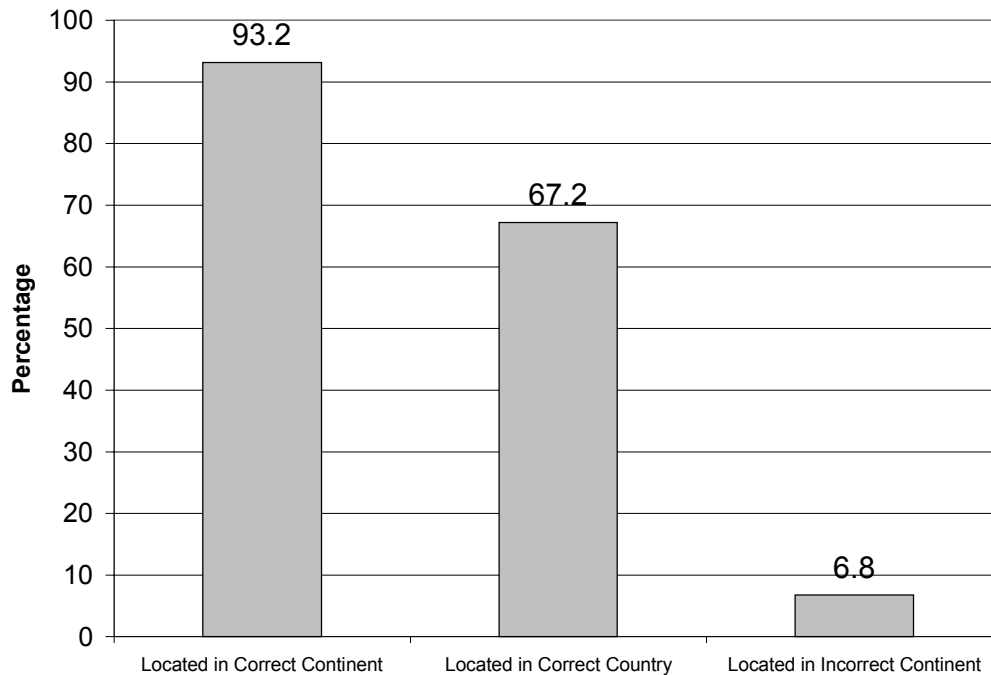


Figure 5.1. Hierarchy of Place Location Knowledge

In agreement with Saarinen's (1973) findings, landmass area also seems to be a factor influencing participant ability to accurately place the location in the correct country. Examples of this observation include China and the United States. All of the participants attempting to locate a United States city placed it in North America, while 98 % placed it in the United States. As for China, all but one participant attempting to locate Beijing, placed it on Asia. Eighty-one percent of these participants placed Beijing correctly in China.

Contrary to these observations, participant ability to accurately place a location in its correct country diminished when it was located in a region with numerous smaller countries. Examples include European and African locations. Eighty-two percent of the participants attempting to locate a European city correctly placed the city on the correct continent. However, only 38 % placed the location in the correct country. Regarding African locations, 85 % of the participants attempting to locate the city placed it in the correct continent, but only 32 % placed the city in its correct country. These observations further exemplify the hierarchy of location knowledge.

This observation of hierarchy leads to an observation regarding geography literacy. Similar to other studies of geography literacy (Cross, 1987; Helgren, 1983; Muller, 1985), participant place location knowledge outside of North America and Western Europe was poor. Place location error patterns for Asian, African, Eastern European, and South American cities were, at best “hit or miss.” The range for errors look more like a guessing game than genuine knowledge of the place location (see Figures 4.3 and 4.4). Consequently, it would be interesting to compare how well a person would be able to locate significant locations after being taught according to the *Geography for Life* standards.

Discussion of Sketch Mapping Ability

Most participants, as *Geography for Life* recommends, were able to draw from memory a map of the world. While the results reveal that current event knowledge is positively related to participant ability to construct a mental map of the world, other interesting observations and patterns emerged. These include the inclusion/exclusion of continents, the inaccuracies observed for each continent, the influence of current event knowledge, the discussion of the above average, average, and below average mental maps, and the interesting misplacement of Antarctica on some of the mental maps.

Sketch Mapping Examples

Out of the 80 maps analyzed, 67 of the maps included each of the seven continents of the world. Of these complete maps 50 of them scored in the upper 2.5% of the sample. Twelve of the 15 maps scoring outside the lowest 2.5% were incomplete. Consequently, it is reasonable to say that the participants were able to draw from memory a map of the world. The top scoring sketch maps had cartographic errors ranging from 5.23 to 10.02 (See Figures 5.2-5.4). Sketch maps scoring within 95% of the mean scored between 10.099 – 13.44 (See Figures 5.5-5.7). The lowest scoring maps had cartographic errors ranging from 13.57 to 35.41(see Figures 5.8-5.9).

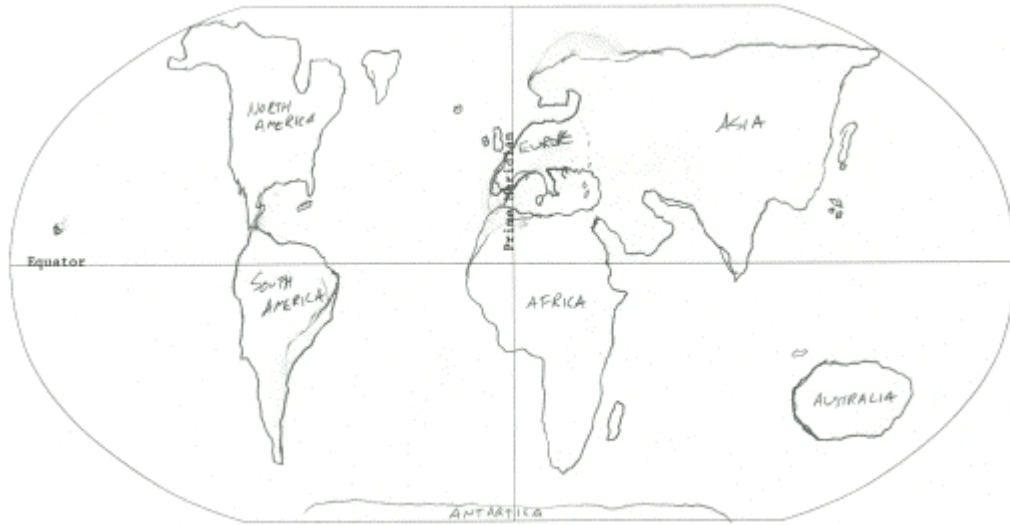


Figure 5.2. Mental Map A

Figure 5.2 displays mental map A, the most accurately drawn mental map in the sample. The map's Mental Map Error is 5.23. MM Location Error is 3.29, and the MM Area Error is 1.94. Europe and Australia are the most inaccurate continents. Most of the error is attributed to Location Error for each continent. The most accurate continents on the map are Asia and North America.



Figure 5.3. Mental Map B

Figure 5.3 displays mental map B, another example of one of the best-sketched maps. The map's Mental Map Error is 5.5. The continents on this map are placed a bit more accurately than mental map A. The MM Location Error is 2.99 and the MM Area Error is 2.51. Antarctica and Europe are the most inaccurately sketched continents. Much of this error is attributed to Area Error. The most accurately placed continents are Africa and South America.

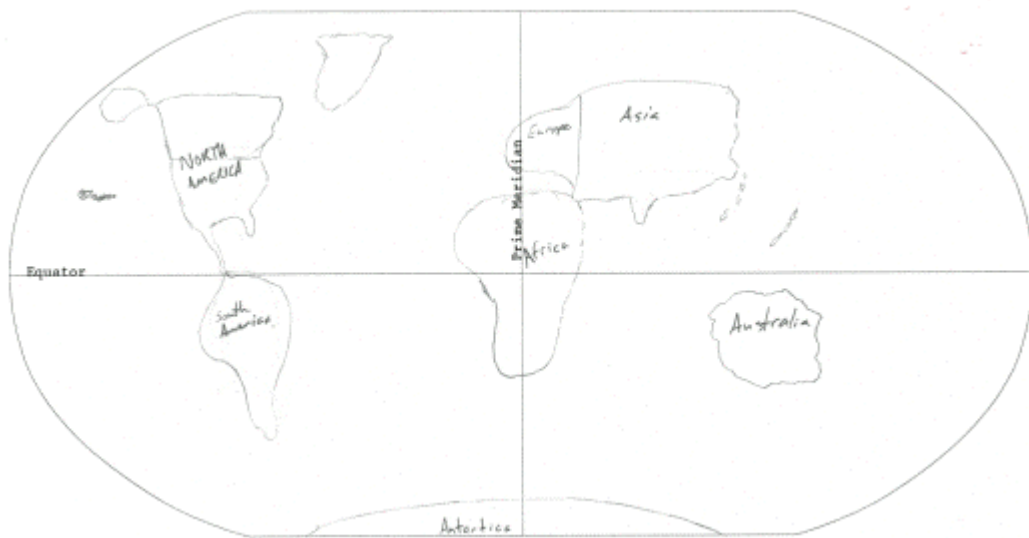


Figure 5.4. Mental Map C

Figure 5.4 shows mental map C, another accurately drawn map. However, the differences between mental maps A and B are clear. The Mental Map Error for the map is 6.8. The MM Location Error is 4.25 and the MM Area Error is 2.55. The most accurate continents drawn are North America, Africa, and Antarctica. The least accurately sketched continents are Australia and South America. Most of this error is attributed to Location Error.



Figure 5.5. Mental Map D

Figure 5.5 displays mental map D, which is an example that rated within 95 % of the mean score. The Mental Map Error is 10.66, MM Location Error is 5.12, and MM Area Error is 5.54. The most inaccurately drawn continents are Antarctica, Australia, and Europe. Most of Antarctica's error is related to its entire misplacement at the North Pole. Europe accounted for about one-fourth of the Mental Map Error, because its size is exaggerated. The only continent that was drawn with a cartographic error of less than 1.0 was Africa.



Figure 5.6. Mental Map E

Figure 5.6 is mental map E, which also scored within 95% of the mean. The map's Mental Map Error is 10.18, MM Location Error is 4.68, and MM Area Error is 5.5. Europe and North America are the most inaccurately drawn continents. Each continent has an Area Error over 1.5 (150%). Asia and Antarctica are the most accurately drawn continents. Each has a cartographic error less than 1.0.

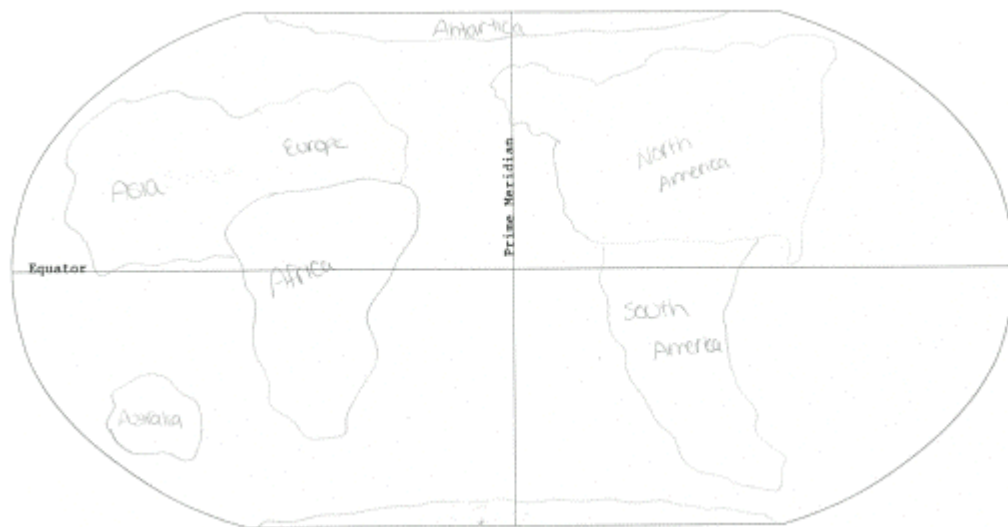


Figure 5.7. Mental Map F

Figure 5.7 is mental map F, a map that scored within 95% of the mean. The Mental Map Error is 11.29, MM Location Error is 7.0, and MM Area Error is 4.29. The Location Error of 7.0 indicates that each continent was completely misplaced. However, the participant did a fair job of drawing the continents to scale. Asia and Australia were the best-drawn continents as each were drawn greater than 85% accurately to scale. North America was the most inaccurately drawn continent, as it occupies most of the northeastern quadrant of the world.

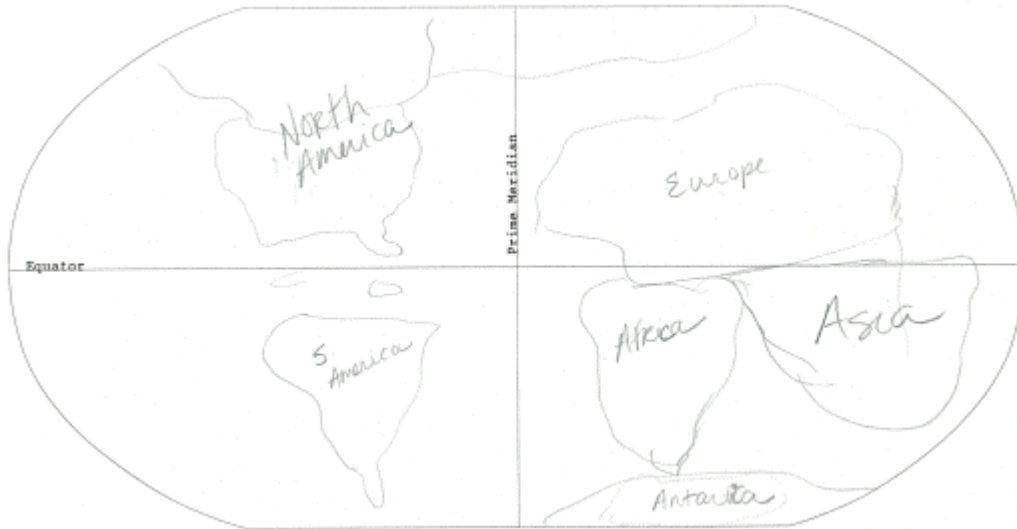


Figure 5.8. Mental Map G

Figure 5.8 shows mental map G, which is one of the maps scoring in the lower 2.5% of the sample. The Mental Map Error is 26.7, the MM Location Error is 5.29, and the MM Area Error is 21.41. The map includes six continents. Australia is excluded. Europe is drawn nearly six times larger than its real area, and North America is drawn 1.66 times too large. Africa and Antarctica are the most misplaced continents.



Figure 5.9. Mental Map H

Figure 5.9 shows mental map H, which scored the highest Mental Map Error in the sample. The next closest scored map was the only map that was missing two continents. Mental map H is missing Asia. The Mental Map Error is 35.59, the MM Location Error is 6.28, and the MM Area Error is 29.31. Europe was drawn twelve times too large, while North America was drawn 2.26 times too large. Africa, Antarctica, and Australia are entirely misplaced. South America is the only continent with a cartographic error less than 1.0.

An interesting pattern emerged regarding the drawing inconsistencies observed for Australia, North America, and Europe. Similar to Saarinen et al.'s findings (1996), Europe and North America's landmasses were the most exaggerated of the seven continents. The mean area error for the seventy-nine participants that drew Europe was 1.87 (187%). The mean Area Error for the eighty participants that drew North American was 1.11 (111%). Europe and North America may have been the most exaggerated in size because they were the more familiar continents to the participants. Student exposure to the Mercator map projection, as noted by Saarinen et al. (1996), may also be a contributing factor.

Australia was the most excluded continent. Six participants did not include the continent on their sketch map. It was also the least-accurately placed continent. Only 12 % of Australia's landmass, on average, was located accurately on the world map. As previously mentioned, this could be related to the lack of media and education coverage Australia receives in the United States. People will not know much about a region if it is not discussed on a regular basis.

Antarctica's Placement

An interesting error committed by 12 (15%) of the participants was the placement of Antarctica at the North Pole (see Figures 5.5, 5.7, and 5.9). After the data were collected and this pattern was observed, participants from Group 1 were asked to offer some thoughts concerning why this occurred. Some responses indicated that participants may have simply confused the location of the North and South poles. However, several students, including two participants who placed Antarctica in the north, explained that this error might have happened because of the United States' relative location in the north. That is, in the United States many

people associate the north with cold weather and ice, while the south is associated with warm and tropical environments. Another explanation may be the lack of attention Antarctica receives in media and education, which results in students being unfamiliar with its location.

Influence of Current Event Knowledge

As mentioned in Chapter Two, current event knowledge is one of many variables influencing mental mapping abilities. This research confirms that a person with a stronger understanding of current event knowledge will, in general, demonstrate better mental mapping abilities. This relationship appears stronger for place location ability than sketch mapping ability.

Current event knowledge significantly correlated with participant performance on each of the cumulative mental mapping ability variables (see Table 4.4). However, when the variables were measured on a continent-by-continent basis the results were different. Regarding place location abilities, current event knowledge influenced the placement of cities in each of the continents except for Asia. The relationship was lowest for Africa and South America, while it was strongest for North America and Europe (see Table 4.5). This inconsistency can be attributed to several things. First, North America and Europe dominated United States news, and they made up most of the questions used to gauge current event knowledge. This allowed the study to assess current event knowledge for these two continents more completely than the other five continents. In addition, regardless of current event knowledge, the attention these areas receive may have influenced participant accuracy due to consistent exposure to the regions.

Current event knowledge had less influence on continent-by-continent sketch mapping abilities than world sketch mapping abilities (see Table 4.6). Knowledge of current events only correlated significantly with cartographic accuracy for Africa. This may be because place location and sketch mapping are entirely two different tasks. As already explained Europe and North America were the most exaggerated continents drawn by the participants. With this in mind, and considering the domination of current events by these two nations, distortions may be related to current event knowledge. That is areas that dominate the media, may dominate the

people's image of the world, thus leading to exaggerations of those areas. Moreover, areas that are not given much attention are more prone to be left out or drawn inaccurately due to the lack of exposure the regions receive. Having an overall grasp on what is going on in the world however does appear to influence the ability to draw an accurate world sketch map.

The strong relationship between current event knowledge and place location abilities is further explained by the results gathered for North America (see Table 4.7). Current event knowledge was clearly related to a participant's ability to accurately place North American cities on the world map. However, current event knowledge was not related to a participant's ability to sketch the continent accurately.

Conclusion

When research for this thesis began, *Geography for Life* had been in circulation for about two years. This thesis indicates how well college students were able to perform the specified tasks without having learned geography according to the standards set forth in *Geography for Life*.

In summary, a person's ability to mentally map the world is related to a person's knowledge of current events. Persons with a grasp of world events demonstrate better place location knowledge and more accurate world sketch mapping abilities. However, the results also reveal that people continue to lack consistent knowledge of regions outside of the United States. Participants in this study displayed place location ignorance for many Eastern European, Asian, and African cities. Their mental sketch maps of the world also reveal geographic illiteracy. Australia, to illustrate, was the most misplaced and excluded continent. In addition, Antarctica was placed in the northern hemisphere on 15 % of the participant sketch maps. These results are alarming.

Lack of global awareness among students in the 1980's alerted the geography and education communities to unite and develop activities and resources to facilitate geography literacy. *Geography for Life* was a major outcome of these efforts.

This thesis offers baseline data that can be used for future research. The results can be employed to compare and study the effects *Geography for Life* has on geography literacy. The performance of the recommended geography skills and tasks at other grade levels should also be assessed and researched. Future researchers could look at the relationship between current event knowledge and the hierarchical structure of place location knowledge. Unlike this study where the participant only placed the city location on the map, future research could ask the participants to identify the continent, the country, and the cartographic location of the city. The results could then be correlated with participant current event knowledge.

The use of Geographic Information Systems (GIS) as a tool to measure mental maps and mental mapping abilities is another area for further study. Researchers could develop GIS tools to study the patterns of shape and position distortion of individual mental maps. GIS would also be useful to better analyze sketch mapping abilities by combining the techniques used in this study with Saarinen and MacCabe's (1995) technique in which the inclusion of significant nations were counted. Each of these measures should lead to more comprehensive analysis of mental mapping skills.

In addition to its utility for future research, the results of this thesis offer implications for current and future educators. Careful use of known teaching strategies and activities can help improve place location knowledge and sketch mapping skills. One recommendation is to have students learn about current events while using a world map. As previously explained, many news stories do not include a map. Those that do, usually use local and regional maps relevant to the event. Therefore, having students use a world map to find and track the locations of significant current events may help improve the understanding of an event's location relative to the entire world and its political boundaries. Another recommended activity is map drawing. As noted by Metz (1990) and Taketa (1996), teaching and practicing sketch mapping are excellent tools for teaching basic map skills and world spatial relations. Lastly, teaching about and using different map projections may also help improve one's awareness of the relative size, shapes, and locations of the seven continents.

In conclusion, this thesis provides useful data about current event knowledge, place location knowledge, and sketch mapping abilities. The results of this thesis and the examination of the recommended areas for future geography research should contribute to the use, awareness, and enrichment of current and future geography education resources.